Amrita Vishwa Vidyapeetham

School of Engineering

Department of Electronics and Communication Engineering

Branch: Electronics and Computer Engineering

Vision of the Department

To provide a value-based learning environment for producing engineers with a blend of technical skills, moral values and leadership qualities in the field of Electronics, Communication and Computing channelized towards technological advancement to cater to the needs of the industry and the society.

Mission of the Department

M1: Achieving excellence in teaching and learning with an emphasis on fundamental knowledge and hands-on exposure to match the state-of-the-art in technology.

M2: Providing an environment for core competency development and enhancing quality research in emerging areas.

M3: Facilitating professional growth to the students for higher education and career in industry and academia.

M4: Imbibing the essence of human values, ethics and professional skills to sustain socio- economic development.

Program Educational Objectives (PEOs)

PEO1: To integrate fundamental knowledge of basic science, mathematics and engineering to work on complex problems in the field of electronics and communication engineering.

PEO2: To promote independent research and continuous learning by providing hands-on exposure in electronics, signal processing and communication domains.

PEO3: To provide a platform to explore and pursue interests in diversified fields for a successful career.

PEO4: To nurture team spirit and leadership qualities with a sense of social responsibility and produce engineers with an ability to integrate engineering and society.

Program Objectives

To understand the

PO1: principles of Electronics

PO2: principles of Electronic System Design

PO3: development of Very Large Scale Integrated Circuits

PO4: principles of Computing & Embedded Systems

PO5: principles of Computer Engineering

Program Specific Outcomes (PSO)

PSO1: To design, develop and prototype Electronic Systems

PSO2: To develop Cyber-Physical & Automated Systems

POS3: To design and develop Embedded Systems

Course Outcome (CO)

Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behavior that students acquire in their progress through the course.

Program Outcomes (POs)

Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behavior that students acquire through the program. National Board for Accreditation (NBA) has defined the program outcomes for each discipline.

Program Outcomes for Engineering

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
Cr	-	Credits
AES	-	Aerospace Engineering
AIE	-	Computer Science and Engineering - Artificial Intelligence
BIO	-	Biology
CCE	-	Computer and Communication Engineering
CHE	-	Chemical Engineering
CHY	-	Chemistry
CSE	-	Computer Science and Engineering
CVL	-	Civil Engineering
CUL	-	Cultural Education
EAC	-	Electronics for Computer Engineering
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
ELC	-	Electrical and Computer Engineering
ENGG	-	Engineering Sciences (including General, Core and Electives)
HUM	-	Humanities (including Languages and others)
IC	-	Integrated Circuit
MAT	-	Mathematics
MEE	-	Mechanical Engineering
MAOM	-	Mastery over Mind
MIMO	-	Multiple Input and Multiple Output
PHY	-	Physics
PRJ	-	Project Work (including Seminars)
SCI	-	Basic Sciences (including Mathematics)
VLSI	-	Very Large Scale Integration

Semester wise Course Details

CURRICULUM

Semester I

Cat.	Code	Title	L T P	Credit
SCI	23ECE101	Nature Inspired Engineering	3 0 0	3
SCI	23MAT124	Engineering Mathematics I	3 1 0	4
ENGG	23ECE102	Problem Solving and Algorithmic Thinking	1 0 3	2
ENGG	23ECE103	Fundamentals of Electrical Engineering	3 0 0	3
SCI	23ECE104	Physics of Semiconductors	3 0 0	3
ENGG	23ECE181	Electrical Engineering Laboratory	0 0 3	1
ENGG	23ENG101	Technical Communication	2 0 3	3
ENGG	22ADM101	Foundations of Indian Heritage	2 0 1	2
HUM	22AVP103	Mastery Over Mind (MAOM)	1 0 2	2
		TOTAL	**29**	**23**

Semester II

Cat.	Code	Title		L T P	Credit
SCI	23MAT130	Engineering Mathematics II		3 1 0	4
ENGG	23ECE105	Computer Programming		3 0 0	3
ENGG	23EAC112	Digital Electronics		3 0 0	3
SCI/ENGG	23ECE114	Network Analysis		3 0 0	3
		23MAT127	Laplace Transforms		
		23ECE115	Circuit Analysis		
ENGG	23EAC111	Computer Hardware and System Essentials		3 0 0	3
ENGG	23ECE184	Introduction to Internet of Things		0 0 3	1
ENGG	23EAC181	Computer Hardware and System Essentials Laboratory		0 0 3	1
ENGG	23EAC182	Digital Electronics Laboratory		0 0 3	1
ENGG	23ECE182	Computer Programming Laboratory		0 0 3	1
HUM	22ADM111	Glimpses of Glorious India		2 0 1	2
		TOTAL		**30**	**22**

Semester III

Cat.	Code	Title		L T P	Credit
ENGG	23CHY109	Engineering Chemistry B		2 1 0	3
ENGG	23EAC201	Electronics Circuits -I		3 0 0	3
ENGG	23EAC202	Signal Processing		3 1 0	4
ENGG	23EAC203	Data Structures and Algorithms		3 1 0	4
SCI/ENGG	23ECE205	Foundations of Data Science		3 1 0	4
		23MAT223	Probability and Statistics		
		23ECE206	Data Processing		
ENGG	23EAC204	Sensors and Instrumentation		3 0 0	3
ENGG	23EAC281	Electronics Circuits -1 Laboratory		0 0 3	1
ENGG	23EAC282	Signal Processing Laboratory		0 0 3	1
ENGG	23EAC283	Data Structures and Algorithms Laboratory		0 0 3	1
HUM		Amrita Value Program 1		1 0 0	1
SCI	23ENV300	Environmental Science			P/F
HUM	23LSE201	Life Skills for Engineers I		1 0 2	P/F
		TOTAL		**34**	**25**

Semester IV

Cat.	Code	Title		L T P	Credit
ENGG	23ECE211	Microcontrollers & Interfacing		3 0 0	3
ENGG	23EAC211	Electronics Circuits II		3 1 0	4
SCI/ENGG	23EAC213	Computer Systems and Architecture		3 0 0	3
ENGG	23EAC212	Electronics System Design and Automation		3 1 0	4
SCI/ENGG	23ECE216	Machine Learning		3 0 0	3
		23MAT218	Optimization Techniques		
		23ECE217	Machine Learning Models		
ENGG	23ECE284	Microcontrollers & Interfacing Laboratory		0 0 3	1
ENGG	23ECE285	Machine Learning Laboratory		0 0 3	1
ENGG	23EAC284	Electronics Circuits –II Laboratory		0 0 3	1
HUM	23LSE211	Life Skills for Engineers II		1 0 2	2
HUM		Amrita Value Program 2		1 0 0	1
HUM	23LAW300	Indian Constitution			P/F
		TOTAL		**31**	**23**

Semester V

Cat.	Code	Title		
ENGG	23ECE313	Embedded Systems	3 0 0	3
ENGG	23ECE302	VLSI Design	3 0 0	3
ENGG	23EAC301	Database Management Systems	3 0 0	3
ENGG	23EAC302	Data Communication and Networks	3 0 0	3
ENGG		Professional Elective I	3 0 0	3
PRJ	23EAC381	Open Laboratory I	0 0 3	1
ENGG	23ECE387	Embedded Systems Laboratory	0 0 3	1
ENGG	23ECE383	VLSI Design Laboratory	0 0 3	1
ENGG	23EAC382	Database Management Systems Laboratory	0 0 3	1
HUM	23LSE301	Life Skills for Engineers III	1 0 2	2
ENGG	23LIV390	Live-in - Lab I		3
		TOTAL [+3]	**31**	**21**

Semester VI

Cat.	Code	Title		
ENGG	23EAC311	Cyber Physical Systems	3 0 0	3
ENGG	23EAC312	Software Engineering	3 0 0	3
ENGG	23EAC313	IoT and Cloud Computing	3 0 0	3
ENGG		Professional Elective II	3 0 0	3
ENGG		Professional Elective III	3 0 0	3
PRJ	23EAC383	Open Laboratory II	0 0 6	2
ENGG	23EAC384	Cyber Physical Systems Laboratory	0 0 3	1
ENGG	23EAC385	IoT and Cloud Computing Laboratory	0 0 3	1
HUM	23LSE311	Life Skills for Engineers IV	1 0 2	2
ENGG	23LIV490	Live-in –Lab II		3
		TOTAL [+3]	**31**	**21**

Semester VII

Cat.	Code	Title	L T P	Credit
ENGG		Professional Elective IV	3 0 0	3
ENGG		Professional Elective V	3 0 0	3
ENGG		Professional Elective VI	3 0 0	3
PRJ	23EAC498	Project Phase I	0 0 24	8
		Free Elective	2 0 0	2
ENGG	23EAC497	Technical Writing		P/F
		TOTAL	**35**	**19**

Semester VIII

Cat.	Code	Title	L T P	Credit
PRJ	23EAC499	Project Phase II	0 0 18	6
		TOTAL	**18**	**6**
		TOTAL CREDITS	**160**	

PROFESSIONAL ELECTIVES

Cyber Physical Systems

Cat.	Code	Title	L T P	Credit
ENGG	23EAC321	Modeling and Analysis of Cyber Physical Systems	3 0 0	3
ENGG	23EAC322	Security and Privacy in Cyber-Physical Systems	3 0 0	3
ENGG	23EAC323	Control Thoery	3 0 0	3
ENGG	23EAC324	Model Predictive Control	3 0 0	3
ENGG	23EAC325	Intelligent Control Systems	3 0 0	3
ENGG	23EAC326	Industrial Process Control	3 0 0	3
ENGG	23EAC327	Industry 4.0 and IIoT	3 0 0	3
ENGG	23EAC328	Robotics for Cyber Physical Systems	3 0 0	3
ENGG	23EAC329	Medical Robotics	3 0 0	3
ENGG	23EAC330	Smart Health Technology	3 0 0	3
ENGG	23EAC331	Estimation and Filtering for Sensor Data Fusion	3 0 0	3
ENGG	23EAC332	Brain Computer Interface	3 0 0	3
ENGG	23EAC333	Wireless Sensor Technology	3 0 0	3

Electronic System Design and Automation

Cat.	Code	Title	L T P	Credit
ENGG	23EAC340	Digital Controller Design and Embedded Systems	3 0 0	3
ENGG	23EAC341	Advanced Microcomputer Systems Design	3 0 0	3
ENGG	23EAC342	Robotics and Automation	3 0 0	3
ENGG	23EAC343	Industrial Automation	3 0 0	3
ENGG	23EAC344	Intelligent Manufacturing and Automation	3 0 0	3
ENGG	23EAC345	ASIC and SOC	3 0 0	3
ENGG	23EAC346	Electronic Packaging	3 0 0	3
ENGG	23EAC347	System Engineering	3 0 0	3
ENGG	23EAC348	Mixed Signal System Design	3 0 0	3
ENGG	23EAC349	Data Acquisition System Design	3 0 0	3
ENGG	23EAC350	Smart Sensor Technology	3 0 0	3
ENGG	23EAC351	Automotive Electronics for Electrical Vehicles	3 0 0	3

VLSI

Cat.	Code	Title	L T P	Credit
ENGG	23ECE331	Analog IC Design	3 0 0	3
ENGG	23ECE332	Digital IC Design	3 0 0	3
ENGG	23ECE333	Functional Verification	3 0 0	3
ENGG	23ECE334	Physical Design of ICs	3 0 0	3
ENGG	23ECE335	Mixed Signal IC Design	3 0 0	3
ENGG	23ECE336	VLSI Testing and Testability	3 0 0	3
ENGG	23ECE337	System on Chip	3 0 0	3
ENGG	23ECE338	VLSI Fabrication Technology	3 0 0	3
ENGG	23ECE339	Semiconductor Memories	3 0 0	3
ENGG	23ECE340	FPGA based System Design	3 0 0	3
ENGG	23ECE341	Hardware Security and Trust	3 0 0	3
ENGG	23ECE342	VLSI System Design	3 0 0	3

Devices and Circuits

Cat.	Code	Title	L T P	Credit
ENGG	23ECE351	Design of ICs for Optical Communication	3 0 0	3
ENGG	23ECE352	Optoelectronic Integrated Circuit Design	3 0 0	3
ENGG	23ECE353	Optoelectronic Materials and Devices	3 0 0	3
ENGG	23ECE354	Radio Frequency Integrated Circuits	3 0 0	3
ENGG	23ECE355	IC Design for Sensor Systems	3 0 0	3
ENGG	23ECE356	Microelectromechanical Devices	3 0 0	3
ENGG	23ECE357	Energy Harvesting Technologies and Circuits	3 0 0	3
ENGG	23ECE358	FinFET Technology	3 0 0	3
ENGG	23ECE359	Nanoelectronics	3 0 0	3
ENGG	23ECE360	Energy Materials	3 0 0	3
ENGG	23ECE361	Thin Electronics Films	3 0 0	3

Embedded Systems

Cat.	Code	Title	L T P	Credit
ENGG	23ECE431	Operating Systems	3 0 0	3
ENGG	23ECE432	Real Time Systems	3 0 0	3
ENGG	23ECE433	MIPS Architecture	3 0 0	3
ENGG	23ECE434	Parallel and Pipelined based Computer Architecture	3 0 0	3
ENGG	23ECE435	Parallel Computing	3 0 0	3
ENGG	23ECE436	Embedded Systems for Robotics	3 0 0	3
ENGG	23ECE437	Multicore Architecture	3 0 0	3
ENGG	23ECE438	Embedded Automotive Systems	3 0 0	3
ENGG	23ECE439	Real Time Operating Systems	3 0 0	3
ENGG	23ECE440	FPGA based Embedded Systems	3 0 0	3

Signal Processing

Cat.	Code	Title	L T P	Credit
ENGG	23ECE441	Agent Based Modeling	3 0 0	3
ENGG	23ECE442	Computer Vision	3 0 0	3
ENGG	23ECE443	Biomedical Signal Processing	3 0 0	3
ENGG	23ECE444	Natural Language Processing	3 0 0	3
ENGG	23ECE445	AI in Speech Signal Processing	3 0 0	3
ENGG	23ECE446	Image Processing	3 0 0	3
ENGG	23ECE447	Multirate Signal Processing and Wavelets	3 0 0	3
ENGG	23ECE448	Statistical Signal Processing	3 0 0	3
ENGG	23ECE449	Adaptive Signal Processing	3 0 0	3

Common Electives

Cat.	Code	Title	L T P	Credit
ENGG	23ECE450	Deep Learning	3 0 0	3
ENGG	23ECE451	Reinforcement Learning	3 0 0	3
ENGG	23ECE452	Internet of Things	3 0 0	3
ENGG	23ECE453	Blockchain Technology	3 0 0	3
ENGG	23ECE454	Understanding ICT Standardisation: Principles and Practices	3 0 0	3
ENGG	23ECE455	Robotics System Design	3 0 0	3

Other Electives

Cat.	Code	Title	L	Credit
ENGG	23ECE461	Software Defined Networks	3 0 0	3
ENGG	23ECE462	Information Security	3 0 0	3
ENGG	23ECE463	Neuroengineering	3 0 0	3
ENGG	23ECE464	Control Systems	3 0 0	3
ENGG	23ECE465	Computer Networks and Protocols	3 0 0	3
ENGG	23ECE466	Cellular Mobile Communications	3 0 0	3
ENGG	23ECE467	Information Theory and Coding	3 0 0	3
ENGG	23ECE468	Signal Estimation and Detection	3 0 0	3
ENGG	23ECE469	Wireless Local Area Networks	3 0 0	3
ENGG	23ECE470	Performance Evaluation of Networks and Computing Systems	3 0 0	3
ENGG	23ECE471	Quantum Information Theory	3 0 0	3
ENGG	23ECE472	Remote Sensing Systems	3 0 0	3
ENGG	23ECE473	Physical Chemistry of Materials and Processes	3 0 0	3
ENGG	23ECE474	Vehicular Communication and Networks	3 0 0	3
ENGG	23ECE475	Automotive Systems	3 0 0	3
ENGG	23ECE476	Electric Vehicles	3 0 0	3

Evaluation Pattern

Assessment Component	Weightage	
	Theory and Lab Integrated Theory Courses	Lab Courses (LTP: 0 0 X //1 0 X)
Continuous Assessment	30	40
Mid Term Exam	30	20
End Sem/Project	40	40

- Continuous assessment can be quiz/assignment/mix of quiz and assignment totaling up to four (4)

List of courses in Amrita Value Programme I & II			
Course Code	Title	L-T-P	Credits
22ADM201	**Strategic Lessons from Mahabharatha**	**1-0-0**	**1**
22ADM211	**Leadership from Ramayana**	**1-0-0**	**1**
22AVP210	**Kerala Mural Art and Painting**	**1-0-0**	**1**
22AVP218	**Yoga Therapy and Lessons**	**1-0-0**	**1**
22AVP212	**Introduction to Traditional Indian Systems of Medicine**	**1-0-0**	**1**
22AVP201	**Amma's Life and Message to the modern world**	**1-0-0**	**1**
22AVP204	**Lessons from the Upanishads**	**1-0-0**	**1**
22AVP205	**Message of the Bhagavad Gita**	**1-0-0**	**1**
22AVP206	**Life and Message of Swami Vivekananda**	**1-0-0**	**1**
22AVP207	**Life and Teachings of Spiritual Masters of India**	**1-0-0**	**1**
22AVP208	**Insights into Indian Arts and Literature**	**1-0-0**	**1**
22AVP213	**Traditional Fine Arts of India**	**1-0-0**	**1**
22AVP214	**Principles of Worship in India**	**1-0-0**	**1**
22AVP215	**Temple Mural Arts in Kerala**	**1-0-0**	**1**
22AVP218	**Insights into Indian Classical Music**	**1-0-0**	**1**
22AVP219	**Insights into Traditional Indian Painting**	**1-0-0**	**1**
22AVP220	**Insights into Indian Classical Dance**	**1-0-0**	**1**
22AVP221	**Indian Martial Arts and Self Defense**	**1-0-0**	**1**
22AVP209	**Yoga and Meditation**	**1-0-0**	**1**

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY				
Cat.	**Course Code**	**Title**	**L T P**	**Credit**
SCI	**23CHY240**	**Computational Chemistry and Molecular Modelling**	**3 0 0**	**3**
SCI	**23CHY241**	**Electrochemical Energy Systems and Processes**	**3 0 0**	**3**
SCI	**23CHY242**	**Fuels and Combustion**	**3 0 0**	**3**
SCI	**23CHY243**	**Green Chemistry and Technology**	**3 0 0**	**3**
SCI	**23CHY244**	**Instrumental Methods of Analysis**	**3 0 0**	**3**
SCI	**23CHY245**	**Batteries and Fuel Cells**	**3 0 0**	**3**
SCI	**23CHY246**	**Corrosion Science**	**3 0 0**	**3**
PHYSICS				
SCI	**23PHY240**	**Advanced Classical Dynamics**	**3 0 0**	**3**
SCI	**23PHY241**	**Electrical Engineering Materials**	**3 0 0**	**3**
SCI	**23PHY242**	**Physics of Lasers and Applications**	**3 0 0**	**3**
SCI	**23PHY243**	**Concepts of Nanophysics and Nanotechnology**	**3 0 0**	**3**
SCI	**23PHY244**	**Physics of Semiconductor Devices**	**3 0 0**	**3**
SCI	**23PHY245**	**Astrophysics**	**3 0 0**	**3**
Mathematics				
SCI	**23MAT240**	**Statistical Inference**	**3 0 0**	**3**
SCI	**23MAT241**	**Introduction to Game Theory**	**3 0 0**	**3**
SCI	**23MAT242**	**Numerical Methods and Optimization**	**3 0 0**	**3**

FREE ELECTIVES

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM				
Cat.	Course Code	Title	L T P	Credit
HUM	23MNG331	Financial Management	3 0 0	3
HUM	23MNG332	Supply Chain Management	3 0 0	3
HUM	23MNG333	Marketing Management	3 0 0	3
HUM	23MNG334	Project Management	3 0 0	3
HUM	23MNG335	Enterprise Management	3 0 0	3
HUM	23MNG336	Operations Research	3 0 0	3
HUM	23MEE321	Industrial Engineering	3 0 0	3
HUM	23MEE322	Managerial Statistics	3 0 0	3
HUM	23MEE323	Total Quality Management	3 0 0	3
HUM	23MEE324	Lean Manufacturing	3 0 0	3
HUM	23CSE321	Software Project Management	3 0 0	3
HUM	23CSE322	Financial Engineering	3 0 0	3
HUM	23CSE323	Engineering Economic Analysis	3 0 0	3
HUM	23CSE324	Information Systems	3 0 0	3

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS				
Cat.	Course Code	Title	L T P	Credit
HUM	23CUL230	Achieving Excellence in Life - An Indian Perspective	2 0 0	2
HUM	23CUL231	Excellence in Daily Life	2 0 0	2
HUM	23CUL232	Exploring Science and Technology in Ancient India	2 0 0	2
HUM	23CUL233	Yoga Psychology	2 0 0	2
HUM	23ENG230	Business Communication	1 0 3	2
HUM	23ENG231	Indian Thought through English	2 0 0	2
HUM	23ENG232	Insights into Life through English Literature	2 0 0	2
HUM	23ENG233	Technical Communication	2 0 0	2
HUM	23ENG234	Indian Short Stories in English	2 0 0	2
HUM	23FRE230	Proficiency in French Language (Lower)	2 0 0	2
HUM	23FRE231	Proficiency in French Language (Higher)	2 0 0	2
HUM	23GER230	German for Beginners I	2 0 0	2
HUM	23GER231	German for Beginners II	2 0 0	2
HUM	23GER232	Proficiency in German Language (Lower)	2 0 0	2
HUM	23GER233	Proficiency in German Language (Higher)	2 0 0	2
HUM	23HIN230	Hindi I	2 0 0	2
HUM	23HIN231	Hindi II	2 0 0	2
HUM	23HUM230	Emotional Intelligence	2 0 0	2
HUM	23HUM231	Glimpses into the Indian Mind - the Growth of Modern India	2 0 0	2
HUM	23HUM232	Glimpses of Eternal India	2 0 0	2
HUM	23HUM233	Glimpses of Indian Economy and Polity	2 0 0	2
HUM	23HUM234	Health and Lifestyle	2 0 0	2
HUM	23HUM235	Indian Classics for the Twenty-first Century	2 0 0	2
HUM	23HUM236	Introduction to India Studies	2 0 0	2
HUM	23HUM237	Introduction to Sanskrit Language and Literature	2 0 0	2
HUM	23HUM238	National Service Scheme	2 0 0	2
HUM	23HUM239	Psychology for Effective Living	2 0 0	2

HUM	23HUM240	Psychology for Engineers	2 0 0	2
HUM	23HUM241	Science and Society - An Indian Perspective	2 0 0	2
HUM	23HUM242	The Message of Bhagwat Gita	2 0 0	2
HUM	23HUM243	The Message of the Upanishads	2 0 0	2
HUM	23HUM244	Understanding Science of Food and Nutrition	2 0 0	2
HUM	23HUM245	Service Learning	2 0 0	2
HUM	23JAP230	Proficiency in Japanese Language (Lower)	2 0 0	2
HUM	23JAP231	Proficiency in Japanese Language (Higher)	2 0 0	2
HUM	23KAN230	Kannada I	2 0 0	2
HUM	23KAN231	Kannada II	2 0 0	2
HUM	23MAL230	Malayalam I	2 0 0	2
HUM	23MAL231	Malayalam II	2 0 0	2
HUM	23SAN230	Sanskrit I	2 0 0	2
HUM	23SAN231	Sanskrit II	2 0 0	2
HUM	23SWK230	Corporate Social Responsibility	2 0 0	2
HUM	23SWK231	Workplace Mental Health	2 0 0	2
HUM	23TAM230	Tamil I	2 0 0	2
HUM	23TAM231	TAMIL II	2 0 0	2

SEMESTER I

23ECE101	Nature Inspired Engineering (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide an understanding of nature from an engineering perspective
- To enable the study of engineering systems inspired by nature
- To motivate the development of technological ideas based on nature

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the principles of systems in nature
CO2: understand engineering principles that are derived from nature
CO3: identify and ideate technological concepts inspired by nature
CO4: apply the concepts learnt to address simple engineering problems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						1					1			
CO2	3	2					1					1			
CO3	2	3					1					2			
CO4	2	3					1					2			

Syllabus

The course will consist of discussions of case studies, broadly classified into three groups of a minimum of 5 each:

Unit 1
Introduction – Biological inspiration; Common characteristics of natural and engineered systems; Examples - Bullet train shape / Kingfisher's beak (helping to reduce aerodynamic stress); Beehive structure (evaporative cooling and natural ventilation); Whale fin structure / Wind turbine blades (role of tubercules); Velcro tape / Hooks and loops (plants); Golden ratio in nature / Fibonacci numbers (ratio of dimensional properties)

Unit II
Biomimetics – Mimicking nature; Examples **-** Gene Therapy / Immunotherapy; Dam / Beavers (structural engineering); Aerodynamics / Flight / Birds (Wings, heavier-than-air flight, Humming Bird); Earthworm / Self-Cleaning by means of small electric currents; Lizards / locomotion (inter-atomic bonding); Lizards – change in direction of hair, with no stickiness / Scotch tape; Bones / Material shaping

Unit III
Bio-inspired Innovations **-** Control Theory / Feedback / Biomechanisms; Digital Electronics / Human logic; Echolocation / Dolphins / Bats (echolocation); Artificial Intelligence / Neural Networks;

Textbooks:

1. Biomimicry: Innovation Inspired by Nature: Benyus J P, Mariner Books, 2002; ISBN **9780060533229.**
2. The Shark's Paintbrush: Biomimicry and How Nature is Inspiring Innovation: Harman J., White Cloud Press, 2013; ISBN 978-1935952848
3. Biomimicry Innovation Inspired by Nature, Matheney B., 2023

References:

1. Engineering Education for the Next Generation – A Nature–Inspired Approach: Stier S C., W W Norton & Co., 2020; ISBN 978-0393713770
2. Biomimicry: When Nature Inspires Amazing Inventions: Menu S, Walker E & Waters A, Triangle Square Publishers, 2020; ISBN 1644210185

Other resources:
1. https://tinyurl.com/Janine-01
2. https://tinyurl.com/Pawlyn-01
3. https://tinyurl.com/Biomimicry-01
4. https://asknature.org/

23MAT124	Engineering Mathematics-I (**Pre-requisite:** Nil)	L-T-P-C: 3-1-0-4

Course Objectives

- To strengthen the concepts of single variable calculus and linear ODEs
- To provide the fundamentals of matrix algebra
- To introduce the concepts and importance of Eigen values and Eigen vectors

Course Outcomes: At the end of the course, the student should be able to

CO1: solve problems involving limits, derivatives and ODEs
CO2: model and solve system of linear equations
CO3: characterize systems using Eigen values and vectors
CO4: apply the mathematical concepts learnt, to engineering problems

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	3											1			
CO2	3	2										2			
CO3	3	2										1			
CO4	3	2										2			

Syllabus

Unit I
Calculus: Limit and Continuity: Limit of Functions, Continuous functions, Discontinuities, Monotonic Functions, Infinite Limits; Derivatives, Integration- Definite Integrals, Mean value theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques. Examples of applications of the above in solving real engineering problems.

Unit II
Differential Equations: Ordinary differential equations (ODE), Linear differential equations, Modelling problems: Electric circuits; Second order Differential Equations, Homogeneous Systems and Non-homogeneous with constant coefficients, System of ODEs, Basic concepts and theory; Examples of applications of the above in solving real engineering problem.

Unit III
Matrix Algebra: Review - System of linear Equations, linear independence; Properties of Matrices, Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal matrices; Eigen values and Eigen vectors; Positive definite, negative definite and indefinite, Diagonalization and Orthogonal Diagonalization; Examples of applications of the above in solving real engineering problem.

Textbook(s)

1. E Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, Tenth Edition, 2018.
2. Srimanta Pal and Subhodh C Bhunia ‘Engineering Mathematics’, John Wiley and Sons, 2012, Ninth Edition.

Reference(s)

1. Monty J. Strauss, Gerald J. Bradley and Karl J. Smith ‘Calculus’, **3rd Edition, 2002.**
2. Dennis G. Zill and Michael R.Cullen, Advanced Engineering Mathematics by, second edition, CBS Publishers, 2012.

23ECE102	Problem Solving and Algorithmic Thinking (**Pre-requisite:** Nil)	L-T-P-C: 1-0-3-2

Course Objectives

- To provide insight into computational logic
- To introduce the fundamentals of computational thinking
- To introduce computational approach to problem solving

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concepts of computational logic
CO2: develop algorithmic thinking
CO3: identify algorithms and their suitability
CO4: apply algorithms to solve a problem

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2											3			
CO2	2											2			
CO3	2	2										2			
CO4	3	2										2			

Syllabus

Unit I
Introduction -Computational thinking, corner stones of computational thinking; characteristics of algorithms; problem solving strategies, computational logic, Boolean expressions and logic, data organization, variables, list, arrays and strings.

Unit II

Algorithmic thinking – name binding, sequence, selection, repetition and modularization; Modeling tools-state diagrams, pseudocodes and flowcharts – code tracing - problem solving with algorithms – merging, searching, sorting and recursions-brute force and greedy algorithms

Unit III

Introduction to analysis of algorithms - Algorithmic complexity, linear, logarithmic and exponential computational complexity – Introduction to Python programming.

Textbook(s)

1. Riley DD, Hunt KA. Computational Thinking for the Modern Problem Solver. CRC press; 2014 Mar 27.

Reference(s)

1 . Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018.

2 . Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.

Lab Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:
Develop logic/flow chart/algorithm for a multifunctional calculator.

Model different circuit topologies with dependent sources and analyze resulting voltage and current sources.

Experiment Contents:

1. Familiarization with flowgorithm
2. Visualization of logical flow in flowgorithm using addition and subtraction of two numbers.
3. Exposure to various formatting methods using problems on addition, subtraction, calculation of area of circle and identification of odd even numbers.
4. Arithmetic operations on vectors and matrices.
5. Solving Quadratic equations and generation of Fibonacci numbers
6. Modelling Simple resistive circuits
7. Use of arrays in solving problems.
8. Familiarization with strings.
9. Searching (linear and binary)
10. Sorting (bubble sort, insertion sort and selection sort)
11. Modelling circuits with dependent sources.

Textbook(s)

1. Gaddis, Tony. Starting Out with Programming Logic and Design, 5/e. Pearson Education India, 2021.

Reference(s)

1. Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018.
2. Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.

23ECE103	**Fundamentals of Electrical Engineering** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide an understanding of fundamental electrical quantities and their measurements
- To help in the use of analytical tools for circuit analysis
- To provide an understanding of electromagnetic machines

Course Outcomes: At the end of the course, the student should be able to

CO1: understand fundamental electrical quantities
CO2: understand the principles of electrical measurements
CO3: analyse ac and dc circuits
CO4: understand the operation of electromagnetic machines

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2	3	2										2			
CO3	3	3										2			
CO4	3														

Syllabus

Unit I

Introduction: ac, dc, Voltage, Current and Power, Current and Voltage sources, Dependent and Independent; Resistance, Inductance (self & Mutual), Capacitance, Series and parallel combination of R, L, C components, Wheatstone's bridge. Power and Energy - Alternating voltage and current, Amplitude, phase, Average and RMS values of waveforms. Complex power, Power factor for purely resistive, RL, RC and RLC circuits.

Unit II

AC and DC circuit Analysis – Ohm's law, Kirchhoff's voltage and Current law, Voltage divider and Current divider Rule, star delta transformation, Mesh and Nodal Analysis, Source transformation, Superposition Theorem, Thevenin & Norton's Theorems, and Maximum power transfer theorem.

Unit III
Electrical Machines – Construction, Principle of operation and applications, DC generator and DC Motors. Significance of back EMF and EMF equation. Types of DC motors, Speed, Torque, Torque-Speed characteristics, Load characteristics, Construction and working principles of three phase induction motor and single phase transformer..

Textbook(s)
1. Charles K,Alexander, Mattew N.O.Saidiku, Fundamentals of Electrical Circuits by Tata McGraw Hill company
2. D.P. Kothari and Nagrath "Electrical Machines", McGraw Hill 2017

Reference(s)
1. Vincent DelToro, "Electrical engineering Fundamentals", PHI second edition 2011
2. S. K. Bhattcharya, "Basic Electrical and Electronics Engineering", Pearson, 2012.

23ECE104	**Physics of Semiconductors** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide an understanding of crystal structure
- To help appreciate the band gap nature of semiconductors
- To introduce the concepts of transport phenomena in semiconductors

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the crystal structure of semiconductors
CO2: understand semiconductors based on energy band gap
CO3: understand current flow in semiconductors
CO4: understand the behaviour of PN junctions & MOSFETs

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											1			
CO2	3											1			
CO3	3											1			
CO4	3											2			

Syllabus

Unit I
Crystal structures - Crystal lattice, basis, unit cell and lattice parameters, crystal systems and Bravais lattices – Structure and packing fractions of SC, BCC, FCC, diamond cubic, NaCL; ZnS structures – crystal planes, directions and Miller indices, Imperfections in crystals.

Unit II
Classical free electron theory - Expression for electrical conductivity, Thermal conductivity, expression - Quantum free electron theory; Tunneling – degenerate states, Fermi- Dirac statistics, Density of energy states, Energy bands in solids; Electron effective mass – concept of hole Intrinsic Semiconductors, Energy band diagram, direct and indirect band gap semiconductors; Carrier concentration in intrinsic and extrinsic semiconductors – Variation of carrier concentration with temperature,; Carrier transport in Semiconductors- Drift, mobility and diffusion, Hall effect.

Unit III
Basic structure of PN junctions – Built-in-potential, Space Charge region, electric field across junction, Forward and reverse bias, band diagram, minority carrier distribution across junction in forward and reverse bias, boundary conditions; Basics of MOSFET – Structure of MOSFET, band diagram of MOS, Ideal MOS Capacitor, FET operation and their applications.

Textbook(s)

1. R.F.Pierret. Semiconductor Device Fundamentals. Pearson (Indian Edition), 2006.
2. Donald Neeman, Semiconductor physics and devices, Basic principles, McGraw-Hill International, 3 Edition.

Reference(s)

1. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
2. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Education (Indian Edition), 2019.
3. Steetman and Banerjee, Solid State Electronic Devices, PHI, 2014

23ECE181	**Electrical Engineering Laboratory** (**Pre-requisite:** Nil)	**L-T-P-C: 0-0-3-1**

Course Objectives

- To provide hands-on experience of identifying electrical components and their specifications
- To help understand circuit theorems using practical circuits and measurements
- To demonstrate the principles of electrical machines

Course Outcomes: At the end of the course, the student should be able to

CO1: identify electrical components and their specifications
CO2: measure electrical quantities such as voltage and current
CO3: verify theorems for dc circuits
CO4: understand the operation of electrical machines

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3								2	2		1			
CO2	3								2	2		1			
CO3	3								2	2					
CO4	3								2	2					

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:
Design a circuit to validate most of the theorems listed in the experiment contents by changing the loads (appliances such as different power rating of lamp or others)

- Design Wheatstone bridge and modify one arm with one unknown resister (like sensor) and find the required load.

Experiment Contents:

1. Identification of electrical components and their specifications.
2. Familiarization of equipments like Multimeter, Function generator, DC Power supply and DSO, etc.
3. Verification of Kirchhoff's laws.
4. Verification of Superposition theorem
5. Verification of Thevenin and Norton theorems
6. Speed control of a D.C motor.
7. Single phase transformers – turns ratio measurement, Step down/up
8. Measurement of unknown resistance using Wheatstone bridge.
9. System Development (**Mandatory**)

Textbook(s)

1. Hughes, Electrical & Electronic Technology, Pearson Education India, 2010.
2. D. P. Kothari and I. J. Nagrath, Electrical Machines, Tata McGraw-Hill, 2017

Reference(s)

1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd, 2011
2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Education India, 2015

23ENG101	Technical Communication (Pre-requisite-NilL)	L-T-P-C: 2-0-3-3

Course Objectives

- To develop techniques of scanning for specific information, comprehension and organization of ideas
- To introduce the fundamentals of mechanics of formal writing, documentation and presentation
- To introduce the art of critical thinking and analysis

Course Outcomes: At the end of the course, the student should be able to

CO1: apply the basic elements of language in formal correspondence by interpreting and analyzing information and to organize ideas in a logical and coherent manner
CO2: understand and summarize technical documents
CO3: understand the mechanics of writing and the elements of formal correspondence
CO4: compose project reports/documents, revise them for language accuracy and make technical presentations

CO-PO Mapping

CO-PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1									2	3		3			
CO2									2	2		3			
CO3									2	3		3			
CO4									2	2		3			

Syllabus

Unit I
Error Analysis**,** Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal) prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers and sentence linkers, impersonal passive, modifiers, phrasal verbs, General Reading and Listening comprehension - rearrangement & organization of sentences

Unit II
Different kinds of written documents: Definitions- Descriptions- Instructions-Recommendations- User manuals - Reports – Proposals; Formal Correspondence: Writing Formal Letters/Emails; Punctuation; Scientific Reading & Listening Comprehension

Unit III
Technical paper writing: Documentation style - Document editing – Proof reading - Organizing and Formatting; Tone and style; Graphical representation; Reading and listening comprehension of technical documents; Mini Technical project / Term paper (10 -12 pages); Technical presentations

Reference(s)

1. Hirsh, Herbert. L Essential Communication Strategies for Scientists, Engineers and Technology Professionals. II Edition. New York: IEEE press, 2002
2. Anderson, Paul. V. Technical Communication: A Reader-Centred Approach. V Edition. Harcourt Brace College Publication, 2003
3. Strunk, William Jr. and White. EB. The Elements of Style New York. Alliyan & Bacon, 1999.
4. Riordan, G. Daniel and Pauley E. Steven. Technical Report Writing Today VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.
5. Michael Swan. Practical English Usage Oxford University Press, 2000

22ADM101 **Foundations of Indian Heritage** **L-T-P-C: 2-0-1-2**

Course Objectives

- To study fundamental concepts of Indian Heritage
- To discuss the cultural, philosophical, and historical facets of India
- To familiarize eternal and all-pervading nature of India’s cultural and spiritual ethos

Course Outcomes: At the end of the course, the student should be able to

CO1: understand true essence of India’s cultural and spiritual heritage
CO2: understand the ethical and political strategic concepts to induce critical approach to various theories about India.
CO3: get familiarized with the multidimension of man’s interaction with nature, fellow beings and society in general.
CO4: appreciate the socio-political and strategic innovations based on Indian knowledge systems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				2				2							
CO2		1				1	1	3							
CO3						1	2	3							
CO4	3					3	3	3							

Syllabus
Unit I
Introduction - Educational Heritage of Ancient India- Life and Happiness- Impact of Colonialism and Decolonization- A timeline of Early Indian Subcontinent

Unit II
Pinnacle of Selflessness and ultimate freedom- Indian approach towards life- Indian Mahatmas.

Unit III

Man's association with Nature- Metaphors and Tropes- Indian approach towards strategic thinking- India: In the Views of Other Scholars and Travellers- Personality Development Through Yoga- Hallmark of Indian philosophical tradition- Conversations on Compassion with Amma

Textbook(s)

Foundations of Indian Heritage, Amrita Vishwa Vidyapeetham (University publication)

Reference(s)

1. Aurobindo, “Foundations of Indian Culture”, The Sri Aurobindo Library Inc., 1953.
2. Basham A. L., “The wonder that was India”, Sidwick and Jackson, 1954.
3. Sai Deepak J., “India, that is Bharat: Coloniality, Civilisation, Constitution”, Bloomsbury, 2021.

22AVP103	Mastery Over Mind	L-T-P-C: 1-0-2-2

Course Objectives

- To enhance health and wellbeing of all faculty, staff, and students (UN SDG -3).
- To manage stressful emotions and anxiety, in turn facilitating inner peace and harmony.
- To enhance the understanding of experiential learning based on the University's mission: "Educationfor Life along with Education for Living" and is aimed to allow learners to realize and rediscoverthe infinite potential of one's true Being and the fulfilment of life's goals.

Course Outcomes: At the end of the course, the student should be able to

CO1: describe what meditation is and to understand its health benefits.
CO2: understand the causes of stress and how meditation improves well-being.
CO3: understand the science of meditation.
CO4: learn and practice MA OM meditation in daily life.
CO5: understand the application of meditation to improve communication and relationships.
CO 6: understand the power of meditation in compassion-driven action.

CO-PO Mapping

PO/ PSO CO	PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO10	PO1 1	PO1 2	PSO 1	PSO2
CO1								1	2	2		2		
CO2			2		2				2	2		2		
CO3					2			2	2	2		2		
CO4			3		3		2	3	3	3		3		
CO5			2		2			2	2	3		3		
CO6			2					2	2	2		2		

Syllabus

The course syllabus will be covered in six units as described below

Unit 1: Describe Meditation and Understand its Benefits (CO1)

A: Importance of meditation. How does meditation help to overcome obstacles in life (Pre-recorded video with Swami Shubhamritananda Puri)

Reading 1: Why Meditate? (Swami Shubamritananda ji)

Reading 2: 'Stillness of the Mind' Chapter 17 in Amritam Gamaya (2022). MataAmritanandamayi Mission Trust.

Additional Reading: Abhyasa Yoga: The Yoga of Practice. (Br. Achyutamrita Chaitanya)

B: Understand how meditation works. Understand how meditation helps in improvingphysical and mental health. Understand how meditation helps in the development of personality *(Pre-recorded video with Dr. Ram Manohar)*
Reading 1: Allen, Cynthia (2020) The Potential Health Benefits of Meditation
Additional Reading: Sharma, Hari (2022) Meditation: Process and Effects

Unit 2: Causes of Stress and How Meditation Improves Well-being (CO2)

A: Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced dietin supporting meditation. (Pre-recorded video with Dr. Ram Manohar)

B: Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to relieve stress. Basics of stress management at home and the workplace. (Pre-recorded video with Prof Udhaykumar)

Reading 1: Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress. Mayo Clinic. https://www.mayoclinic.org/tests-procedures/meditation/in-depth/meditation/art-20045858 (PDF provided)

Reading 2: 'Efficient Action.' Chapter 28 in Amritam Gamaya (2022). MataAmritanandamayi Mission Trust.

Unit 3: The Science of Meditation (CO3)

A: A preliminary understanding of the Science of meditation. What can modern science tell us about this tradition-based method? (Pre-recorded video with Dr. Shyam Diwakar)

B: How meditation helps humanity according to what we know from scientific research (Pre-recorded video with Dr. Shyam Diwakar)

Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)

Reading 2: 'Science and Spirituality.' Chapter 85 in Amritam Gamaya (2022). MataAmritanandamayi Mission Trust.

Unit 4: Practicing MA OM Meditation in Daily Life (CO4)

Guided Meditation Sessions following scripts provided (Level One to Level Five)

Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami AtmanandaPuri)

Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). MataAmritanandamayi Mission Trust.

Unit 5: Improving Communication and Relationships (CO5)

How meditation and mindfulness influence interpersonal communication. The role of meditation in improving relationship quality in the family, at the university and in theworkplace. (Pre-recorded video with Dr Shobhana Madhavan)

Reading 1: Seppala E (2022, June 30th) 5 Unexpected Ways Meditation Improves Relationships a Lot. Psychology Today. https://www.psychologytoday.com/intl/blog/feeling-it/202206/5-unexpected-ways-meditation-improves-relationships-lot

Reading 2: 'Attitude.' Chapter 53 in Amritam Gamaya (2022). Mata AmritanandamayiMission Trust.

Unit 6 Meditation and Compassion-driven Action (CO6)

Understand how meditation can help to motivate compassion-driven action. (Pre-recorded video with Dr Shobhana Madhavan)

Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocialbehavior: What do we (not) know? Current Opinion in Psychology, 44, 151-156.

Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). MataAmritanandamyi Mission Trust.

Text Books/Reference Books:

1. Meditation and Spiritual Life-Swami Yatiswarananda, Ramakrishna Math
2. The Complete Works of Swami Vivekananda Vol Vii by Advaita Ashram Mayavati Almora Himalayas
3. Dhyana Yoga-Holy Gita Swami Chinmayanda
4. Voice of God, Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
5. Hindu Dharma-Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
6. Mind: It's Mysteries and control-Swami Sivananda Saraswati
7. Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.
8. Books on Amma's teachings like Awaken children, From Amma's Heart etc.
9. The Science of Meditation: How to Change Your Brain, Mind and Body by Daniel Goleman and Richard. J. Davidson.

10.Allen, Cynthia (2020) The Potential Health Benefits of Meditation
11. Seppala E (2022, June 30th Unexpected Ways Meditation Improves Relationships a Lot.Psychology Today
12. Sharma, Hari (2022) Meditation: Process and Effects
13. Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress.
14. Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: What do we (not) know? Current Opinion in Psychology, 44, 151-156

SEMESTER II

23MAT130	Engineering Mathematics –II (Pre-requisite – Engineering Mathematics-I)	L-T-P-C: 3-1-0-4

Course Objectives

- To introduce the concepts of multivariable calculus
- To introduce the concepts of vector space and inner products
- To provide the foundations of matrix transformations and decompositions

Course Outcomes: At the end of the course, the student should be able to

CO1: solve problems involving vector differentiation and integration
CO2: understand the concepts of vector spaces and orthonormalisation
CO3: apply matrix transformations to linear system
CO4: apply concepts of vector calculus and linear algebra to engineering problems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											1			
CO2	3											1			
CO3	3	2										1			
CO4	3	2										2			

Syllabus

Unit I
Vector Spaces - Vector spaces, subspaces, linear independence, basis, row, column and null spaces and dimension theorem. Inner product space, orthogonally, Gram-Schmidt orthogonalization. Linear Transformation (matrix transformation) and inverse linear transformation; Matrix Decompositions: LU, QR, Jordan, EVD, and SVD decompositions. Examples of applications of the above in solving real engineering problems.

Unit II
Vector Differentiation- Vector and Scalar Functions, Derivatives, Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar field, Directional derivative, Divergence of a Vector field, Curl of a Vector field. Examples of applications of the above in solving real engineering problems.

Unit III
Vector Integration - Line Integral, Line Integrals Independent of Path. Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem. Examples of applications of the above in solving real engineering problems.

Textbook(s)

1. E Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, Tenth Edition, 2018.
2. Howard Anton and Chris Rorres, Elementary Linear Algebra, 11th Edition, Wiley, 2015.

Reference(s)

1. Dennis G. Zill and Michael R. Cullen, Advanced Engineering Mathematics by, second edition, CBS Publishers, 2012.
2. Srimanta Pal and Subhodh C Bhunia 'Engineering Mathematics', John Wiley and Sons, 2012, Ninth Edition.

23ECE105	**Computer Programming** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide understanding of basic programming in C
- To provide knowledge on programming constructs
- To enable development of modular programs

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the syntax and semantics of programming
CO2: apply appropriate programming constructs
CO3: analyze programs and debug errors
CO4: develop programs to solve specific problems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2													2	
CO2	2				2									2	
CO3	2				2							2		2	
CO4	3				2							3		2	

Syllabus

Unit I
Introduction- structure of C program: data types, storage classes, constants, enumeration constant, keywords, variables, operators, expressions, input/output statements, assignment statement conditional statements; number system: binary, decimal, hexadecimal, conversion between number system types; Introduction to tools – IDE, compilation, linking, debugging.

Unit II
Control flow statements **-** if-else, Looping – for, while, do-while, switch case, break and continue, goto and labels; Functions – function prototype, function definition, function call, built-in functions, recursion; Arrays – declaration, initialization, one-dimensional, matrix, multi-dimensional, array operations; string operations – length, compare, concatenate, copy. Recursion – recursive definition, recursive solution, designing recursive functions, limitations of recursion.

Unit III
Pointers – pointer operators, pointer arithmetic, array and pointers, array of pointers, parameters passing – pass by value, pass by reference; Structures – simple structure, nested structure, pointers and structure, array of structures, self-referential structures, dynamic memory allocation, typedef; Input-output – command line arguments; File operations – types, sequential access, random access.

Textbook(s)
1. Kernighan, B.W and Ritchie, D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
2. Forouzan BA, Gilberg RF. Computer Science: A structured programming approach using C. Third Edition, Cengage Learning; 2006.

Reference(s)
1. Byron Gottfried, Programming With C, Fourth Edition, McGraw Hill, 2018.
2. Greg Perry and Dean Miller, "C Programming Absolute Beginner's Guide", Que Publishing; 3rd edition, 2013.
3. JeriHanly and Elliot Koffman. Problem Solving and Program Design in C. Fifth Edition, Addison Wesley (Pearson); 2007.

23EAC112	Digital Electronics (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide an understanding of basic building blocks of digital circuits
- To enable the understanding of Boolean algebra and logic function optimization
- To enable design of combinational and sequential circuits

Course Outcomes: At the end of the course, the student should be able to

CO1: realise a given expression in terms of basic building blocks
CO2: minimise a given logic expression
CO3: design combinational circuits
CO4: design Sequential circuits

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2												2	
CO2	3	2												2	
CO3	3	3	2									2		2	
CO4	3	3	2									2		2	

Syllabus

Unit I
Introduction to logic circuits - Variables and functions, inversion - Truth tables - Logic gates and Networks - Boolean algebra - Synthesis using gates - Design examples - Optimized implementation of logic functions - Karnaugh map - Strategy for minimization - Minimization of product of sums forms - Incompletely specified functions - Multiple output circuits - Tabular method for minimization.

Unit II
Combinational circuit building blocks - Number representation and arithmetic circuits: Addition of unsigned numbers - Signed numbers - Fast adders - Multiplexers - Decoders - Encoders - Code converters - Arithmetic comparison circuits.

Unit III
Sequential circuit building blocks - Basic latch - Gated SR latch - Gated D latch - Master slave and edge triggered - D flip-flops - T flip-flop - JK flip-flop, Registers, Asynchronous Counters, Synchronous Counters, Ring Counter and Johnson Counter, Synchronous sequential circuits - Basic design steps - State assignment problem – Design of Mealy and Moore state models.

Textbook(s)

1. Stephen Brown, Zvonko Vranesic, “Fundamentals of Digital logic with Verilog Design”, Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.
2. R. D. Sudhakar Samuel, “Logic Design: A Simplified Approach”, Sanguine Technical Publishers, Edition 1, 2006.

Reference(s)

1. M Morris Mano and Michael D Ciletti, “Digital Design with Introduction to the Verilog HDL”, Pearson Education, Fifth Edition, Fifth Edition, 2015.
2. John F. Wakerly, “Digital Design Principles and Practices”, Fourth Edition, Pearson Education, 3rd Ed, 2008.
3. Donald D Givone, “Digital Principles and Design”, Tata McGraw Hill Publishing Company Limited, 2003.

23ECE114	Network Analysis (**Pre-requisite:** Fundamentals of Electrical Engineering)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide the concepts of transient analysis of circuits
- To introduce the concepts of frequency response and passive filters

- To introduce two-port networks and network parameters

Course Outcomes: At the end of the course, the student should be able to

CO1: analyse the transient behaviour of circuits
CO2: apply Laplace transforms for circuit analysis
CO3: understand the behaviour of passive filters
CO4: analyse two-port networks

CO-PO Mapping

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
CO1	3	3										2	2		
CO2	3	3										2	2		
CO3	3	2	2									1			
CO4	3	3										1		2	

Syllabus

Unit I
Laplace transform- Laplace Transforms of Simple Time Functions - Inverse Transform Techniques - Basic Theorems for the Laplace Transform. Solution to differential equations – First and second order.

Unit II
Transient Analysis - Time domain analysis of first and second order circuits – source free excitation- with DC Excitation.

Unit III
Resonance - Q-factor and Bandwidth. Frequency response of Series and Parallel circuits. Transfer function -poles and zeroes. Passive filters, filter design, Two-port Networks - impedance - admittance – hybrid - transmission parameters.

Textbook(s)

1. Charles K Alexander, Mathew N. O. Sadiku, “Fundamentals of Electric circuits”, Tata McGraw Hill, 2003.
2. William H. Hayt, Jack Kemmerly and Steven M. Durbin, “Engineering Circuit Analysis”, 8th edition, McGraw-Hill.

Reference(s)

1. John D. Ryder, Myril Baird Reed and W. L. Everitt, “Foundation for Electric Network Theory”, Prentice Hall of India, Second Edition, 2013.
2. M. E. Van Valkenburg, “Network Analysis”, Prentice Hall India Private Limited, Third Edition, 1999.

23EAC111	Computer Hardware and System Essentials (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide understanding of the organization of hardware and interfacing peripherals of a computer system
- To enable installation of an operating system and troubleshooting using system tools
- To introduce PC architecture and processors

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the basic components of computer systems and its functionality
CO2: understand internal interfaces and external peripherals
CO3: understand the concepts of operating systems and their functionalities
CO4: understand different PC architecture and processors

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											3	2		2
CO2	3											3	2		2
CO3	3											3	2		2
CO4	3											3	2		2

Syllabus

Unit I

Introduction: Building block of Computer, CPU, Memory, Motherboards, Internal Components IDE and SATA Devices, Hard Disk Drive and CD/DVDs Drives, SCSI Devices, Expansion Cards- LAN Card, IDE Card, VGA and SVGA Cards, Sound Card, Interface Cards, I/O cards; External Components Monitors: CRT, LCD and LED Displays, Printers: Inkjet Printer, Laser Printer Scanner:- Photo Scanner, Documents Scanner, Bar Cord Scanner Keyboards, Mouse, External Modem, Ports and Connectors, Batteries, Power supply, Pen Drives, SCSI interface devices, Laptop Computers, Digital Advance storage technology.

Unit II

Operating System Basics and Installation, Types of Operating systems, System files FAT and NTFS Dos 6.22, Windows XP, Windows 10, RedHat Linux and Multi Boot Operating System 3.2. MS-Office 2010, Auto-CAD, Acrobat Reader X, Java, Visual Studio, Multimedia software's, and Internet Browsers, Graphics Card, Sound Card, LAN Card, Flash Cards, Web Camera, CCTV Camera, Firewire Cards, Modem, Wireless LAN, Access Point. Introduction to Virus and its types, Effect of Virus for Computer System, Scanning and Antivirus remover tools, Antivirus Utilities for Diagnostic, Safety and Preventive Maintenance Tools, Data Recovery, Concept of Fax and E-mail, PC care and Maintenance, Electrical Power Issues, Troubleshooting PC Hardware:- O/S Troubleshooting issues in computer System

Unit III

Different PC architecture and processors: Pentium, i3, i5, i7 Processor Basics of Processor, AMD, Concept of Core, multicore, Raspberry Pi, etc.

Textbook(s)

1. B. Govinda Rajalu, PC and Clones Hardware, Troubleshooting and Maintenance Tata Mc-graw-Hill Publication

References(s)

2. Electronics and Radio Engineering M.L. Gupta Dhanpat rai & Sons, New Delhi
3. PC Troubleshooting and Repair Stephen J. Bigelow Dream tech Press, New Delhi

23ECE184	Introduction to Internet of Things (**Pre-requisite:** Nil)	L-T-P-C: 0-0-3-1

Course Objectives

- To introduce hardware platforms for interfacing sensors and actuators
- To introduce mobile application development for IoT
- To help build and prototype IoT based systems

Course Outcomes: At the end of the course, the student should be able to

CO1: interface sensors and actuators to hardware platforms
CO2: transfer data and control remote devices
CO3: develop mobile application for IoT
CO4: build and demonstrate IoT based systems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2				3				3	3				2	2
CO2	2				3				3	3				2	2
CO3	3				3				3	3		2		2	2
CO4	3	2			3				3	3		2		2	2

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:
Design an IoT based system to: (should use a technology with least cost possible)

a) count/occupancy (number of students present) of ECE classrooms at each hour of the dept. time table.
b) display this statistics in HoD/department office monitor. The display of counting should be updated every 10 minutes. The same display can also be available in the class room.
c) indicate the availability of teacher(s) in the class hour (this should also be updated every 10min)
d) switch off the display devices off all ECE classrooms from IoT lab (remote).

Experiment Contents:

1. GPIO and ADC Programming – LED – Switch – Relay - Proximity Sensor - Seven Segment
2. ADC Programming - Potentiometer - Temperature Sensor – Moisture Sensor - Gas Sensor
3. LCD and Keypad Interfacing
4. Serial Communication – Bluetooth - GPS.
5. SPI and I2C Programming – RFID - RTC
6. Speed and Direction Control of Motors – DC – Stepper/Servo
7. WebServer and IoT Cloud Communication – ESP8266, Thingspeak
8. Basic Mobile Application Development – MIT App Inventor 2
9. Remote Device Control Android App Development - MIT App Inventor 2

Textbook(s)

1. M. Margolis, B. Jepson, N. R. Weldin, "*Arduino Cookbook: Recipes to Begin, Expand and Enhance Your Projects"*, Third Edition, Oreilly, 2020
2. N. Cameron, "*Electronics Projects with the ESP8266 and ESP32: Building Webpages, Applications and Wifi Enabled Devices"*, Apress, 2021
3. F. Kamriani, K. Roy "*App Inventor 2 Essentials"*, Packt Publishing, 2016

Reference(s)

1. D. Wolber, H. Abelson, E. Spertus, L. Looney, "*App Inventor 2 Create Your Own Android Apps"*, Second Edition, Oreilly, 2018
2. M. Schwartz, "*Esp8266 Internet of Things Cookbook"*, Packt Publishing, 2017

23EAC181	Computer Hardware and System Essentials Laboratory (**Pre-requisite:** Nil)	L-T-P-C: 0-0-3-1

Course Objectives

- To familiarize with different hardware and software in computer systems and peripherals
- To provide hands-on experience in setting up PC and unplugging devices
- To provide hands-on experience on installation of operating systems, device drivers and peripherals

Course Outcomes: At the end of the course, the student should be able to

CO1: identify components of computer system and its peripheral devices
CO2: install-uninstall device drivers and application software
CO3: use system commands for configuration, set ups, troubleshoot and manage
CO4: Demonstrate simple applications using processors

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3								3	3		3		2	3
CO2	3								3	3		3		2	3
CO3	3								3	3		3		2	3
CO4	3								3	3		3		2	3

Syllabus

1. Familiarisation with components of computer systems and peripheral
2. Configure BIOS setup program and troubleshoot the typical problems using BIOS utility.
3. Install Hard Disk and configure to the PC's
4. Install and configure Scanner, Web cam, Cell phone and bio-metric device with system and troubleshoot the problems
5. Install and Configure Dual operating system
6. Printer Installation, Servicing and troubleshoot
7. Assemble a system with add on cards and check the working condition of the system
8. Assembling and Disassembling of Laptop to identify the parts and to install OS and configure it
9. Set up RaspberryPi as PC
10. Basic programming using microprocessor

Textbook(s)
Meizhong Wang,Key Concepts of Computer Studies
https://opentextbc.ca/computerstudies/front-matter/for-students-how-to-access-and-use-this-book/

References(s)
Ajay Rana and Ajit Mittal, Mastering PC Hardware & Networking 1st Edition, Computech Publications Limited

23EAC182	Digital Electronics Laboratory (**Pre-requisite:** Nil)	L-T-P-C: 0-0-3-1

Course Objectives

- To provide hands-on experience in realising simple logic expressions
- To demonstrate the power of logic function optimization
- To enable the implementation of combinational and sequential circuits

Course Outcomes: At the end of the course, the student should be able to

CO1: use datasheets & simulation tools effectively
CO2: realise simple logic circuits
CO3: design & implement combinational circuits

CO4: design & implement sequential circuits

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO															
CO1	3				3				2	2		2		2	
CO2	3								2	2				2	
CO3	3	3	2						2	2		2		2	
CO4	3	3	2						2	2		2		2	

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:
Let them design a calculator or clock which have many functionalities.

Experiment Contents:

1. Verification of Basic Logic Gates.
2. Realization of Basic Gates using Universal Logic Gates.
3. Simplification and Realization of a given Boolean Expression
   i) Using basic gates
   ii) SOP Using NAND gates only
   iii) SOP Using NOR gates only
   iv) POS Using NAND gates only
   v) POS Using NOR gates only and
   vi) Compare and analyze the above implementations
4. Design and verification of Adders and Subtractors.
5. Design and verification of Parallel Adder / Subtractor.
6. Design and verification of Binary to Gray code converter and vice versa.
7. Design and verification of BCD to Excess-3 code converter and vice versa.
8. Design and verification of 2-bit Magnitude Comparator.
9. Design and verification of Multiplexers
10. Implementation and verification of Half adder, full adder, half subtractor and full subtractor using multiplexers.
11. Design and verification of Flip-flops (D, T and JK flipflop).
12. Design and verification of shift Registers.
13. Design and verification of Ring and Johnson Counters.
14. Design and verification of 4-bit asynchronous Up and Down Counters

Textbook(s)

- Stephen Brown, Zvonko Vranesic, “Fundamentals of Digital logic with Verilog Design”, Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.

Reference(s)

1. John F. Wakerly, “Digital Design Principles and Practices”, Pearson Education, Fourth Edition, 2008.
2. K A Navas, “Electronic Lab Manual” – Volume 1, Fifth Edition, Prentice Hall of India, 2015.
3. M Morris Mano and Michael D Ciletti, “Digital Design with Introduction to the Verilog HDL”, Pearson Education, Fifth Edition, Fifth Edition, 2015

23ECE182	Computer Programming Laboratory (**Pre-requisite:** Nil)	L-T-P-C: 0-0-3-1

Course Objectives

- To provide hands-on exposure to programming in C
- To facilitate usage of Integrated Development Environment (IDE)
- To enable develop and debug programs

Course Outcomes: At the end of the course, the student should be able to

CO1: write and execute simple programs
CO2: employ IDE for compiling and debugging
CO3: handle dynamic input-output operations
CO4: develop programs for specific applications

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	2				3				3	3				2	
CO2	2				3				3	3				2	
CO3	2				3				3	3				2	
CO4	3	2			3				3	3		2		2	

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:
Let them develop something which either dept. can use, admin can make use of, finance dept. can make use of or they themselves can make use of.

Experiment Contents:
1. Practice of Simple C Programs.
2. Control statements
3. Array concept
4. 1-D and multi-dimensional arrays operation
5. Strings and sorting of strings
6. Various types of functions and recursive functions
7. Pointers, Strings and pointers
8. Structures
9. File input/output and command line arguments
10. File handling and Dynamic memory allocation

Textbook(s)

1. Kernighan, B.W and Ritchie, D.M, “The C Programming language”, Second Edition, Pearson Education, 2015.
2. Byron S. Gottfried, “Schaum’s Outline of Theory and Problems of Programming with C”, McGraw-Hill Education, 1996.

Reference(s)

1. Byron Gottfried. Programming With C. Fourth Edition, McGraw Hill, 2018.
2. Greg Perry and Dean Miller, “C Programming Absolute Beginner’s Guide”, Que Publishing; 3rd edition, 2013.
3. JeriHanly and Elliot Koffman. Problem Solving and Program Design in C. Fifth Edition, Addison Wesley (Pearson); 2007.

4. Forouzan BA, Gilberg RF. Computer Science: A structured programming approach using C. Third Edition, Cengage Learning; 2006.

Course Objectives

22ADM111	Glimpses of Glorious India	L-T-P-C: 2-0-1-2

- To introduce to the depths and richness of the Indian culture and knowledge traditions
- To enable obtain a synoptic view of the grandiose achievements of India in diverse fields
- To equip with a knowledge of own country and its eternal values

Course Outcomes: At the end of the course, the student should be able to

CO1: understand and analyze the legacy of ancient Indian cultures and a discussion on practical Vedānta
CO2: comprehend the teachings and principles of Kauṭilya, conceptual aspects of Gods, and contribution of the Bhagavadgītā.
CO3: discuss the Indian soft powers and a portrayal of how nature was preserved through the medium of faith
CO4: recognize the contribution that India has made to the world

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	3	3	2	1	2							
CO2	3			2	1			2							
CO3	2	2	2	3	3	2	2	2	3						
CO4			2	2		2	2	2	2						

Syllabus

Unit I
Role of Women in India- Kaūṭilya- Conceptual aspects of Gods

Unit II
Bhagavadgītā: From Soldier to Saṁsārin to Sādhaka - Lessons of Yoga from Bhagavad Gita- Indian Soft powers- Preserving Nature through Faith- Different facets of Ancient Indian Cultures

Unit III

Practical Vedanta- To the World from India: Art and architecture, music, dance, theatre, sports, Yoga- Indian Approach to Science: Chemistry, Physics, Metallurgy, Medical Sciences, Astronomy, Mathematics, Naval engineering.

Textbook

Glimpses of Glorious India, Amrita Vishwa Vidyapeetham (University publication)

Reference(s)

1. Altekar, A. S., “The Position of Women in Hindu Civilization”, Motilal Banarsidass, 1956.
2. B. Padmanabha Rao (ed.), “Bhāskarācārya’s Līlāvatī”, CIFS, 2014.
3. Lal B. B., “The Sarasvatī Flows on: The Continuity of Indian Culture”, Aryan Books International, 2002.

SEMESTER III

23CHY109	Engineering Chemistry B (Pre-requisite: Nil)	L-T-P-C: 2-1-0-3

Course Objective

- To impart knowledge on the concepts of chemistry involved in the application of engineering materials that are used in the industry/day-to day life.

Course Outcomes: At the end of the course, the student should be able to
CO1: characterize the solids using X-ray diffraction technique and analyse the materials using computational tools.
CO2: apply the fundamental principles of electrochemistry to illustrate the functioning of electrochemical energy systems.
CO3: understand the application of polymers in fabricating integrated electronic devices

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						1					1			
CO2	3	2					1					1			
CO3	2	3					1					2			
CO4	2	3					1					2			

Syllabus

Unit I
Solid state- Fundamentals of crystalline structures – unit cell, lattice parameters, Bravais lattices and types of crystals; X-ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique); Elements of symmetry in crystal systems, defects in crystals – stoichiometric, non-stoichiometric, extrinsic and intrinsic defects. Vesta – for visualization of crystal structures. Solar energy - introduction, utilization and conversion, photovoltaic cells - design, construction and working, panels and arrays. Advantages and disadvantages of PV cells. DSSC (elementary treatment).

Unit II
Electrochemical energy system -Faradays laws, origin of potential, electrochemical series, reference electrodes, Nernst equation, introduction to batteries - classification - primary, secondary and reserve (thermal) batteries. Kinetics of electrochemical reaction – Tafel equations. Characteristics - cell potential, current, capacity and storage density, energy efficiency. Construction, working and application of Leclanche cell-Duracell, lead acid batteries. Ni-Cd battery, Lithium ion batteries. Fuel cell - construction and working of PEMFC and biofuel cell.

Unit III
Polymer and composite materials -Conducting polymers: Conducting mechanisms - Electron transport and bipolar polymers. Photoconductive polymers: Charge carriers, charge injectors, charge transport, charge trapping. Liquid crystalline polymers: Fundamentals and process, liquid crystalline displays –applications. Polymers for light emitting diodes – introduction, polymer structures, Organic LEDs-their functioning-advantages and disadvantages over conventional LEDs – their commercial uses. Piezoelectric materials – working principle and applications.

Textbooks and References:

1. Chemistry: A Molecular Approach, 4th Edition Nivaldo J. Tro, Santa Barbara City College
2. Patrick M. Woodward, Pavel Karen, John S. O. Evans, Solid State Materials Chemistry, Cambridge University Press, 2021
3. Vladimir S. Bagotsky, Alexander M. Skundin, Yurij M. Volfkovich, Electrochemical Power Sources Batteries, Fuel Cells, and Supercapacitors, John Wiley and Sons, 2015.
4. Bansi D. Malhotra, Handbook of Polymers in Electronics, Rapra Technology Limited, 2002
5. Ye Zhou, Guanglong Ding, Polymer Nanocomposite Materials: Applications in Integrated Electronic Devices, Wiley-VCH, 2021.
6. Jain and Jain, "Engineering Chemistry", Dhanpat Rai Publishing company, 2015.

23EAC201	Electronic Circuits - I	L-T-P-C: 3-0-0-3
	(**Pre-requisite:** Physics of Semiconductors)	

Course Objectives

- To enable the design of diode-based circuits
- To enable the design of MOSFET-based amplifiers
- To enable an understanding of BJTs & FinFETs

Course Outcomes: At the end of the course, the student should be able to

CO1: understand diode operation
CO2: analyse diode-based circuits for specific applications
CO3: understand the operation of transistors
CO4: analyse MOSFET-based amplifiers

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2	3	2										2	2		
CO3	3														
CO4	3	2	2									2	2		

Syllabus

Unit I
Diode and its applications: PN Junction Diodes - Forward and Reverse Biasing - Reverse Saturation Current - Diode current components - Cut-in voltage - VI Characteristics - Diode Models; Rectification– Half-wave, Full-wave and Bridge; Rectifier with and without filter; Wave shaping circuits: Clipping & Clamping Circuits, voltage multiplier; Zener Diodes -Shunt voltage regulator.

Unit II
MOSFET – Introduction, Regions of Operation, MOSFET Characteristics; MOSFET biasing - Voltage divider biasing & Constant current biasing; MOSFET as a switch and an amplifier; Single-stage amplifier configurations- Common Source, Common Gate & Source Follower; Parasitic capacitances in MOSFET, MOSFET Frequency response.

Unit III
Introduction to BJT – BJTs, NPN transistors, VI characteristics-Region of operation; BJT Transistor biasing and as an amplifier and switch. FinFET - Introduction, Construction, advantages, VI characteristics and applications.

Textbook(s)

1. Adel S Sedra, Kenneth C Smith and Arun N Chandorkar, "Microelectronic Circuits – Theory and Applications", Seventh Edition, Oxford University Press, 2017.
2. "FinFET and Other Multi-Gate Transistors"-by J.P Colinge

References(s)

1. Donald A Neamen, "Electronic Circuits – Analysis and Design", Third Edition, McGraw Hill Education, 2006.
2. Albert Malvino and David Bates, "Electronic Principles", Eighth Edition, McGraw Hill Education, 2016.

23EAC202	Signal Processing (**Pre-requisite**: Engineering Mathematics - I)	L-T-P-C: 3-1-0-4

Course Objectives

- To introduce the concepts of Signals and Systems
- To provide the foundation of transforms
- To enable the design of digital filters

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concepts of Signals and Systems
CO2: understand transform techniques
CO3: signals and systems using transform techniques
CO4: design simple digital filters for specific applications

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2	2	2	
CO2	3											2	2	2	
CO3	3	2										2	2	2	
CO4	3	2	2										2	2	

Syllabus

Unit I
Introduction to Signals- Continuous time and discrete time signals - Classification of Signals: Periodic, Aperiodic, Even, Odd, Energy and Power signals, Deterministic and Random signals, Elementary signals: unit step, unit impulse, unit ramp, sinusoidal and complex exponential signals - Basic operations on signals: Multiplication by a scalar, signal addition, linear combination, signal multiplication, time shifting, time scaling, combination of time shifting and time scaling- Introduction to Systems- Classification of Systems: Continuous time, discrete time, Invertible, non-invertible, Causal, non-causal systems, time-invariant, time-variant systems, Linear and non-linear systems, BIBO stable and unstable systems, Time Domain characterization of continuous time and discrete time LTI system-Convolution Integral-Convolution Sum.

Unit II
Introduction to Fourier representation of Signals-Continuous time Fourier series: Dirichlet conditions, Gibbs Phenomenon, Properties of Continuous time Fourier series - Linearity, Time shifting, Frequency shifting, Time scaling, Time reversal, multiplication, Convolution and Parseval's theorem. Discrete time Fourier Series: Properties of DTFS -Linearity, Time shifting, Time scaling, Time reversal- Discrete time Fourier Transform: Properties of DTFT -Linearity, Time shifting, Frequency shifting, Time scaling, Time reversal, and Convolution property.

Unit III
Z-Transform: Definition – ROC - Inverse Z-transforms - Unilateral Z Transform– Introduction to Filters- Types of filters- low pass, band pass, high pass, band reject- Finite Impulse Response (FIR) filters: symmetric and anti-symmetric FIR filters – design of linear phase FIR filter using Windowing method – FIR differentiators – Hilbert transformer – Introduction to IIR filters.

Textbook(s)
1. Alan V. Oppenheim, Alan S. Wilsky, S. Hamid Nawab, "Signals and Systems". Prentice Hall India private Limited, Second Edition, 1997.
2. John G Proakis, G. Manolakis, "Digital Signals Processing Principles, Algorithms, Applications", Prentice Hall India Private Limited, Fourth Edition, 2007.

References(s)

1. Simon Haykin, Barry Van Veen, "Signals and Systems", Second Edition, John Wiley and Sons, 2007.
2. Sanjit K. Mitra, "Digital Signal Processing, A computer based approach", Tata McGraw Hill Publishing Company Limited, Fourth Edition, 2010.

23EAC203	Data Structures and Algorithms (**Pre-requisite:** Computer Programming)	L-T-P-C: 3-1-0-4

Course Objectives

- To introduce data structures and algorithmic approaches
- To provide exposure to implement data structures
- To introduce basic performance measures and analysis techniques for algorithms

Course Outcomes: At the end of the course, the student should be able to

CO1: understand data structures and abstract data types
CO2: understand various algorithmic approaches
CO3: understand performance measures and categorize algorithms
CO4: apply data structures and algorithms to solve classical problems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3	2										3			3
CO3	3	2	2									3			3
CO4	3	2	2									2			3

Syllabus

Unit I

Refresher of Data Structures - Abstract Data Types and Data Structures - Principles, and Patterns. Basic complexity analysis – Best, Worst, and Average Cases - Asymptotic Analysis -Analyzing Programs – Space Bounds, recursion- linear, binary, and multiple recursions. -Sorting and Selection – Linear Sorting –Divide and Conquer based sorting –Analysis using Recurrence Tree based Method - Merge Sort - Quick Sort - Studying Sorting through an Algorithmic Lens. Arrays, Linked Lists and Recursion: Using Arrays - Lists - Array based List Implementation – Linked Lists – LL ADT – Singly Linked List – Doubly Linked List – Circular Linked List Stacks and Queues: Stack ADT - Array based Stacks, Linked Stacks – Implementing Recursion using Stacks, Stack Applications. Queues - ADT, Array based Queue, Linked Queue, Double-ended queue, Circular queue, applications.

Unit II

Trees: Tree Definition and Properties – Tree ADT - Basic tree traversals - Binary tree - Data structure for representing trees – Linked Structure for Binary Tree – Array based implementation. Priority queues: ADT – Implementing Priority Queue using List – Heaps. Maps and Dictionaries: Map ADT – List based Implementation – Hash Tables – Dictionary ADT. Skip Lists - Implementation – Complexity

Unit III

Search trees – Binary search tree, AVL tree, Trees – Segment Trees - B-Trees. Implementation. External Memory Sorting and Searching. Graphs: ADT- Data structure for graphs - Graph traversal- Transitive Closure- Directed Acyclic graphs - Weighted graphs – Shortest Paths - Minimum spanning tree – Greedy Methods for MST.

Textbook(s)

1. Goodrich MT, Tamassia R, Goldwasser MH. Data structures and algorithms in Python. John Wiley & Sons Ltd; 2021.

2. Goodrich MT, Tamassia R, Goldwasser MH. Data structures and algorithms in Java. Sixth edition, John Wiley & Sons Ltd; 2014.

References(s)

1. Tremblay JP, Sorenson PG. An introduction to data structures with applications. Second Edition, Tata McGraw-Hill; 2017.
2. Shaffer CA. Data Structures and Algorithm Analysis. Third Edition, Dover Publications; 2012.

23ECE205	Foundations of Data Science	L-T-P-C: 3-1-0-4
	(**Pre-requisite:** Engineering Mathematics - II)	

Course Objectives

- To introduce the statistical concepts necessary for exploratory data analysis
- To provide the foundations of data pre-processing, interpretation & visualization
- To introduce the concepts of statistical testing

Course Outcomes: At the end of the course, the student should be able to

CO1: understand descriptive statistics and data distributions
CO2: apply pre-processing techniques
CO3: interpret and visualise data
CO4: apply statistical tests

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										3			
CO2	3	2										2			
CO3	3	2										3			
CO4	3	2										2			

Syllabus

Unit I
Introduction- Data Science, Importance of probability for Data science, Axioms of probability, Conditional probability and Bayes theorem; Random variables: Discrete, Uniform and Binomial Distribution, Continuous, Normal Distribution, Exponential and Poisson Distribution; Types of Data, Central tendency measures, Dispersion measures, Skewness and Mean, Covariance and Correlation, Central limit theorem.

Unit II
Data Processing- Collection Strategies, Data Pre-Processing Overview, Data Cleaning, Data Integration, Encoding techniques- Ordinal, One hot and Binary, Data Reduction-PCA, Data Transformation and Discretization, Exploratory data analysis: Visualization before analysis, visualizing a single variable, Examining multivariate Data- Heat map.

Unit III
Statistical Testing -Introduction to Hypothesis Testing-Null and alternative hypothesis, Type of Errors, A/B testing, Parametric test: the T-test, Z-test, non-parametric tests- Chi-square tests, P-value, Confidence Intervals, Parametric confidence intervals, Bootstrap confidence intervals

Textbook(s)

1. Carlos Fernandez-Granda, “Probability and Statistics for Data Science”, 2017.
2. Cathy O'Neil and Rachel Schutt, “Doing Data Science”, Straight Talk from The Frontline, O'Reilly, 2014.

Reference(s)

1. Joel Grus, “Data Science from Scratch” First Edition, April 2015
2. Chirag Shah, “A Hands-On Introduction to Data Science, Cambridge University Press.
3. Elizabeth Purdom, Statistical Methods for Data Science, 2023.
4. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman, “Mining of Massive Datasets. v2.1”, Cambridge University Press. 2nd edition, 2014.

23EAC204	**Sensors and Instrumentation**	**L-T-P-C: 3-0-0-3**
	(**Pre-requisite**: Foundation of Electrical Engineering)	

Course Objectives

- To introduce the concepts and working principles of Sensors and Transducers
- To provide the foundation of sensors technology
- To enable understanding of measurement and instrumentation systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the physical phenomena behind the operation of different types of sensors and actuators
CO2: identify and use suitable sensors for targeted applications
CO3: measure various performance parameters of the sensors
CO4: understand calibration and its importance

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO															
CO1	3											2		2	
CO2	3											2		2	
CO3	3	2										2		3	
CO4	3	2	2											3	

Syllabus

Unit I

Introduction- Sensors and Transducers, Definition and types of Sensors, Physical principles of Sensors, Example of Smart Sensors in nature, Classification of sensors – Resistive Sensors – Principle of operation, construction details, characteristics and applications of Potentiometer, Strain gauge, Resistance Temperature Detector (RTD), Thermistors, Light Dependent Resistor (LDR). Instrumentation and Industrial Instrumentation, Design and selection of Sensors, Characteristics of sensors – Static characteristics and Dynamic characteristics - Range, Resolution, Sensitivity, Error, Accuracy and Precision, Repeatability, Impedance, Response Time, Linearity, Dead band, Backlash.

Unit II

Transducers, Sensor Technology and their applications - Inductive transducers, Capacitive transducers, Introduction to Piezoelectricity, Working principle of Piezoelectric Transducers, - Applications of Piezoelectric Transducers; Hall Effect Transducers: Introduction to Hall Effect, Working principle of Hall Effect Transducers, Applications of Hall Effect Transducers; Development in sensor technology – Semiconductor sensors, Smart sensors, Microsensors, Radiation sensors, Ultrasonic sensors, Chemical sensors and Bio sensors - Sensor Applications - Automobile, Home Appliances, Aerospace sensors, Environmental monitoring.

Unit III

Introduction to measurements and instrumentation: Measurement of Non Electrical Quantities, Non Electrical quantities and their measurement, Types of Non Electrical quantities, Measurement techniques for Non Electrical quantities;

Measurement of Temperature: Principles of Temperature measurement, Types of Temperature Sensors, Thermocouples and their applications, Measurement of Pressure: Principles of Pressure measurement, Types of Pressure Sensors, Piezoelectric Transducers and their applications, Strain Gauges and their applications; Measurement of Flow: Principles of Flow measurement, Types of Flow Sensors and their applications, Ultrasonic Flow meters. Errors in measurements – gross errors, systematic errors, and random errors, Calibration and Standard – process of calibration, classification of standards, and standards for calibration.

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Textbook(s)

1. D V S Murthy, Transducers and Instrumentation, PHI 2nd Edition 2013
2. D Patranabis, Sensors and Transducers, PHI 2nd Edition 2013
3. Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs, and Applications”, Springer; 4th ed. 2016.

Reference(s)

1. Modern Sensors Handbook 2007 Edition by Pavel Ripka, Aloisk Tipek, ISTE LTD
2. “Introduction to Instrumentation and Measurement, 3rd Edition”, Robert B. Northrop, Publisher: CRC – Press – Taylor and Francis Group

23EAC281	**Electronic Circuits – I Laboratory** (**Pre-requisite:** Physics of Semiconductors)	**L-T-P-C: 0-0-3-1**

Course Objectives

- To enable the study and extraction of device parameters from datasheets
- To provide hands-on experience on the design of diode-based circuits
- To provide hands-on experience on the design of amplifiers

Course Outcomes: At the end of the course, the student should be able to

CO1: Use datasheets effectively
CO2: Simulate diode and transistor based circuits
CO3: Prototype and characterize diode and transistor circuits
CO4: Prototype and Characterize transistor amplifiers

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		2						2	2		2	2		
CO2	3	2	2		3				2	2		2	2		
CO3	3	2	2						2	2			2		
CO4	3	2	2						2	2			2		

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:
Design a microphone amplifier to amplify your audio signal. Take this as input, design a driver amplifier using MOSFET to drive a speaker of 12W. You can quickly design a regulated power supply necessary for this circuit (12V-15V).

Design a multistage voltage amplifier (Low Noise Amplifier-LNA to be used in 2-3G base station) which will have a frequency response (600MHz to 3GHz) and a gain of 18dB.

Contents for experiment

1. Familiarization of Electronic Components.
2. VI Characteristics of Semiconductor diode.
3. VI Characteristics of Zener diode.
4. Rectifiers with and without filters.
5. Zener shunt regulator.
6. Characteristics of MOSFET in CS configuration.
7. MOSFET as switch
8. Common source amplifier using MOSFET.
9. Frequency response of MOSFET
10. Characteristics of BJT in CE configuration.
11. Common emitter amplifier using BJT.

Textbook(s)

1. Adel S Sedra, Kenneth C Smith and Arun N Chandorkar, "Microelectronic Circuits – Theory and Applications", Seventh Edition, Oxford University Press, 2017.

References(s)

1. Donald A Neamen, "Electronic Circuits – Analysis and Design", Third Edition, McGraw Hill Education, 2006.
2. Albert Malvino and David Bates, "Electronic Principles", Eighth Edition, McGraw Hill Education, 2016.

23EAC282	Signal Processing Laboratory (**Pre-requisite:** Nil)	L-T-P-C: 0-0-3-1

Course Objectives

- To provide hands-on exposure to generation and visualization of signals
- To provide hands-on experience to process signals using Linear Time Invariant (LTI) systems
- To enable frequency domain analysis of signals and systems

Course Outcomes: At the end of the course, the student should be able to

CO1: generate, visualize signals and interpret their properties
CO2: conduct operations on signals
CO3: analyze Linear Time Invariant systems
CO4: analyze and interpret the spectral properties using transforms

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3				3	3		2			2
CO2	3				3				3	3		2			2
CO3	3	3			3				3	3		2			2
CO4	3	3			3				3	3		3			2

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:

Integrate background music to vocal with different play rates and audio effects
1) System to vary the play rate of audio file

- Read the audio file and implement time scaling operation to obtain a variable play rate.
- Analyse the properties of the given system in terms of linearity, stability, causality.
- Understand the effects of the aforementioned operation in the frequency domain.

2) System to create audio effects

- Read audio file and implement audio effects such as echo and chorus.
- Analyse the effect of these effects in the frequency domain.

3) Guitar note generation

- Create multiple Guitar notes by using CTFS approach.
- Analyse the effect of adding harmonics in the generated note.

Experiment Contents:

1. Generation of Signals.
2. Basic Operations on Signals-Operation on dependent variable
3. Basic Operations on Signals-Operation on independent variable
4. Types of signals-Periodicity, Even, Odd, Energy and Power
5. Properties of Systems-Linearity, Time invariance, stability
6. Continuous and Discrete-time Convolution
7. Verification of system interconnections
8. CTFS and Gibbs Phenomenon
9. CTFT and its properties
10. DTFS and its properties
11. DTFT and its properties
12. Z-transform

Textbook(s)

2. Luis F. Chaparro, Aydin Akan, "Signals and Systems Using MATLAB", Third edition, Academic Press, 2019.
3. D Sundararajan, "Signals and Systems: A Practical Approach", Second edition. Springer International Publishing, 2022.

Reference(s)

1. Won Young Yang, "Signals and Systems with MATLAB", Second Edition, Springer International Publishing, 2009.
2. Luis Chaparro, "Signals and Systems using MATLAB", Elsevier Publishing, 2010.

Course Objectives

23EAC283	**Data Structures and Algorithms Laboratory** (**Pre-requisite:** Computer Programming)	**L-T-P-C: 0-0-3-1**

To provide hands-on experience on implementing data structures
To enable implementation of simple algorithms
To enable apply algorithms to specific problems

Course Outcomes: At the end of the course, the student should be able to

CO1: implement data structures
CO2: implement and execute algorithms
CO3: analyze run-time complexity
CO4: apply algorithms to specific problems

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3				3				3	3		3			3

CO2	3				3				3	3		3			3
CO3	3	3			3				3	3		3			3
CO4	3	2			3				3	3		3			3

Syllabus
Experiment Contents:

1. Stacks, queue, binary trees using arrays
2. Linked list - hash tables
3. Sorting algorithms – bubble, insertion, shell, selection, heap, quick
4. Graph representation and traversal algorithms
5. Single source shortest path algorithm-minimum spanning tree algorithms.
6. Run time complexity on (2) and (3)
7. Applications

Textbook(s)

1. Goodrich MT, Tamassia R, Goldwasser MH. Data structures and algorithms in Python. John Wiley & Sons Ltd; 2021.
2. Goodrich MT, Tamassia R, Goldwasser MH. Data structures and algorithms in Java. Sixth edition, John Wiley & Sons Ltd; 2014.

Reference (s)

1. Tremblay JP, Sorenson PG. An introduction to data structures with applications. Second Edition, Tata McGraw-Hill; 2017.
2. Shaffer CA. Data Structures and Algorithm Analysis. Third Edition, Dover Publications; 2012.

22ADM211	**Leadership from Ramayana**	**L-T-P-C: 1-0-0-1**

Course Objectives

To provide a deeper understanding of the ethical grandeur of Indian culture, and be inspired to follow the ideals of the characters depicted in Ramayana

Course Outcomes: At the end of the course, the student should be able to

CO1: appreciate the significance of Rāmāyaṇa as an itihāsa, and important aspects of Bālakāṇḍa.
CO2: understand the family values and ideal human relationships portrayed in the Ayodhyakāṇḍa and Aranyakāṇḍa of Rāmāyaṇa.
CO3: understand dharma and its nuances, emphasizing its applicability in an individual’s life through Kishkindhakāṇḍa and Sundarakāṇḍa of Ramayana
CO4: appreciate the triumph of dharma over adharma through Yuddhakāṇḍa of Rāmāyaṇa.
CO5: appreciate the spiritual values from Rāmāyaṇa in resolving personal and social conflicts through varied effective presentations of important episodes of the Rāmāyaṇa

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2	2	3	3	3		3			
CO2						3	3	3	3	2		3			
CO3						3	2	3	3	3		3			
CO4						3		3	3	3		3			
CO5						3		3	3	2		3			

Syllabus

Unit I

An overview of Valmiki's epic. Introduction to the content and structure of the epic text and it's principal characters. Bala-Kāṇḍa: Preparing for the renowned mission; Ayodhya-Kāṇḍa: Harbinger of an Entire Tradition of Nobleness. Araṇya-Kāṇḍa: Tale of the forest life

Unit II

Kishkindha-Kāṇḍa: The Empire of Holy Monkeys. Sundara-Kāṇḍa: Heart of the Ramayana; Yuddha-Kāṇḍa:The most popular part of the Ramayana; Uttara-Kāṇḍa: An attempt to explain the untold stories

Unit III

Ramayana and Modern-day learning, Ecological Awareness in the Ramayana; Different Ramayana: Epic that connects the world.

Textbooks/References

1. Leadership Lessons from the Ramayana, ASCSS
2. Rajagopalachari. C, The Ramayana
3. Valmiki, The Ramayana, Gita Press

23ENV300	Environmental Science (**Pre-requisite:** Nil)	P / F

Course Objectives

- To study the nature and facts about environment.
- To appreciate the importance of environment by assessing its impact on the human world.
- To study the integrated themes and biodiversity, pollution control and waste management.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand aspects of nature and environment
CO2: analyze impact of environment on human world
CO3: to comprehend pollution control and waste management

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
CO1						3	2	3							
CO2						3	2	3							
CO3						3	2	3							

Syllabus

Unit I
Introduction- Overview of the global environment crisis; Biogeochemical cycles; Climate change and related international conventions & treaties and regulations. Ozone hole and related International conventions & treaties and regulations; Over population; Energy crisis; Water crisis; Ground water hydrogeology; Surface water resource development.

Unit II
Ecology, biodiversity loss and related international conventions– treaties and regulations. Deforestation and land degradation; Food crisis; Water pollution and related International and local conventions – treaties and regulations. Sewage

- domestic and industrial; Effluent treatment; Air pollution and related international and local conventions, treaties and regulations. Other pollution (land, thermal, noise).

Unit III

Solid waste management (municipal, medical, e-waste, nuclear, household hazardous wastes). Environmental management, Environmental accounting, Green business, Eco-labelling, Environmental Impact Assessment. Constitutional-legal and regulatory provisions; Sustainable development.

Textbook(s)

1. R. Rajagopalan, "Environmental Studies – From Crisis to Cure", Oxford University Press, 2005, ISBN 0-19-567393-X.

Reference(s)

1. G.T. Miller Jr., "Environmental Science", 11th Edition, Cenage Learning Pvt. Ltd., 2008.
2. Benny Joseph, "Environmental Studies", Tata McGraw-Hill Publishing company Limited, 2008.

23LSE201	LIFE SKILLS FOR ENGINEERS I	L-T-P-C: 1 0 2-P/F

Pre-requisite(s): An open mind and the urge for self-development, basic English language skills, knowledge of high school level mathematics.

Course Objectives

- Assist students in inculcating Soft Skills and developing a strong personality
- Help them improve their presentation skills
- Support them in developing their problem solving and reasoning skills
- Facilitate the enhancement of their communication skills

Course Outcomes

CO1: Soft Skills: To develop greater morale and positive attitude to face, analyse, and manageemotions in real life situations, like placement process.

CO2: Soft Skills: To empower students to create a better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.

CO3: Aptitude: To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.

CO4: Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis.

CO5: Verbal: To infer the meaning of words and use them in the right context. To have a better understanding of the basics of English grammar and apply them effectively.

CO6: Verbal: To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	3	3		3
CO2									2	3		3
CO3		3		2								
CO4		3		2								
CO5										3		3
CO6									3	3		3

Syllabus

Soft Skills

Soft Skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Learning to benefit from constructive criticisms and feedback, Need for change in mindset and up-skilling to keep oneself competent in the professional world.

Managing Self: Knowing oneself, Self-perception, Importance of positive attitude, Building and displaying confidence, Avoiding being overconfident, Managing emotions, stress, fear. Developing Resilience and handling failures. Self-motivation, Self-learning, and continuous knowledge up- gradation / Life-long learning. Personal productivity - Goal setting and its importance in career planning, Self-discipline, Importance of values, ethics and integrity, Universal Human Values.

Aptitude

Problem Solving I

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices,Square roots, Cube Roots and Simplification.

Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest. Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership. Averages: Basics, and Weighted Average.

Data Interpretation: Tables, Bar Diagrams, Venn Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, Network Diagrams and other forms of data representation.

Verbal

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of wordanalysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misused words, commonly confused words and wrong form of words in English.

Grammar (**Basic**): Help students learn the usage of structural words and facilitate students to identifyerrors and correct them.

Reasoning: Stress the importance of understanding the relationship between words through analogy questions.

Speaking Skills: Make students conscious of the relevance of effective communication in today's worldthrough various individual speaking activities.

Reference(s):

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita VishwaVidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
9. Cracking the New GRE 2012
10. Kaplan's – GRE Comprehensive Programme
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations,Amrita Vishwa Vidyapeetham.

12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.

Evaluation Pattern: 50:50

Assessment	Internal	External
Continuous Assessment (CA) – Soft Skills	30	-
Continuous Assessment (CA) – Aptitude	10	25
Continuous Assessment (CA) – Verbal	10	25
Total	50	50
Pass / Fail		

*CA - Can be presentations, speaking activities and tests.

SMESTER IV

Course Objectives

23ECE211	Microcontrollers and Interfacing (**Pre-requisite:** Digital Electronics)	L-T-P-C: 3-0-0-3

- To provide understanding of Microcontrollers and its Applications
- To enable the understanding of Microcontroller Peripherals and their configuration
- To provide insight on the design of a simple Embedded System for specific Applications

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the fundamentals of Microcontroller and its Peripherals
CO2: configure the Internal Peripherals of a Microcontroller
CO3: interface External Peripherals with an Embedded Platform
CO4: design a Microcontroller based System for real world applications

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			2
CO2	3	2	2									2			2
CO3	3	2	2									2			3
CO4	3	3	3									2			3

Syllabus

Unit I
Introduction to Embedded Systems - Introduction to ARM Architecture - ARM Programmer's Model - ARM Processor Modes and States - Addressing Modes - ARM Instruction Set - Types - Data Processing Instructions - Assembly Language Programming - Binary Encoding of Data Processing Instructions - Data Transfer Instructions - Binary Encoding of Data Transfer Instructions

Unit II
Pipeline in Processor - Pipeline Hazards - ARM 3 Stage Pipeline - LPC2148 Microcontroller Architecture – GPIO - PLL - Introduction to serial communication - Serial Transmission and Reception using UART

Unit III
ADC - DAC - External Interrupt - Timer - PWM - Seven Segment - Relay - DC Motor - Stepper Motor - LCD - Keypad - Temperature Controller - DC Motor Speed Control - Remote Device Control

Textbook(s)

1. S. Furber, "*ARM system On Chip Architecture"*, Second Edition, Pearson, 2015.
2. LPC2148 User manual, NXP Semiconductors, https://www.nxp.com/docs/en/user-guide/UM10139.pdf

Reference(s)

1. T. Noergaard, "Embedded Systems Architecture A Comprehensive Guide for Engineers and Programmers", Newnes, 2013
2. A. Sloss, D. Symes, C. Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", First Edition, Elsevier, 2004.

23EAC211	Electronic Circuits - II	L-T-P-C: 3-1-0-4
	(**Pre-requisite:** Electronic Circuits - I)	

Course Objectives

- To provide an understanding of negative feedback and its effect on amplifier performance
- To enable the design of linear circuits using opamps
- To enable the design of non-linear circuits using opamps

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concept of negative feedback and its effects
CO2: understand the specifications and parameters of opamps
CO3: analyse linear circuits based on opamps
CO4: analyse non-linear circuits based on opamps

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2	3											2	2		

CO3	3	2	2									2	2		
CO4	3	2	2									2	2		

Syllabus

Unit I
Feedback concepts– types of feedback, Series and shunt configurations; Feedback network - effect on Gain, Bandwidth, input/output impedance; Analysis of single stage amplifier with feedback with respect to Gain, Bandwidth, Impedance, etc.

Unit II
Operation Amplifier- Ideal Characteristics, DC imperfections, Input offset voltage, slew rate, input offset current, CMRR, input impedance. Linear applications of opamp- Inverting and Non-inverting Amplifier, Voltage follower, Summing amplifier, Difference & Instrumentation Amplifier, Integrator and Differentiator.

Unit III
Non-Linear Applications of opamps- Comparators, Schmitt Trigger - Precision Rectifiers - Peak detectors- Principles of Sinusoidal Oscillators - RC phase shift oscillator, Wein-Bridge Oscillator, LC and Crystal Oscillators; Multivibrators- astable and monostable multivibrator.

Textbook(s)

1. A S. Sedra, K. C. Smith and A. N. Chandorkar, “Microelectronic Circuits -Theory and Applications”, Seventh Edition, Oxford University Press, 2017.

References(s)

2. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, Fourth Edition, Tata McGraw Hill Publishing Company Limited, 2015.
3. J. Millman and A.Grabel, “Microelectronics”, Second Edition, McGraw-Hill, 2001.

Course Objectives

23EAC213	**Computer Systems and Architecture** (**Pre-requisite:** Digital Electronics)	**L-T-P-C: 3-0-0-3**

- To provide introduction to Computer System Architecture
- To provide foundation on various building blocks of a Computer Architecture
- To introduce the concepts of Pipelining and Parallel Processing

Course Outcomes: At the end of the course, the student should be able to

CO1: understand various functional units and mathematical operations of Computer Systems
CO2: design data-path and control-path operations during execution
CO3: understand Memory Organization and Input Output interfacing
CO4: understand the effect of Pipelining and Parallel Processing

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3											3			3
CO2	3	2	2									3			3
CO3	3	2	2									3			3
CO4	3	2										3			3

Syllabus

Unit I
Introduction to computer system – Usage of basic digital blocks - Floating point number – IEEE single precision and double precision representation - Floating point arithmetic - Floating point adder/Subtractor - Addressing modes with examples - Data path and controller design – Single bus dataflow unit - Multi bus architecture

Unit II

Introduction to CPU design - Processor organization - Execution of complete instruction - Design of control unit - Hardwired Control - Microprogrammed Control - Memory and system organization – CPU and memory interaction - Organization of memory modules and interfacing - Cache memory: introduction, related mapping and replacement policies -

Unit III

Input/output processing - Introduction to Interrupts - Interrupt controlled I/O transfer DMA - Introduction to RISC and CISC approaches - Introduction to pipelining - Pipeline performance - Hazards in pipeline and types – Introduction to Parallel Processing - Parallel Processing Performance – Multithreading - Cache coherence for shared data - Message passing in distributed memory systems - Mathematical modeling of performance.

Textbook(s)

1. V. Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", Fifth edition, Indian Edition, McGraw-Hill Education, 2011.
2. Patterson DA, Hennessy JL. Computer Organisation and Design, The Hardware/Software interface (ARM Edition). Fourth Edition, Morgan Kaufmann; 2010.

Reference(s)

1. Behrooz Parhami, "Computer Architecture", Indian Edition, Oxford University Press, 2012.
2. John P. Hayes, "Computer Architecture and Organisation", Indian Edition, McGraw-Hill Education, 2017.

23EAC212	Electronic Systems Design and Automation (Pre-requisite: Nil)	L-T-P-C: 3-1-0-4

Course Objectives

- To familiarize with the basics of designing the physical architecture of electronic systems
- To provide the concept and importance of EMI/EMC in electronic system design
- To provide foundation for design and automation

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the physical architectural design fundamentals for electronic systems
CO2: examine the impact of interconnections on electronic system performance at various abstraction levels
CO3: understand th**e** EMC & EMI issues in electronic systems design
CO4: understand and develop the frameworks required for automation

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2								3		2
CO2	3	2	3	2	2								3		2
CO3	3	2	3	2									3		2
CO4	3	2	2	2	3								3		2

Syllabus

Unit I

Introduction – Introduction to electronic (industrial electronics) system Design, Product development process, Life Cycle, Product architecture, Electronic Product design and development Methodology, product innovations. Introduction to the concept of reliability and quality, Reliability mathematics, Calculation of system Reliability

Unit II

Circuit diagrams- Computer Aided Design(CAD) – PCB fabrication -Creating circuit design with capture -Designing PCB with layout -Project structures and layout tool set, PCB design rules for Digital, High Frequency, Analog, Power Electronics and Microwave circuits; Introduction to EMI/EMC- Design concerns for Engineers -Electromagnetic environment –

Potential emission levels -Methods of noise coupling -Nature of interference -EMC and PCB- Open area test sites: OATS measurements, measurement precautions.

Unit III

Electronic Design Automation (EDA)- EDA tool, steps like simulation, design, validation with some example like Synopsis, Cadence; PLC/SCADA- File structure and addressing formats – PLC project development -Instruction Set- PLC Applications – Open PLC with Rpi – Open PLC and Modbus – Simple automation projects with Open PLC and Rpi.

Text Book(s)/References

1. Jens Lienig, Juergen Scheible, "Fundamentals of Electronic system design ," Springer International Publishing, 2020.
2. Mark I. Montrose, "EMC and the Printed Circuit Board Design, Theory, and Layout Made Simple",
3. Frederick D. Hackworth, "Programmable Logic Controllers: Programming Methods and Applications", Pearson Education, 2004.
4. Josef Bernhardt, "PLC Programming with the Raspberry Pi and the OpenPLC Project" Elektor,2021

Course Objectives

23ECE216	**Machine Learning** (**Pre-requisite:** Foundations of Data Science)	**L-T-P-C: 3-0-0-3**

- To provide the foundations of machine learning
- To introduce supervised and unsupervised learning techniques
- To enable the appreciation of machine learning techniques

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the mathematical foundations of machine learning
CO2: understand supervised and unsupervised learning techniques
CO3: apply machine learning techniques to standard datasets
CO4: analyze the performance of machine learning models

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										3			
CO2	3	2										2			
CO3	3	3										2			
CO4	3	3										2			

Syllabus

Unit I

Review of Multi-variable Calculus – partial derivatives, gradient, Hessian and Jacobian, multi-variate Taylor's series; Unconstrained Optimization – local and global minima, gradient descent, step-size, adaptive learning rate; Constrained Optimization – Lagrange multipliers and KKT condition; Introduction to Machine Learning – supervised vs. unsupervised, regression vs. classification, data normalization, missing data problem and data imbalance problem, underfitting and overfitting, bias vs. variance; Performance Evaluation – evaluation measures, train- test- and validation datasets, cross-validation, hyperparameter tuning.

Unit II

Linear Models – linear regression, stochastic gradient descent, minibatch, regularization, early stopping, logistic regression; Support Vector Machines (SVM); Classification – K-Nearest Neighbor (KNN); Naïve Bayes; Decision Trees, Bagging, Random Forest, Boosting; Clustering – linkage algorithms, K-Means, DBSCAN.

Unit III

Neural Networks – artificial neural networks (ANN), multi-layer perceptron, neural network structures, fully connected, convolutional and recurrent neural networks, automatic differentiation, backpropagation, Optimizers – momentum, RMSP, ADAM; Dropout; Applications of ANN to regression and classification.

Textbook(s)

1. Hui Jiang, "Machine Learning Fundamentals", Cambridge university Press, 2021.

2. Aurelion Geron, “Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow”, O’Reilly, Third Edition, 2023.

Reference(s)

1. Goodfellow, I., Bengio, Y. and Courville, A., 2016. Deep learning. MIT press.
2. Christopher M Bishop. Pattern Recognition and Machine Learning. Springer 2010.
3. Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, “Mathematics for Machine Learning”, Cambridge University Press, 2020.

23ECE284	Microcontrollers and Interfacing Laboratory	L-T-P-C: 0-0-3-1
	(**Pre-requisite:** Digital Electronics)	

Course Objectives

- To provide hands-on experience of a Microcontroller and its Peripherals
- To provide experience in the interfacing of External Peripherals with a Microcontroller
- To enable the design and implementation of simple Embedded Systems

Course Outcomes: At the end of the course, the student should be able to

CO1: program in Assembly Language and Embedded C
CO2: configure the Internal Peripherals of a Microcontroller
CO3: interface External Peripherals with a Microcontroller
CO4: prototype a Microcontroller based System

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3				3	3		2			3
CO2	3	2			3				3	3		2			3
CO3	3	2			3				3	3		2			3
CO4	3	3	3		3				3	3		2			3

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:
Design an office automation where all interfaces of it might be used for controlling several of office items/machineries.

Experiment Contents:

1. Assembly Language Programs for Addition, Subtraction, Indirect Addressing Modes
2. LED Blinking and Control of LED with Switch using GPIO Peripheral in LPC2148
3. Serial Transmission and Reception using UART
4. Sensor Interfacing using ADC
5. Square Wave Generation using Timer
6. DC Motor Speed Control using PWM
7. LCD Interfacing
8. Term Project

Textbook(s)

1. LPC2148 User manual, NXP Semiconductors, https://www.nxp.com/docs/en/user-guide/UM10139.pdf

References(s)

1. Sloss, D. Symes, C. Wright, “*ARM System Developer's Guide: Designing and Optimizing System Software”*, First Edition, Elsevier, 2004.

23ECE285	Machine Learning Laboratory	L-T-P-C: 0-0-3-1
	(**Pre-requisite:** Foundations of Data Science)	

Course Objectives

- To provide hands-on experience in the training of ML models
- To enable the performance analysis of Machine Learning algorithms
- To enable the identification of optimal model hyperparameters

Course Outcomes: At the end of the course, the student should be able to

CO1: preprocess data
CO2: train ML models
CO3: analyze the performance of ML algorithms
CO4: optimize model performance

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	3				3				2	2		3			
CO2	3				3				2	2		2			
CO3	3	2			3				2	2		3			
CO4	3	2	2		3				2	2		2			

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:
Develop a useful application (case study) which can be used directly by student, faculty, dept. management, school, university or anyone or organization.

Experiment Contents:
1. Data pre-processing: data cleaning, scaling, encoding
2. Descriptive Statistics - central tendency and dispersion
3. Regression- single- and multi-variable
4. Classification – logistic regression, KNN, Naïve Bayes', decision trees
5. Clustering - K-Means, DBSCAN, GMM
6. Performance Evaluation: confusion matrix, accuracy, precision, recall, specificity, ROC, inertia, silhouette score, hyper-parameter tuning for optimizing the performance
7. Artificial Neural Networks - Case Studies involving classification

Textbook(s)

1. Wei-Meng Lee, "Python Machine Learning", Wiley, 2019.
2. Aurelion Geron, "Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow", O'Reilly, Third Edition, 2023.

Reference(s)

1. Thomas Nield, "Essential Math for Data Science", O'Reilly, 2022.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, Second Edition, 2023.
3. Jason Brownlee, "Machine Learning Algorithms from Scratch", Available Online, 2018.
4. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015.

23EAC284	Electronic Circuits – II Laboratory (**Pre-requisite:** Electronic Circuits I)	L-T-P-C: 0-0-3-1

Course Objectives

- To enable the study and extraction of device parameters from datasheets
- To provide a hands-on experience of the effect of negative feedback
- To provide hands-on experience on the design of linear and non-linear circuits

Course Outcomes: At the end of the course, the student should be able to

CO1: use datasheets effectively
CO2: simulate Linear and Non-linear circuits
CO3: understand the effect of negative feedback
CO4: prototype and characterize Linear and Non-Linear circuits using opamps

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	3		2						2	2		2	2		
CO2	3	2	2		3				2	2		2	2		
CO3	3	2	2						2	2			2		
CO4	3	2	2						2	2			2		

Syllabus
Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

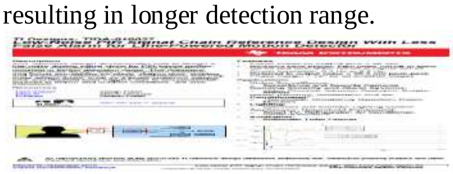
Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:

- To design transimpedance amplifier to amplify the AC signal of a photodiode. The circuit should reject DC signals. Switching speed should be more than 3MHz.

Reference:
https://www.ti.com/lit/an/sboa324/sboa324.pdf?ts=1684025930170&ref_url=https%253A%252F%252Fwww.ti.com%252Fsitesearch%252Fen-us%252Fdocs%252Funiversalsearch.tsp%253FlangPref%253Den-US%2526searchTerm%253Dinstrumentation%2Bamplifier%2526nr%253D966034

- To design a low-noise analog signal chain for PIR-based motion detection subsystems in line-powered applications resulting in longer detection range.



Reference:
https://www.ti.com/lit/ug/tidueh9/tidueh9.pdf?ts=1684027114303&ref_url=https%253A%252F%252Fwww.ti.com%252Ftool%252FCIRCUIT060004

Contents for Experiments

1. Voltage/Current series Feedback amplifier
2. Current/Voltage shunt Feedback amplifier
3. Inverting and Non-inverting Amplifier and Voltage Follower

4. Difference and Summing Amplifiers.
5. Instrumentation Amplifier
6. Integrator and Differentiator.
7. Precision Rectifier-Half wave and Full wave
8. Comparator and Schmitt Trigger
9. RC phase shift oscillator/ Wein-Bridge Oscillator.
10. Astable and Monostable multivibrators

Textbook(s)

1. A S. Sedra, K. C. Smith and A. N. Chandorkar, "Microelectronic Circuits -Theory and Applications", Seventh Edition, Oxford University Press, 2017.

References(s)

1. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Fourth Edition, Tata McGraw Hill Publishing Company Limited, 2015.
2. J. Millman and A.Grabel, "Microelectronics", Second Edition, McGraw-Hill, 2001

23LSE211	**LIFE SKILLS FOR ENGINEERS II**	**L-T-P-C: 1-0-2-2**

Pre-requisite(s): An inquisitive mind, basic English language skills, knowledge of high schoollevel mathematics.

Course Objectives

- Assist students in inculcating Soft Skills and developing a strong personality.
- Help them improve their presentation skills.
- Aid them in developing their problem solving and reasoning skills.
- Facilitate them in improving the effectiveness of their communication.

Course Outcomes

CO1: Soft Skills: To develop greater morale and positive attitude to face, analyse, and manageemotions in real life situations, like placement process.

CO2: Soft Skills: To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.

CO3: Aptitude: To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.

CO4: Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis.

CO5: Verbal: To learn to use more appropriate words in the given context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.

CO6: Verbal: To be able to read texts critically and arrive at/ predict logical conclusions. To learn to organize speech and incorporate feedback in order to convey ideas with better clarity.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	3	3		3
CO2									2	3		3
CO3		3		2								
CO4		3		2								
CO5										3		3
CO6									3	3		3

Syllabus

Soft Skills

Communication: Process, Language Fluency, Non-verbal, Active listening. Assertiveness vs. aggressiveness. Barriers in communication. Digital communication

Presentations: Need, importance, preparations, research and content development, structuring and ensuring flow of the presentation. Ways and means of making an effective presentation: Understanding and connecting with the audience – using storytelling technique, managing time, appropriate language, gestures, posture, facial expressions, tones, intonations and grooming. Importance of practice to make an impactful presentation.

Aptitude

Problem Solving II

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.

Logarithms, Inequalities and Modulus: Basics

Time and Work: Basics, Pipes & Cistern, and Work Equivalence.

Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races andCircular tracks.

Logical Reasoning: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams,Binary Logic, and Logical Connectives.

Verbal

Vocabulary: Aid students learn to use their vocabulary to complete the given sentences with the rightwords. Usage of more appropriate words in different contexts is emphasized.

Grammar (**Basic-intermediate**): Help students master usage of grammatical forms and enablestudents to identify errors and correct them.

Reasoning: Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication.

Reading Comprehension (**Basics**): Introduce students to smart reading techniques and help themunderstand different tones in comprehension passages.

Speaking Skills: Make students be aware of the importance of impactful communication throughindividual speaking activities in class.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquette of email writing.

Reference(s)

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita VishwaVidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), *"Effective Team Building: How to make * winning team",* London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
9. Cracking the New GRE 2012
10. Kaplan's – GRE Comprehensive Programme
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.

Evaluation Pattern: 50:50

Assessment	Internal	External
Continuous Assessment (CA) – Soft Skills	30	-
Continuous Assessment (CA) – Aptitude	10	25
Continuous Assessment (CA) – Verbal	10	25
Total	50	50

*CA - Can be presentations, speaking activities and tests.

22ADM201	Strategic Lessons from Mahabharata	L-T-P-C: 1-0-0-1

Course Objectives

To provide deeper understanding of the ethical grandeur of Indian culture, and be inspired to follow the ideals of the characters depicted therein

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the impact of itihasas on Indian civilization with a special reference to the Adiparva of Mahabharata
CO2: understand the importance of fighting adharma for the welfare of the society through Sabha and Vanaparva.

CO3: understand the nuances of dharma through the contrast between noble and ignoble characters of the epic as depicted in the Vana, Virata, Udyoga and Bhishma parvas
CO4: get deeper understanding of the Yuddha Dharma through the subsequent Parvas viz., Drona, Karna, Shalya, Sauptika Parvas
CO5: appreciate the spiritual instruction on the ultimate triumph of dharma through the presentations of the important episodes of the MB with special light on Shanti, Anushasana, Ashwamedhika, Ashramavasika, Mausala, Mahaprasthanika and Swargarohana Parvas

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1		3	1			3			
CO2						2	3	3	3	3		3			
CO3						3	3	3	3	3		3			
CO4						3		3	3	2		3			
CO5						3	1	3	1	1		3			

Syllabus

Unit I

Mahābhārata - A Brief Summary- A Preamble to the Grand Itihāsa- The Unbroken Legacy; Dharmic Insights of a Butcher; The Vows We Take; Kingship and Polity Acumen

Unit II

Karna – The Maestro that Went Wide off the Mark; Tactics of Krishna; Yajnaseni; Popular Regional Tales; Maha Prasthanam – The Last Journey.

Unit III

Mahabharata - An All-Encompassing Text; Mahābhārata- Whats and What Nots; Nyayas in Mahabharata.

Textbooks/References

1. Leadership Lessons from the Mahabharat, ASCSS
2. Rajagopalachari. C, The Mahabharata

23LAW300	Indian Constitution (Pre-requisite: Nil)	P/F

Course Objectives

To know about Indian constitution, Indian society, central and state government functionalities in India

Course Outcomes: At the end of the course, the student should be able to
CO1: understand the functions of the Indian government
CO2: understand and abide the rules of the Indian constitution
CO3: understand and appreciate different culture among the people

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
CO1	-	-	-	-	-	3	2	3	-	-	-	-	-	-	-
CO2	-	-	-	-	-	3	2	3	-	-	-	-	-	-	-
CO3	-	-	-	-	-	3	2	3	-	-	-	-	-	-	-

Syllabus

Unit I
Historical Background – Constituent Assembly of India – Philosophical Foundations of The Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for Citizens.

Unit II
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

Unit III
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

Textbook(s)
1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi, 24th Edition, 2021.
2. R. C. Agarwal, "Indian Political System", S. Chand and Company, New Delhi, 12th Edition, 2019.

Reference(s)
1. Sharma, Brij Kishore, "Introduction to the Constitution of India", Prentice Hall of India, New Delhi, 7th Edition, 2019.

SEMESTER V

Course Objectives

23ECE313	**Embedded Systems** (**Pre-requisite:** Microcontrollers and Interfacing)	**L-T-P-C: 3-0-0-3**

- To provide foundation on Embedded System Platforms
- To enable configuration of advanced peripherals for Embedded Applications
- To provide basic understanding of Real Time Operating Systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the architectural features of an Embedded System
CO2: configure the peripherals of an advanced Microcontroller
CO3: understand the concepts of Real Time Operating Systems
CO4: understand the design of an Embedded System

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3		2									2		3	
CO2	3	2	2									2		3	
CO3	3		2									2		3	
CO4	3	2	3									2		3	

Syllabus

Unit I
Introduction- Architecture, hardware and software requirements, applications; Cortex M3 architecture – Registers - Operating Modes - NVIC - Memory Map - MPU – Exceptions - Debug Support in Cortex M3 - Stack Pointer - Link Register - Program Status Registers - Interrupt Mask Registers - Control Registers - Stack Memory Operations - Reset Sequence - Bit Banding - Memory Access Attributes - Advantages of Bit Banding – Pipelining - Detailed Cortex M3 Architecture - Bus Interfaces - Reset Types - Preempt and Sub Priority - Interrupt Input and Pending Behavior

Unit II
Bus Faults - Memory Management Fault - Usage Fault - Hard Fault - Methods of dealing with Faults - Supervisory Call - Pendable Service Call - System Tick Timer - Sleep on Exit - Wake up Interrupt Controller - Multiprocessor Communication - Self Reset Control - Debug Architecture - CoreSight Architecture, Modified CoreSight Architecture - TM4C123 Architecture - GPIO - ADC - Timers - PWM - External Interrupt

Unit III
SPI - I2C – DAC Interfacing using SPI – RTC Interfacing using I2C - Software Architectures - Round Robin - Round Robin with Interrupt - Function Queue Scheduling - RTOS software architecture – Task - Task States - Context of Task - Shared Data Problem – Reentrancy – Semaphore – Types - Semaphore problems - Priority Inversion - Deadly Embrace - Ways to Protect Shared Data, Message Queue - Mailbox – Pipe - Pitfalls with MQ, Mailboxes and Pipes

Textbook(s)

1. J. Yiu, “The Definitive Guide to the ARM Cortex M3 and Cortex M4 Processors”, Third Edition, Elsevier Inc., 2014
2. M. A. Mazidi, S. Chen, S. Naimi, Ti Tiva Arm Programming for Embedded Systems: Programming Arm Cortex-M4 TM4C123G with C, 2016
3. Richard Barry, “Using the FreeRTOS Real Time Kernel ARM Cortex-M3 Edition”, Real Time Engineers Ltd., 2010.

Reference(s)

1. D. V. Gadre, S. Gupta, *Getting Started with Tiva ARM Cortex M4 Microcontrollers*, Springer, 2018
2. Richard Barry, “*Mastering the FreeRTOS Real Time Kernel, A Hands-On Tutorial Guide”*, Real Time Engineers Ltd., 2016.

23ECE302	**VLSI Design**	**L-T-P-C: 3-0-0-3**
	(**Pre-requisite:** Electronic Devices and Circuits, Digital Electronics)	

Course Objectives

- To enable design of CMOS logic circuits at the schematic and layout level
- To enable an understanding of dc and transient characteristics of MOS circuits
- To enable the analysis of RC delays in CMOS circuits

Course Outcomes: At the end of the course, the student should be able to

CO1: design schematics and layout of CMOS circuits
CO2: characterize the DC and transient behaviour of CMOS circuits
CO3: analyze effect of device sizing on RC delays
CO4: understand different CMOS circuit enhancements for improved speed, area and delay

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	3	2	2										3		
CO2	3	2											3		
CO3	3	2											3		
CO4	3												3		

Syllabus

Unit I
VLSI Design – Introduction, VLSI design flow - MOSFETs as logic switches – Pass Characteristics of MOSFETs, CMOS logic design, Transmission gates-based design, CMOS Layers, RC of an Interconnect, Design of FET Arrays, CMOS physical layouts and stick diagrams - Design Rules, CMOS Process Flow.

Unit II
MOSFET characteristics and sizing - MOSFET channel and current equations, Scaling Theory. FET RC Model, Elmore Delay calculation. DC switching characteristics of CMOS inverter - DC characteristics of NAND and NOR gates - Transient response of Inverter. Power Dissipation, Gate design for transient performance, Logical Effort.

Unit III
CMOS logic circuit design Techniques - Mirror circuits – Pseudo NMOS - Clocked CMOS - Dynamic CMOS logic circuits, Domino, MODL, CVSL.

Textbook(s)

1. J. P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley and Sons, 2006.
2. Neil Weste, David Harris, Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson Education, 4th Edition, 2011.

Reference(s)

1. Jan M. Rabey, Anantha Chandrakasan, and Borivoje Nikolic, "Digital Integrated Circuits-A Design Perspective", Second Edition, Prentice Hall/Pearson, 2003.
2. Sung-Mo Kang, Yusuf Leblechi, "CMOS Digital Integrated Circuits - Analysis and Design", Tata McGraw Hill Publishing Company Limited, Third Edition, 2003.

23EAC301	Database Management Systems (**Pre-requisite:** Data Structure and Algorithm)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce fundamental concepts of database management systems
- To enable systematic design of relational databases
- To provide the knowledge of SQL programming constructs for building relational databases and querying information

Course Outcomes: At the end of the course, the student should be able to

CO1: understand basic concepts of database systems
CO2: apply programming constructs in SQL effectively
CO3: apply E-R models and formal methods to design relational databases

CO4: understand database management concepts

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			2
CO2	3	2			2							2			2
CO3	3	2													2
CO4	3	2										2			2

Syllabus

Unit I
Introduction - General introduction to database systems; Database - DBMS distinction, approaches to building a database, data models, three-schema architecture of a database, challenges in building a DBMS, components of a DBMS. E/R Model - Conceptual data modeling - motivation, entities, entity types, attribute types, relationship types, E/R diagram notation. Relational Data Model - Concept of relations, schema-instance distinction, keys, referential integrity and foreign keys, relational algebra operators: selection, projection, cross product, joins, division, example queries, tuple relation calculus, domain relational calculus, converting the database specification in E/R notation.

Unit II
SQL - Introduction, data definition in SQL, table, key and foreign key definitions, update behaviors. Querying in SQL - basic select-from-where block and its semantics, nested queries - correlated and uncorrelated, notion of aggregation, aggregation functions group by and having clauses, embedded SQL. Dependencies and Normal forms - Importance of a good schema design, problems encountered with bad schema designs, motivation for normal forms, dependency theory - functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF, join dependencies and definition of 5NF.

Unit III
Data Storage and Indexes - file organizations, primary, secondary index structures, various index structures - hash-based, dynamic hashing techniques, multi-level indexes, B+ trees. Transaction processing and Error recovery - concepts of transaction processing, ACID properties, concurrency control, locking based protocols for CC, error recovery and logging, undo, redo, undo-redo logging and recovery methods.

Textbook(s)

1. Database System Concepts (Sixth Edition) Avi Silberschatz, Henry F. Korth, S. Sudarshan McGraw-Hill 2011
2. Database Management Systems, Third Edition Raghu Ramakrishnan and Johannes Gehrke McGraw-Hill ©2003

References(s)

3. Fundamentals of Database Systems, 7th Edition Ramez Elmasri, University of Texas at Arlington Shamkant B. Navathe Pearson India ©2011
4. Database Systems: The Complete Book, (2nd Edition, 2014) Hector Garcia-Molina, Jeffrey D Ullman and Jennifer Widom Pearson India

23EAC302	**Data Communication and Networks** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide an introduction to the concepts of data communication
- To enable an understanding of the principles of computer networks
- To provide an introduction to standard protocols

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concepts of data communication
CO2: understand the layered architecture of Internet and protocols
CO3: understand the concepts of switching, routing and reliable transport of data
CO4: understand the operation of network protocols

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	2											2			2
CO2	2											2			2
CO3	2											2			2
CO4	2											2			2

Syllabus

Unit I
Introduction to Data Communications- Communication, data communication, line coding (signal representation), data communication through wired channel, data communication through wireless channels. Computer Networks- Network Types and topology -The Internet- Protocol Layering- The OSI Model- TCP/IP Protocol suite. Physical Layer- Data and Signals –Transmission Impairments- Data rate limits- Performance-Digital Transmission – Digital to Digital conversion-Transmission modes - Multiplexing- Transmission Media – Guided and Unguided media-Circuit Switching- Packet Switching and Switches.

Unit II
Data link layer- Error detection and correction - Medium Access control - Random access- Controlled access. Connecting Devices. Network Layer- IPv4 Protocol and Addresses - Transition from IPv4 to IPv6 Protocol- Routing Algorithms.

Unit III
Transport Layer- Transport Layer protocols – UDP- TCP- TCP Services and Features- TCP Segment and Connection. Application Layer - WWW and HTTP - DNS.

Textbook(s)

1. Behrouz Forouzan, “Data Communication and Networking”, Tata McGraw Hill, 5th edition, 2012.
2. William Stallings, “Data and Computer Communications”, 9th edition, Pearson Education Asia, 2011.

References(s)

3. James Kurose and Keith Ross, “Computer Networking: A Top-down Approach” 6th edition, Addison Wesley 2010.
4. Andrew S Tannenbaum, David J. Whetheral, “Computer Networks”, Prentice Hall, 5th edition, 2010.
5. Larry L. Peterson and Bruce S. Davie, “Computer Networks - A Systems Approach”, Morgan Kaufmann, Fifth Edition, 2011.

23EAC381	Open Laboratory -1 (**Pre-requisite:** Nil)	L-T-P-C: 0-0-3-1

Course Objectives

- To provide platform for creative and innovative thinking
- To enable understanding of available state of art in the identified area of interest
- To enable simulation/hardware-prototyping of solutions to effectively transform ideas to reality

Course Outcomes: At the end of the course, the student should be able to

CO1: analyze practical problems and investigate scope for applying technology to develop feasible solutions
CO2: design the required system using appropriate EDA tools and implement the hardware

CO3: analyze the implementation impact and suggest improvements or modifications
CO4: present the concept with adequate validation on technical aspects and cost analysis

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO2	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO3	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO4	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3

23ECE387 **Embedded Systems Laboratory** **L-T-P-C: 0-0-3-1**
(**Pre-requisite:** Microcontrollers and Interfacing)

Course Objectives

- To provide hands-on experience to use peripherals of an advanced Microcontroller
- To enable implementation of Real Time Operating System (RTOS) concepts
- To enable design of an Embedded System using advanced Microcontroller

Course Outcomes: At the end of the course, the student should be able to

CO1: configure peripherals of an advanced Microcontroller
CO2: interface External Peripherals with an Embedded Platform
CO3: implement Task Management and Inter Task Communication using RTOS
CO4: prototype an Embedded System using advanced Microcontroller

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		2		3				3	3		2			3
CO2	3		2		3				3	3		2			3
CO3	3		2		3				3	3		2			3
CO4	3	3	3		3				3	3		2			3

Syllabus
Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:
Let them develop something for cafeteria a process of giving an order till customer has gone out of café.

Experiment Contents:
1. GPIO Programming using Cortex M4
2. Delay Time Generation using Timer
3. Analog Sensor Interfacing using ADC
4. External DAC Interfacing using SPI
5. External RTC Interfacing using I2C
6. Task Management using FreeRTOS
7. Inter Task Communication using FreeRTOS
8. Term Project

Textbook(s)

1. M. A. Mazidi, S. Chen, S. Naimi, Ti Tiva Arm Programming for Embedded Systems: Programming Arm Cortex-M4 TM4C123G with C, 2016
2. Richard Barry, "Using the FreeRTOS Real Time Kernel ARM Cortex-M3 Edition", Real Time Engineers Ltd., 2010.

Reference(s)

3. Richard Barry, "Mastering the FreeRTOS Real Time Kernel, A Hands-On Tutorial Guide", Real Time Engineers Ltd., 2016.

23ECE383	VLSI Design Laboratory (**Pre-requisite:** Digital Electronics)	L-T-P-C: 0-0-3-1

Course Objectives

- To enable the use of simulation tools for analyzing CMOS circuits
- To provide hands-on experience in HDL modeling and simulation of digital subsystems
- To provide a background in the synthesis and implementation of HDL models

Course Outcomes: At the end of the course, the student should be able to

CO1: model and simulate combinational subsystems using HDLs
CO2: model and simulate sequential subsystems using HDLs
CO3: implement HDL models on FPGA
CO4: model and simulate CMOS logic circuits

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	3				3				3	3		2	3		
CO2	3				3				3	3		2	3		
CO3	3	2			3				3	3		2	3		
CO4	3	2			3				3	3		2	3		

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

1. Write Verilog code to design following combinational circuits using Gate level (Structural) modeling-
   (i) Half adder
   (ii) 2:1 Multiplexer
2. Write Verilog code to design following combinational circuits using Data flow modeling-
   (i) Half adder
   (ii) 2:1 Multiplexer
3. Write Verilog code to design following combinational circuits using Gate level (Structural) modeling-
   (i) Full adder using half adders and any other required logic gate
   (ii) 4:1 Multiplexer using 2:1 Multiplexers only
   (iii) 8:1 Multiplexer using 2:1 Multiplexers only
4. Write Verilog code to design following sequential circuits using behavioral modeling-
   (i) D Latch
   (ii) D Flip-flop
   (iii) T Flip-flop
   (iv) JK Flip-flop
5. Write a Verilog code to design 4-bit Up/Down counter using behavioral modeling.
6. Implementation of sequence detector using Mealy and/or Moore FSM.
7. Implementation of FIFO and LIFO.
8. Design and analyze the transient characteristics for CMOS logic schematics.

9. Design and analyze the transient Characteristics for Full Adder and Ripple Carry Adder using CMOS logic in schematic.
10. Design and analyze the transient characteristics for D-Flip Flop, JK Flipflop, and T-Flip Flop using CMOS logic in schematic.

Textbook(s)

1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Second Edition, Pearson, 2003. Michael D Ciletti, "Advanced Digital Design with the Verilog HDL", Second Edition, Pearson, 2017.
2. J. P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley and Sons, 2006.

Reference(s)

1. T. R. Padmanabhan and B. Bala Tripura Sundari, "Design through the Verilog HDL", First Edition, Wiley Interscience, 2004.
2. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.

23EAC382	Database Management Systems Laboratory (**Pre-requisite:** Data Structure and Algorithms)	L-T-P-C: 0-0-3-1

Course Objectives

- To provide hands-on experience on the SQL programming language
- To enable efficient query of information from relational databases
- To enable implementation and management of relational databases

Course Outcomes: At the end of the course, the student should be able to

CO1: create and perform basic operations on tables
CO2: apply queries to efficiently retrieve information
CO3: apply SQL features for data and access management
CO4: develop relational databases for specific applications

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3				3	3		2			2
CO2	3				3				3	3		2			2
CO3	3				3				3	3		2			2
CO4	3	2			3				3	3		2			2

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Experiment Contents:

1. Set up a local database, schema and management console
2. Create and modify SQL tables
3. Basic SQL query structure and variations
4. Set operations, aggregation functions
5. Nested subqueries
6. Joins
7. Indexing
8. Views and authorization
9. Data types, schemas, and integrity constraints
10. PL/SQL Programs using Triggers, Stored Procedures, Functions and Exception Handling.

Textbook(s)

5. Database System Concepts (Sixth Edition) Avi Silberschatz, Henry F. Korth, S. Sudarshan McGraw-Hill 2011 ISBN 978-0071325226/ 0-07-352332-1
6. Database Management Systems, Third Edition Raghu Ramakrishnan and Johannes Gehrke McGraw-Hill ©2003 ISBN: 978-0072465631/ 0-07-246563-8

References(s)

1. Fundamentals of Database Systems, 7th Edition Ramez Elmasri, University of Texas at Arlington Shamkant B. Navathe Pearson India ©2011 ISBN 978-0321369574
2. Database Systems: The Complete Book, (2nd Edition, 2014) Hector Garcia-Molina, Jeffrey D Ullman, and Jennifer Widom Pearson India ISBN: 978-9332518674, 9-33-251867-X

23LSE301	**LIFE SKILLS FOR ENGINEERS III**	**L-T-P-C: 1-0-2-2**

Pre-requisite(s): Willingness to learn, communication skills, basic English language skills,knowledge of high school level mathematics.

Course Objectives

- Help students understand corporate culture, develop leadership qualities and becomegood team players
- Assist them in improving group discussion skills
- Help students to sharpen their problem solving and reasoning skills
- Empower students to communicate effectively

Course Outcomes

CO1 - Soft Skills: To improve the inter-personal communication and leadership skills, vital forarriving at win-win situations in Group Discussions and other team activities.

CO2 - Soft Skills: To develop the ability to create better impact in a Group Discussions through examination, participation, perspective-sharing, ideation, listening, brainstorming and consensus.

CO3 - Aptitude: To identify, investigate and arrive at appropriate strategies to solve questionson geometry, statistics, probability and combinatorics.

CO4 - Aptitude: To analyze, understand and apply suitable methods to solve questions on logical reasoning.

CO5 - Verbal: To be able to use diction that is more refined and appropriate and to be competent in spotting grammatical errors and correcting them.

CO6-Verbal: To be able to logically connect words, phrases, sentences and thereby communicate their perspectives/ideas convincingly.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									3	3	2	3
CO2										3	2	2
CO3		3		2								
CO4		3		2								
CO5										3		3
CO6									3	3		3

Syllabus

Soft Skills

Professional Grooming and Practices: Basics of corporate culture, key pillars of business etiquette – online and offline: socially acceptable ways of behavior, body language, personal hygiene, professional attire and Cultural adaptability and managing diversity. Handling pressure, multi-tasking. Beingenterprising. Adapting to corporate life: Emotional Management (EQ), Adversity Management, Health consciousness. People skills, Critical Thinking and Problem solving.

Group Discussions: Advantages of group discussions, Types of group discussion and Roles played ina group discussion. Personality traits evaluated in a group discussion. Initiation techniques andmaintaining the flow of the discussion, how to perform well in a group discussion. Summarization/conclusion.

Aptitude

Problem Solving III

Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.

Permutations & Combinations: Basics, Fundamental Counting Principle, CircularArrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes'Theorem.

Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

Logical Reasoning: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding

\& Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Verbal

Vocabulary: Create an awareness of using refined language through idioms and phrasal verbs. **Grammar** (**Upper Intermediate-Advanced**): Train Students to comprehend the nuances of Grammarand empower them to spot errors in sentences and correct them.

Reasoning: Enable students to connect words, phrases and sentences logically.

Oral Communication Skills: Aid students in using the gift of the gab to interpret images, do a video synthesis, try a song interpretation or elaborate on a literary quote.

Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.

Reference(s)

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita VishwaVidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), *"Effective Team Building: How to make * winning team",* London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Public Sector – Engineer Management Trainee Recruitment Exam (General English)
9. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
10. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
11. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
12. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
13. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
14. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
15. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
16. A Modern Approach to Logical Reasoning, R S Aggarwal.
17. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern: 50:50

Assessment	Internal	External
Continuous Assessment (CA) – Soft Skills	30	-
Continuous Assessment (CA) – Aptitude	10	25
Continuous Assessment (CA) – Verbal	10	25
Total	50	50

*CA - Can be presentations, speaking activities and tests.

Course Objectives

23LIV390	Live-in Lab -1 (**Pre-requisite:** Nil)	L-T-P-C: 0-0-9-3

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Centered Design and Participatory Rural Appraisal.
- Assess the user need through quantitative and qualitative measurements
- Design a solution by integrating human centered design concepts
- Devising proposed intervention strategies for sustainable social change management

Course Outcome: At the end of the course, the student should be able to

CO1: learn ethnographic research and utilise the methodologies to enhance participatory engagement.
CO2: prioritize challenges and derive constraints using Participatory Rural Appraisal.

CO3: identify and formulate the research challenges in rural communities.
CO4: design solutions using human centered approach.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3		3		1	1		3	3		3
CO2		3						3	3	3		
CO3		3					1		3	3		3
CO4	3		3				3	3	3	3		3

Syllabus

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after 4th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

The objectives and the projected outcome of the project will be reviewed and approved by the department chairperson and a faculty assigned as the project guide.

SEMESTER VI

23EAC311	Cyber Physical Systems (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the mathematical foundation for modeling CPS

- To enable build models of CPS for simple use cases
- To introduce networking, intelligence and security aspects of CPS

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the mathematical concepts of CPS
CO2: apply model based design to build CPS models
CO3: analyze the performance of simple CPS models
CO4: understand the role of networking, sensing, security and intelligent systems

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO															
CO1	3											2		3	
CO2	3	2										2		3	
CO3	3	2	2									2		3	
CO4	3	2										2		3	

Syllabus

Unit I
Introduction – Overview of CPS, characteristics, CPS in the real world, Computational vs. Physical Systems, Fundamental approach, CPS Genesis, Modeling, Design, Verification and Validation, Assembly and Deployment; trends and challenges of modern cyber-physical systems.

Unit II
Modeling Cyber-Physical Systems: Overview of Continuous, Discrete, and Hybrid Models, dynamics of a physical system; Properties of Systems -Causal Systems, Memoryless Systems, Linearity and Time Invariance, Stability; Feedback Control, Controller Design techniques, Logic based system specification; Discrete Systems - Discrete Signals, Modeling Actors as Functions; The Notion of State- Finite-State Machines, Transitions, When a Reaction Occurs, Update Functions, Software Tools Supporting FSMs, Moore Machines and Mealy Machines;

Unit III
Requirements and Design- Processors and Sensors: Sensors and CPS – trends, Sensors, CPS, and IoT, Actuators and servos, Embedded CPS architectures, Communications, Security, Processors; CPS design and analysis of their performance- Canonical Example: Stopping a car, Feedback, Reduced-gravity Drone; Trajectory Planning and examples, Aviation example, Typical requirements; Guidance techniques, Classical optimization and examples, Dynamic Programs, Automotive example.

Textbook(s)
1. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015
2. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems: A Cyber-Physical Systems Approach, 2011.

References(s)
http://www.feron.org/Eric/OMSCS-CyberPhysicalSystems/page.html
http://LeeSeshia.org

23EAC312	**Software Engineering** (**Pre-requisite:** Computer Programming)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To introduce the challenges in software engineering
- To provide exposure to life-cycle models
- To introduce the concepts of specification, design and testing

Course Outcomes: At the end of the course, the student should be able to

CO1: understand concepts of software engineering
CO2: understand the models for software development life-cycle
CO3: understand software specification and design processes

CO4: understand the concepts of software testing

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2											2			2
CO2	2											2			2
CO3	2	2										2			2
CO4	2	2										2			2

Syllabus

Unit I
Introduction to software engineering, writing requirements, system analysis, system design, software design, testing, deployment, maintenance, updates, quality attributes and, crisis management. Software development life cycles-water fall model, V-model, evolutionary model, RAD model, concurrent-Agile model, enhancement model, spiral model, prototype model.

Unit II
Introduction to Agile methodologies, types-scrum, Kanban framework, LEAN, extreme programming; Scrum framework, product owner, scrum master, development team, product backlog, sprint backlog, product increment, daily scrum; Agile sprint planning-creation of user stories, estimation and assignment of story points, building and refining product backlog; Introduction to DevOp tools; Case studies on latest agile frameworks.

Unit III
Introduction to full stack development-front end development, data base handling, backend development, API, web server, version control; Testing-objectives, unit testing, integration testing, acceptance testing, regression testing, validation testing, system testing, black-box testing, white box testing; Test harness-test drivers, test stubs.

Textbook(s)

1. R. S. Pressman, "Software Engineering: A Practitioners Approach", McGraw Hill, 7th edition, 2010
2. Rajib Mall, "Fundamentals of Software Engineering", PHI Publication, 3rd edition, 2009

References(s)

1. Crowder JA, Friess S, "Agile project management: managing for success", Cham: Springer International Publishing; 2015.
2. Gregory J, Crispin L., "More agile testing: learning journeys for the whole team", Addison-Wesley Professional; 2014.
3. Rubin KS., "Essential Scrum: a practical guide to the most popular agile process", Addison-Wesley; 2012.

23EAC313	IoT and Cloud Computing (**Pre-requisite:** Fundamentals of IoT)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide understanding of Access Technologies and underlying Protocols
- To provide foundation on Cloud Layers and Deployment Models
- To enable integration of IoT and Cloud Computing

Course Outcomes: At the end of the course, the student should be able to

CO1: understand IoT Technologies and Protocols
CO2: understand IoT based system design
CO3: understand different Cloud Deployment Models and their uses
CO4: understand integration of IoT and Cloud Computing Platforms

CO-PO Mapping

PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3

CO															
CO1	3	2									2		3	2
CO2	3	2									2		3	2
CO3	3	2									2		3	2
CO4	3	2									2		3	2

Syllabus

Unit I
Drivers behind New Network Architectures - IoT Architecture - Core IoT Functional Stack - IoT Data Management and Compute Stack - Sensor and Actuators - Smart Object - Connecting Smart Objects - IoT Access Technology - 802.15.4

Unit II
LoRaWAN - IP as IoT Network Layer - Need for IP Optimization in IoT - IoT Transport Methods - IoT Application Layer Protocols - CoAP - MQTT - Data Analytics for IoT – Introduction to Big Data Analytics - Basic Hadoob Architecture - IoT Strategies for Smart Cities, Transportation

Unit III
Introduction to Cloud Computing – Elastic Computing and its Advantages – Types of Cloud and Cloud Providers – Data Center Infrastructure – Virtual Machine – Containers – Virtual Networks – Virtual Storage

Textbook(s)

3. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, J. Henry, *"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things"*, First Edition, Cisco Press, 2017
4. D. Comer, *"The Cloud Computing Book: The Future of Computing Explained"*, CRC Press, 2021

Reference(s)

1. S. Manvi, G. Shyam,*" Cloud Computing: Concepts and Technologies"*, CRC Press, 2021

23EAC383	Open Laboratory -II (**Pre-requisite:** Nil)	L-T-P-C: 0-0-6-2

Course Objectives

- To provide platform for creative and innovative thinking
- To enable understanding of available state of art in the identified area of interest
- To enable simulation/hardware-prototyping of solutions to effectively transform ideas to reality

Course Outcomes: At the end of the course, the student should be able to

CO1: analyze practical problems and investigate scope for applying technology to develop feasible solutions
CO2: design the required system using appropriate EDA tools and implement the hardware
CO3: analyze the implementation impact and suggest improvements or modifications
CO4: present the concept with adequate validation on technical aspects and cost analysis

CO-PO Mapping

PO/PSO															

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO2	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO3	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO4	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3

23EAC384	Cyber Physical Systems Laboratory (Pre-requisite: Nil)	L-T-P-C: 0 0 3 1

Course Objectives

- To study about the modelling of CPS
- To understand the data flow mechanisms and time driven events with CPS
- To develop the CPS for the given specifications

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the design paradigms of CPS
CO2: select the suitable modeling and tools to develop CPS
CO3: describe the required interfacing for modeling with CPS
CO4: develop optimal computational options for cyber-physical systems for the given requirement

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO2	PSO 3
CO1	3	2	2	2	2								2	3	3
CO2	3	2	2	2	2								2	3	3
CO3	3	2	2	2	2								2	3	3
CO4	3	2	2	2	2								2	3	3

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Experiment Contents:

1. Finite state machines -Timed automata
2. Data flow modeling-Synchronous data flow
3. Generating discrete events
4. Modeling interfaces for CPS-Asynchronous modeling with CPS
5. Simple hybrid systems with sensors (Mouse double click detector, motion detector, fast clip speed test)
6. Scheduling real time control tasks with RTOS
7. Case studies

Textbook(s)

1. Peter Mardwel, “Embedded System Foundations of Cyber Physical Systems” Springer 2nd Edition, Springer Netherlands, 2010.

Reference(s)

1. E. A. Lee, Sanjit Seshia “Introduction to Embedded Systems – A Cyber–Physical Systems Approach”, Penguin Random House LLC, 2016.
2. Rajeev Alur, “Principles of Cyber-Physical Systems”, MIT Press, 2015.

23EAC385	**IoT and Cloud Computing Laboratory** (**Pre-requisite:** Fundamental of IoT)	**L-T-P-C: 0-0-3-1**

Course Objectives

- To provide hands-on experience on IoT Hardware
- To provide exposure to Cloud Computing Platforms
- To enable integration of IoT with Cloud Computing Systems

Course Outcomes: At the end of the course, the student should be able to

CO1: prototype simple IoT based Systems
CO2: use Cloud Computing Platforms for Data Processing
CO3: integrate IoT with Cloud Computing
CO4: demonstrate simple IoT Applications on Cloud

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2				3	3		2		3	2
CO2	3	2			3				3	3		2		3	3
CO3	3	2			3				3	3		2		3	3
CO4	3	2	3		3				3	3		2		3	3

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Experiment Contents:

1. GPIO and Motor Control using Raspberry Pi
2. Sensor interfacing and Data Logging using Raspberry Pi with SenseHAT
3. LCD Interfacing using Raspberry Pi
4. Web Server Implementation using Raspberry Pi
5. Raspberry Pi and IoT Cloud Server Interface using MQTT Protocol
6. Machine Learning using IRIS Dataset using Raspberry Pi
7. Image Processing using Raspberry Pi
8. Building Machine Learning Models using Azure Cloud Platform
9. Training Deep Neural Networks on Azure

Textbook(s)

1. S. Monk, “Raspberry Pi Cookbook: Software and Hardware Problems and Solutions”, Fourth Edition, Oreilly, 2022

2. D. J. Norris, "Machine Learning with the Raspberry Pi Experiments with Data and Computer Vision", Apress, 2020
3. Pajankar, "Raspberry Pi Image Processing Programming Develop Real-Life Examples with Python, Pillow, and SciPy", Apress, 2017
4. Korner, K. Waaijer, "Mastering Azure Machine Learning", Packt Publishing, 2020

References(s)

1. P. Waher, "*Mastering Internet of Things: Design and Create your own IoT Applications using Raspberry Pi 3*", Packt Publishing, 2018
2. D. J. Norris, "*Beginning Artificial Intelligence with the Raspberry Pi*", Apress, 2017
3. D. Mukunthu, P. Shah, W. H. Tok, "*Practical Automated Machine Learning on Azure*", Fourth Edition, Oreilly, 2019

23LSE311	LIFE SKILLS FOR ENGINEERS IV	L-T-P-C: 1-0-2-2

Pre-requisite(s): Self-confidence, presentation skills, listening skills, basic English languageskills, knowledge of high school level mathematics.

Course Objectives

- Help students prepare resumes and face interviews with confidence
- Support them in developing their problem-solving ability
- Assist them in improving their problem solving and reasoning skills
- Enable them to communicate confidently before an audience

Course Outcomes

CO1: Soft Skills: To acquire the ability to present themselves confidently and showcase theirknowledge, skills, abilities, interests, practical exposure, strengths and achievements to potential recruiters through a resume, video resume, and personal interview.

CO2: Soft Skills: To have better ability to prepare for facing interviews, analyse interview questions, articulate correct responses and respond appropriately to convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.

CO3: Aptitude: To manage time while applying suitable methods to solve questions on arithmetic, algebra and statistics.

CO4: Aptitude: To investigate, understand and use appropriate techniques to solve questionson logical reasoning and data analysis.

CO5: Verbal: To use diction that is less verbose and more precise and to use prior knowledge of grammar to correct/improve sentences.

CO6: Verbal: To understand arguments, analyze arguments and use inductive/deductivereasoning to arrive at conclusions. To be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									3	3		2
CO2								2	3	3		2
CO3		3		2								
CO4		3		2								
CO5										3		3
CO6									3	3		3

Syllabus

Soft Skills

Teamwork: Value of teamwork in organizations, Definition of a team. Why team? Effective team building. Parameters for a good team, roles, empowerment and need for transparent communication, Factors affecting team effectiveness, Personal characteristics of members and its influence on team. Project Management Skills, Collaboration skills.

Leadership: Initiating and managing change, Internal problem solving, Evaluation and co-ordination, Growth and productivity, Importance of Professional Networking.

Facing an interview: Importance of verbal & aptitude competencies, strong foundation in core competencies, industry orientation / knowledge about the organization, resume writing (including cover letter, digital profile and video resume), being professional. Importance of good communication skills,etiquette to be maintained during an interview, appropriate grooming and mannerism.

<u>Aptitude</u>

Problem Solving II

Sequence and Series: Basics, AP, GP, HP, and Special Series.

Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.

Logical reasoning: Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.

Campus recruitment papers: Discussion of previous year question papers of all major recruiters ofAmrita Vishwa Vidyapeetham.

Competitive examination papers: Discussion of previous year question papers of CAT, GRE,GMAT, and other management entrance examinations.

Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

<u>Verbal</u>

Vocabulary: Empower students to communicate effectively through one-word substitution. **Grammar**: Enable students to improve sentences through a clear understanding of the rules ofgrammar.

Reasoning: Facilitate the student to tap his reasoning skills through Syllogisms, critical reasoningarguments and logical ordering of sentences.

Reading Comprehension (**Advanced**): Enlighten students on the different strategies involved intackling reading comprehension questions.

Public Speaking Skills: Empower students to overcome glossophobia and speak effectively andconfidently before an audience.

Writing Skills: Practice formal written communication through writing emails especially composing job application emails.

References

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita VishwaVidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Public Sector – Engineer Management Trainee Recruitment Exam (General English)
9. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
10. A Modern Approach to Verbal Reasoning – R.S. Aggarwal
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations,Amrita Vishwa Vidyapeetham.
12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
15. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
16. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
17. A Modern Approach to Logical Reasoning, R S Aggarwal.
18. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal

Evaluation Pattern: 50:50

Assessment	Internal	External
Continuous Assessment (CA) – Soft Skills	30	-
Continuous Assessment (CA) – Aptitude	10	25
Continuous Assessment (CA) – Verbal	10	25
Total	50	50

*CA - Can be presentations, speaking activities and tests.

23LIV490	Live-in Lab -II (**Pre-requisite:** Nil)	L-T-P-C: 0-0-9-3

Course Objectives

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Centered Design and Participatory Rural Appraisal.
- Assess the user need through quantitative and qualitative measurements
- Design a solution by integrating human centered design concepts

- Devising proposed intervention strategies for sustainable social change management

Course Outcome: At the end of the course, the student should be able to

CO1: learn ethnographic research and utilise the methodologies to enhance participatory engagement.
CO2: prioritize challenges and derive constraints using Participatory Rural Appraisal.
CO3: identify and formulate the research challenges in rural communities.
CO4: design solutions using human centered approach.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3		3		1	1		3	3		3
CO2		3						3	3	3		
CO3		3					1		3	3		3
CO4	3		3				3	3	3	3		3

Syllabus

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after 4th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

The objectives and the projected outcome of the project will be reviewed and approved by the department chairperson and a faculty assigned as the project guide.

SEMESTER VII

23EAC498	**Project Phase -I** (**Pre-requisite:** Nil)	**L-T-P-C: 0-0-24-8**

Course Objectives

- To define the problem of the proposed research work
- To apply the concepts of engineering design in solving the research problem
- To demonstrate and validate the results of the design concept

Course Outcomes: At the end of the course, the student should be able to

CO1: formulate a suitable research problem
CO2: develop solution to the problem
CO3: analyze and implement the solution
CO4: prepare report and present the outcomes

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3

CO2	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO3	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO4	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3

23EAC497	Technical Writing (**Pre-requisite:** Nil)	P/F

Course Objectives

- To enable understand the importance of research publications, plagiarism and resoruces
- To provide technical writing skills
- To encourage and motivate for research publications following necessary ethics

Course Outcomes: At the end of the course, the student should be able to

CO1: understand various formats of technical writing
CO2: check the plagiarism and citations
CO3: understand the difference between publication and patent
CO4: write technical research article in a given format

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1								3	3	3		3			
CO2								3	3	3		3			
CO3								3	3	3		3			
CO4								3	3	3		3			

SEMESTER VIII

23EAC499	Project Phase 1I (**Prerequisite:** Nil)	L-T-P-C: 0-0-18-6

Course Objectives

- To define the problem of the proposed research work
- To apply the concepts of engineering design in solving the research problem
- To demonstrate and validate the results of the design concept

Course Outcomes: At the end of the course, the student should be able to

CO1: formulate a suitable research problem
CO2: develop solution to the problem
CO3: analyze and implement the solution
CO4: prepare report and present the outcomes

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO2	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO3	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3
CO4	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3

Syllabus

Phase-1 project can be extended. However, it is also possible to present internship work as project. It is suggested that faculty can work closely with student and company manager with whom student is working.

Professional Electives

Cyber Physical Systems

23EAC321	Modeling and Analysis of Cyber Physical Systems (**Pre-requisite:** Cyber Physical Systems)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the principles of modeling and analysis of cyber-physical systems
- To provide exposure to various analytical tools to study cyber-physical systems
- To enable the modeling and analysis of specific cyber-physical systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the techniques for modeling and analysis of cyber-physical systems
CO2: apply analytical techniques to model cyber-physical systems
CO3: apply modeling language and software tools to model the processes and requirements
CO4: develop detailed models and specifications for specific cyber-physical systems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3											2		3	
CO2	3	2			2									3	
CO3	3	2			2									3	
CO4	3	2	2		2				2	2				3	

Syllabus

Unit I
Modeling of CPS – Synchronous and Asynchronous Models; Safety and Liveness Requirements; Dynamical Systems Modeling – Continuous-Time and Linear Systems, Design and Analysis; Timed Models – timed processes, timing protocols, timed automata; Real-Time Scheduling; Hybrid Systems Modeling.

Unit II
Model Based System Engineering of CPS – approach and concepts; SysML Modelling **-** process and requirements modelling.

Unit III
Applications and Use Cases – smart city, smart grid, intelligent transport systems, precision agriculture.

Textbook(s)
1. Alur, Rajeev. Principles of cyber-physical systems. MIT press, 2015.
2. Holt, Jon, and Simon Perry. SysML for systems engineering. IET, Third Edition, 2018.

References(s)
1. Song, Houbing, Danda B. Rawat, Sabina Jeschke, and Christian Brecher, eds. Cyber-physical systems: foundations, principles and applications. Morgan Kaufmann, 2016.
2. Martín, José L. Risco, Saurabh Mittal, and Tuncer Ören, eds. Simulation for Cyber-Physical Systems Engineering: A Cloud-Based Context. Springer Nature, 2020.

23EAC322 **Security and Privacy in Cyber-Physical Systems** **L-T-P-C: 3-0-0-3**
(Pre-requisite: Nil**)**

Course Objectives

- To address the Privacy and Security issues and concerns faced in CPS environments
- To teach how to encrypt a message using encryption methods and make privacy and security choices
- To implement CPS security projects

Course Outcomes: At the end of the course, the student should be able to

CO1: understand how to provide security to the cyber-physical systems components
CO2: understand how to conduct attacks on cyber-physical systems protocols and systems
CO3: design cyber-physical systems and architectures that preserves the privacy of the CPS components
CO4: implement security protocols for CPS

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			2				2	2		3		3	
CO2	3	2							2	2		3		3	
CO3	3	3							2	2		2		3	
CO4	3	3	3	2	2				2	2		2		3	

Syllabus

Unit I

Overview of Security and Privacy in Cyber-Physical Systems**:** Introduction, Defining Security and Privacy, Defining Cyber-Physical Systems, Approaches to Secure Cyber-Physical Systems, Threats, threat detection Ongoing Security and Privacy Challenges for CPS.

Unit II

Security and Privacy Issues in CPSs, Local Network Security for CPSs, Internet-Wide Secure Communication, Security and Privacy for Cloud-Interconnected CPSs. National Security Implications of Attacks on Cyber-Physical Systems. Security Challenges in IoT Environments, Access Control Adaptation: Motivations and Design Guidelines

Unit III

Data Privacy Issues in Distributed Security**:** Monitoring Systems, Privacy Protection for Cloud-Based Robotic Networks, Security Challenges and Applications, Lightweight Crypto and Security, Cyber-Physical Vulnerabilities of Wireless Sensor Networks in Smart Cities. Recent Trends/Contemporary Issues

Textbook

Houbing Song (Editor), Glenn A. Fink (Editor), Sabina Jeschke (Editor), “Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications” ISBN: 978-1-119-22607-9 October 2017 Wiley-IEEE Press.

References

1. Suh, Sang C., et al., eds. *Applied cyber-physical systems*. Springer New York, 2014.
2. "Cybersecurity and Privacy in Cyber-Physical Systems, Yassine Maleh, Mohammad Shojafar, Ashraf Darwish, Abdelkrim Haqiq, 1st Edition, CRC Press, 2019".

23EAC323	**Control Theory** (**Pre-requisite**: Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide knowledge of the modeling of physical systems
- To enable performance analysis of physical systems
- To enable the use of control theory for the performance enhancement of physical systems

Course Outcomes: At the end of the course, the student should be able to

CO1: model control systems in the continuous domain using classical control approach.
CO2: analyze control systems using state space models.
CO3: understand the nonlinear systems characteristics and analyze the stability of nonlinear Systems.
CO4: understand the control schemes used for different applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2				2	2			2	2	2
CO2	3	2	2		2				2	2		2	2	2	2
CO3	3	2	2		2				2	2		2	2	2	2
CO4	3	3	3		2				2	2			2	2	2

Syllabus

Unit I

Mathematical Modeling of physical systems- Transfer function-stability with reference to 's' plane, transient and steady state analysis, steady state errors, Performance Indices. controllers- P, PI and PID modes of feedback control.

Unit II

Analysis of control systems in state space -State space model of a system, state transition matrix, state space representation in canonical forms, solution of homogeneous state equations, controllability and observability.
Design of control systems in state space- Design by pole placement, State Feedback gain using Ackerman's formula. State Observers- Full order observer, reduced order observer, Design of control system with observers.

Unit III
Nonlinear systems: Introduction - characteristics of nonlinear systems. Types of nonlinearities. Analysis through Linearisation about an operating point. Stability Analysis- Definition of stability- asymptotic stability and instability - Liapunov methods to stability of linear and nonlinear systems; System level design of control schemes

Textbooks and References
[1] Norman Nise, â€œControl System Engineeringâ€ • , John Wiley & Sons, Inc., Sixth Edition, 2011.
[2] Dorf R. C. and Bishop R. H, â€œModern control systemsâ€ • , 12th Edition, Prentice Hall
[3] M. Gopal, â€œDigital Control and State Variable Methodsâ€ • , Tata McGraw-Hill, 2006.
[4] M. Vidyasagar, "Nonlinear systems analysis", Second Edition, Prentice Hall, 1993.

23EAC324	Model Predictive Control (**Pre-requisite:** Control Theory)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the fundamentals of predictive control.
- To provide the knowledge of different types of Model Predictive Control strategies.
- To enable application of Model Predictive control strategies for physical processes.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concepts of predictive control.
CO2: understand working of discrete-time and continuous-time model predictive control algorithms.
CO3: apply model predictive control algorithms for design of controllers for constrained control problems.
CO4: apply model predictive control strategies to regulate processes.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3								2	2		3		3	
CO2	3	2							2	2		3		3	
CO3	3								2	2		2		3	
CO4	3	3	2						2	2		2		3	

Syllabus

Unit I
Day-to-day Application Example of Predictive Control- Models Used in the Design-State-space Models with Embedded Integrator-Predictive Control within One Optimization Window- Receding Horizon Control- Predictive Control of MIMO Systems-State Estimation-State Estimate Predictive Control.

Unit II
Discrete-time MPC with Constraints: Formulation of Constrained Control Problems-Numerical Solutions Using Quadratic Programming-Predictive Control with Constraints on Input Variables-Stability Analysis.

Unit III
Continuous time MPC-Model Structures for CMPC Design-Model Predictive Control Using Finite Prediction Horizon-Optimal Control Strategy-Receding Horizon Control-Continuous time MPC with Constraints-Formulation of the

Constraints-Numerical Solutions for the Constrained Control Problem-Classical MPC Systems in State-space Formulation-Generalized Predictive Control in State-space Formulation-Implementation of Predictive Control Systems

Textbook(s)

1. Liuping Wang, “Model Predictive Control System Design and Implementation Using MATLAB”, Springer, 2009.
2. James B. Rawlings, David Q. Mayne, Moritz M. Diehl, “Model Predictive Control: Theory, Computation, and Design”, 2nd Edition, Nob Hill Publishing, 2017.

23EAC325	**Intelligent Control Systems** (**Pre-requisite:** Control Theory)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To introduce the concepts of Artificial Neural Networks and Fuzzy Logic
- To provide an understanding of nonlinear control systems
- To enable application of Artificial Neural Network and Fuzzy Logic for design of nonlinear control systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the basics of artificial neural network and fuzzy logic applications for nonlinear control
CO2: understand the concepts of nonlinear controller design.
CO3: analyse the given process to identify the appropriate control strategy.
CO4: design a simple control strategy for a nonlinear system.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			2				2	2		3		3	
CO2	3	2							2	2		3		3	
CO3	3	3							2	2		2		3	
CO4	3	3	3	2	2				2	2		2		3	

Syllabus

Unit I

Basic Concepts for Intelligent Systems: Artificial Neural Networks – Multilayer Perceptron Networks - Radial Basis Function Networks - Back-propagation- Recurrent Networks - System Identification Using Neural Networks - Fuzzy logic - Knowledge Representation - Fuzzy Sets - Fuzzy Rules and Reasoning - Fuzzy Logic Control - Mamdani Model - Takagi-Sugeno Model - System Identification using T-S Fuzzy Models.

Unit II

Nonlinear Control: Nonlinear State-space Model - Lyapunov Stability Theory - Lyapunov's Indirect Method - Nonlinear Control Strategies Direct Adaptive Control Using Neural Networks: Direct Adaptive Control - SISO and MIMO Systems - Back-stepping Control.

Unit III

Fuzzy Model Based Control: T-S Fuzzy model - Linear Matrix Inequality (LMI) Technique - Fixed Gain state Feedback Controller Design Technique - Variable Gain Controller Design using Single Linear Nominal Plant and each Linear Subsystem as Nominal Plant - Controller Design using Discrete T-S Fuzzy System.

References

1. Behera L., Kar I., *"Intelligent Systems and Control: Principles and Applications"*, Oxford University Press, 2009.
2. Gopal M., *"Digital Control and State Variable Methods"*, 4th Edition, McGraw Hill Education India, 2017.
3. Zi-Xing C., *"Intelligent Control: Principles, Techniques and Applications"*, World Scientific Publishing Co. Pvt. Ltd., 1997.
4. Jang J. S. R., Sun C. T., Mizutzni E., *"Neuro-Fuzzy and Soft Computing*", Pearson, 2015.

23EAC326	Industrial Process Control (**Pre-requisite:** Control Theory)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the fundamentals of process control
- To provide the working knowledge of different types of actuators used in process control industry.
- To enable understanding of different control strategies used in process control industries.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concepts of process control.
CO2: understand controller design principles for process control applications.
CO3: understand working of different actuators used in process control.
CO4: apply control strategies to regulate physical processes.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3								2	2		3		3	
CO2	3	2							2	2		3		3	
CO3	3								2	2		2		3	
CO4	3	3	2						2	2		2		3	

Syllabus

Unit I
Incentives for Chemical Process Control - Design aspects - Hardware for a Process Control System - Modelling of Chemical Processes: Development of a mathematical model with examples of STH and CSTR - State Variables and State Equations - Dead Time - linearization of Nonlinear systems - Input-output Model - Degrees of freedom and process controllers - Transfer function of a process with single/ multiple outputs. Dynamic Behavior of First Order - second order and higher order systems.

Unit II
Controller Principles: Process characteristics - Control System Parameters - Discontinuous controller Modes - Two-Position - Multi position - Floating Control Mode - Continuous controller Mode – P - I and D - Composite control Modes: PI – PD - PID. Control action generation in electronic - pneumatic controllers – Direct Digital Control: components and working of DDC – benefits of DDC. Design of Feed Back controllers: Outline of Design problems - simple performance criteria – time integral performance content - selection of a feedback controller - controller tuning.

Unit III
Control Valves: Terminology – control valve characteristics – valve classifications and types – valve positioned – selection criteria for control valves. P & I Diagram: Terminology – instrument identification - examples. Advanced control strategies: Cascade - Feed-forward – feedforward – feedback and Ratio Control.

Textbook(s)

1. G Stephanopoulos, "Chemical Process control: An Introduction to Theory and Practice", Pearson Education, 2015.
2. C. D. Johnson, "Process control Instrumentation Technology," Pearson Education, Eighth Edition, 2013.
3. Surekha Bhanot, "Process Control: Principles & Applications," Oxford University Press, 2008

23EAC327	Industry 4.0 and IIoT **(Pre-requisite:** Data Communications and Networks**)**	L-T-P-C: 3-0-0-3

Course Objectives

- To acquire knowledge about Industry 4.0 and Industrial IoT (IIoT)
- To understand smart factories, smart sensors, and cyber-physical systems
- To introduce the role of AI and ML in the context of Industry 4.0

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concepts of Industry 4.0 and IIoT
CO2: understand the role of data analytics and communication
CO3: understand the concepts of secure manufacturing infrastructure
CO4: understand industrial IoT security and fog computing

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										2		2	2
CO2	3	3										3		2	3
CO3	3	3										3		3	3
CO4	3	3										3		3	3

Syllabus

Unit I
Introduction to Industry 4.0 – Need for Industry 4.0, Challenges in integrated development vs Distributed development, Cyber physical systems, Role of data analytics and communication, Smart sensors, Miniaturizations, Cloud, Fog computing, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis, Cybersecurity in Industry 4.0.

Unit II
Secure manufacturing infrastructure, Cyber physical system architecture, Security enforcement. Need for forensics in SCADA, Forensics challenges, Industrial IoT- Layers: IIoT Communication, IIoT Networking. Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science, Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT.

Unit III
Fog Computing in IIoT, Security in IIoT, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry, Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.

Textbook(s)

1. "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress)
2. Industry 4.0 – Development towards the fourth Industrial revolution Kaushik Kumar, Divya Zindani ,J. Paulo Davim

References(s)

1. "Industrial Internet of Things: Cyber manufacturing Systems" by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer)
2. Cyber-security for Industry 4.0 - Andre Wegner, James Graham, Eli Ribble

23EAC328	Robotics for Cyber Physical Systems (**Pre-requisite**: Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide the fundamentals of Robotic systems and terminologies associated with it
- To provide mathematical foundation related to Kinematics, Dynamics, path planning and Control of Robots
- To enable the students to design appropriate robotic systems for specified applications

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the fundamentals of robotic systems and their terminologies
CO2: analyse kinematics and dynamics of various manipulator configurations
CO3: understand the fundamentals of mobile robots
CO4: apply the concept of robots to solve real-world problem.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			2				2	2		3	2	3	
CO2	3	2							2	2		3	2	3	
CO3	3	3							2	2		2	2	3	
CO4	3	3	3	2	2				2	2		2	3	3	

Syllabus

Unit I

Definition of Robotics – Types of Robots - Basics components of Robotics system – DOF and types of joints – Workspace – Robot precession - Types of robotics configurations - Robot end effector: Grippers and Tools. Position analysis and finite rotation and translation - Homogeneous matrices – Direct and Inverse kinematics: Two link planner, PUMA 560, Stanford arm, SCARA and Stewart Platform.

Unit II
Linear and angular velocity vector and matrix – Forward and inverse velocity kinematics (Jacobian) – Fundamentals of robot manipulator dynamics. Path planning – trajectory planning – Continuous trajectory recording (Trajectory following) – Control of Single Robot Joint – Manipulator motion control systems – Force Control – Hybrid Control.

Unit III

Robot Programming – Online and Offline Programming – Teach Pendent – Robot Programming Languages - RAPID language basic commands and Instruction sets – Programming Applications - Pick and Place. Basics of Mobile robots – Locomotion – Types – Perception – Mapping – Localization – Path planning and control. Industrial Applications of robots - Pick and Place, Welding, Assembly – Service Robot application: Underwater robot, surgical robot, autonomous guided vehicle, UAVs.

References

1. Craig, John J., Introduction to Robotics: Mechanics and Control (2009), Prentice Hall Inc.
2. Mark W.Spong, M. Vidyasagar, Robotics Dynamics and control (2008), Wiley publication.
3. 3. Ashitava Ghosal: Robotics- Fundamental Concepts and Analysis (2014), Oxford University Press.
4. 4. S.R.Deb, Robotics Technology and Flexible Automation (2010), Tata Mc-Graw Hill.
5. 5. S K Saha, Introduction to Robotics, 2nd Edition (2016), McGraw Hill Education.

23EAC329	Medical Robotics **(Pre-requisite:** Nil**)**	L-T-P-C: 3-0-0-3

Course Objectives

- To study the design principle and structures of various robots for medical applications
- To understand the basics of robotics kinematics, programming for medical applications
- To analyse and develop skills associated with trajectory planning and control in medical environment

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the fundamentals of medical robots
CO2: understand the fundamentals of robotic systems in medical field and their terminologies
CO3: analyse kinematics and dynamics of various manipulator configurations for medical applications
CO4: apply the concept of robots to solve real-world medical problems

CO-PO Mapping

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2			2				2	2		3	2	3	
CO2	3	2							2	2		3	2	3	
CO3	3	3							2	2		2	3	3	
CO4	3	3	3	2	2				2	2		2	3	3	

Syllabus

Unit I

Basics of robots, types of robots, robotic joints, workspace characteristics, performance characteristics. Kinematics of manipulators, rotational, translation and transformation, homogeneous transformations, types of trajectories, trajectory planning and path planning. Existing clinical applications- Cardiac, abdominal, and urologic procedures with tele-operated robots - Orthopaedic surgery with cooperative robots - Robotic catheters for heart electrophysiology- Mobile robots in the body, Instrument-tissue interaction modelling, Autonomous robotic surgery- Other types of healthcare robots: Physically assistive robotics, Socially assistive robotics

Unit II

Minimally invasive surgery training image-guided interventions, teleoperation cooperative manipulation and surgical navigation. Principle of sensing and transduction, Classification of sensors. Tactile sensors - Proximity and range sensors - Acoustic sensors - Vision sensor systems -Image processing and analysis - Image data reduction – Segmentation – Feature extraction -Object recognition.

Unit III

Electrical actuating systems, Mechanical actuating systems, Pneumatic and hydraulic actuating systems. Robot programming: languages and software packages - MATLAB/Simulink, OpenRDK, ADAMS. Medical robots used for telepresence, surgical assistance, rehabilitation, transportation and sanitation, Tactile Internet.

References

1. Achim Schweikard and Floris Ernst, “Medical Robotics”, 2015, 1st Edition, Springer Nature.
2. Aimee van Wynsberghe, “Healthcare Robots Ethics, Design and Implementation”, 2015, Routledge.
3. Paula Gomes, “Medical Robotics: Minimally Invasive Surgery”, 2012, 1stEdition, Woodhead Publisher, Cambridge.
4. Peter Corke, “Robotics, Vision and Control: Fundamental Algorithms in MATLAB”, Reprint 2013, 1st Edition, Springer-Verlag Berlin Heidelberg.

23EAC330	Smart Health Technology (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To demonstrate the potential benefits of smart technology in eHealth
- To help simplify the care for both patients and their care providers using enabling technologies, and efficiently reduce the burden of treatment
- To understand the underlined technology in this application

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the fundamentals of smart healthcare models and informatics
CO2: understand various network technologies involved with smart healthcare

CO3: study the technology related to security in healthcare.
CO4: study the connectivity and advanced technologies of health care

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			2				2	2		3		3	
CO2	3	2							2	2		3		3	
CO3	3	3							2	2		2		3	
CO4	3	3	3	2	2				2	2		2		3	

Syllabus

Unit I

Wireless Sensor Networks for wellness Monitoring-Types of sensors Actuators-Wireless protocols, Wireless network implementation, Classification of smart home technologies to support elderly people-safety systems-environmental control Systems-Energy control Systems-Reminder Systems-Medication Dispensing systems-communication and Entertainments systems. Pervasive systems in Health care,-SMART-system description, core software & User acceptance. Development of pervasive Mobile technology solution- Methodologies and Tools for the development of pervasive healthcare applications.

Unit II

Networking and communication Issues for pervasive healthcare, E-health through satellite Networks, E-health via Mobile Networks, Personal area Networks-On body networks, off body networks, A health care scenario, healthcare information system architecture, access control framework, context information management, prototype implementation

Unit III

Security threats for pervasive health Care-Intrusion detection, privacy & context Aware Security, Security requirements, challenges, security solutions-TinySec-Encryption and Authentication, Tinysec Packet Format, Tinysec Implementation, Limitation-Ecliptic curve cryptography, Hardware Encryption, Runtime Security Service composition, Biometric methods. Applications and Benefits from telemedicine and Home care, factors affecting the telemedicine and home care, challenges for implementation, case study of telemedicine. Applications: AGETECH framework, OFSETH, FitMobility, Fit4Life, MART. Industry 4.0 and its components, Industry 4.0 in Health Context, Industry 4.0 Design principles, Health 4.0, Health 4.0 Use case through Asthma Inhalers IOT, Asthma control through CPS, Medical Internet of Things (mIoT).

References

1. Antonio Coronato, Giuseppe De Pietro, "Pervasive and Smart Technologies for Healthcare: Ubiquitous Methodologies and Tools" Published in the United States of America by Medical Information Science Reference,2010
2. Christoph Thuemmler • Chunxue Bai, "Health 4.0: How Virtualization and Big Data are Revolutionizing Healthcare", Springer International Publishing Switzerland 2017, ISBN 978-3-319-47616-2.
3. Catrene wg, "Smart Systems for Healthcare and Wellness", January 2014
4. Bruno Bouchard, "Smart Technologies in Healthcare", by CRC Press is an imprint of Taylor & Francis Group, an Informa business, 2017, International Standard Book Number-13: 978-1-4987-2200-1
5. Seyed Shahrestani," Internet of Things and Smart Environments Assistive Technologies for Disability, Dementia, and Aging", Springer publications, 2017, ISBN 978-3-319-60163-2.

23EAC331	Estimation and Filtering for Sensor Data Fusion (**Pre-requisite:** Foundations of Data Science)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the fundamental principles of estimation and filtering of random signals
- To provide the working knowledge of Kalman filtering for fusion of data from multiple sensors
- To enable application of Kalman filtering for specific problems in cyber-physical systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concepts of random processes and estimation
CO2: understand the concepts of Bayesian filtering
CO3: apply appropriate filtering algorithms for sensor data fusion
CO4: develop solutions for specific estimation and tracking problems in cyber-physical systems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2							2	2		3		2	
CO2	3	2							2	2		3		3	
CO3	3	3	2						2	2		2		3	
CO4	3	3	3	2					2	2		2		3	

Syllabus

Unit I
Review of probability and random variables – joint and conditional distribution; Estimation – bias and variance, maximum likelihood (ML) estimation; Linear models – BLUE; Least Squares – consistency and efficiency, the orthogonality principle, MMSE and MAP estimation.

Unit II
Random Processes – auto- and cross-correlation, stationarity, power spectral density, white noise, Gaussian processes; Linear State-Space Models – continuous-time, sampled continuous-time, and discrete-time models; Discrete Kalman Filter – prediction, smoothing and filtering, Information Filter.

Unit III
Smoothing of Sensor Data – fixed-interval, fixed-point and fixed-lag smoothing; Delayed State Measurements; Decentralized Filtering; Extended Kalman Filter. Applications and Use Cases – Inertial Navigation System (INS), Global Positioning System (GPS), Simultaneous Localization and Mapping (SLAM), Trajectory Tracking of Ground and Space Objects, Monte Carlo simulation examples.

Textbook(s)
1. Brown, R. and Hwang, P., "Introduction to random signals and applied Kalman filtering", John Wiley & Sons, Inc., Fourth Edition, 2012.
2. Bar-Shalom, Y., Li, X.R. and Kirubarajan, T., "Estimation with applications to tracking and navigation: theory algorithms and software", John Wiley & Sons, 2001.

References(s)
1. Jazwinski, Andrew H., "Stochastic processes and filtering theory", Courier Corporation, 2007.
2. Haug, Anton J. Bayesian estimation and tracking: a practical guide. John Wiley & Sons, 2012.

Course Objectives

23EAC332	Brain Computer Interface (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

- To introduce the concepts of brain signals
- To provide an understanding of the basics of processing the signals acquired from brain computer interface (BCI) devices
- To apply machine learning techniques for BCI tasks
- To enable the appropriate usage of BCI for medical and non-medical tasks

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the basics features appropriate for the task from various BCIs
CO2: implement a machine learning solution for the BCI task
CO3: analyse signal patterns derived from the BCI
CO4: analyze examples of BCI usage in human service

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			2				2	2		3	2	2	
CO2	3	2							2	2		3	3	2	
CO3	3	3							2	2		2	3	3	
CO4	3	3	3	2	2				2	2		2	3	3	

Syllabus

Unit I

Introduction to neurons, spikes -Recording brain signals – Invasive, non-invasive recording. Frequency domain, time domain analysis – Chaos and dynamic analysis – Artifact reduction – PCA, ICA, feature extraction.

Unit II

Statistical learning approaches for BCI – Adaptive learning approaches - Transfer Learning for BCI. Invasive BCI in animals, humans – Non-invasive BCI, EEG, fMRI, MEG – Issues in BCI

Unit III

ERP – P300 usage – Visual evoked potential for BCI – EcoG and motor control. Detection of disorders – Neuroprotheses – Patient communication – Human cognition – Introduction to non-medical applications of BCI - Generating Handwriting from EMG, Mapping hand movements from EMG, Lie detection, gaming – Ethics of BCI

References

1. Brain-Computer Interfacing An Introduction, Rajesh P. N. Rao, Cambridge University Press, 2013.
2. Brain-Computer Interfaces, Principles and Practice, Jonathan R. Wolpaw, Elizabeth Winter Wolpaw, Oxford University Press, 2012
3. EEG Signal Processing, Saeid Sanei and J.A. Chambers, John Wiley & Sons, 2007
4. Brain–Computer Interfaces 1 Foundations and Methods, Maureen Clerc, Laurent. Bougrain, Fabien Lotte, Wiley, 2016
5. Signal Processing and Machine Learning for Brain--Machine Interfaces, Toshihisa Tanaka and Brain–Computer Interface Research A State-of-the-Art Summary, Christoph Guger, Brendan Z. Allison, Kai Miller, Springer, 2020
6. Brain–Computer Interfaces: Technology and Applications, Maureen Clerc. Laurent Bougrain, Fabien Lotte, Wiley, 2016.

23EAC333	**Wireless Sensor Technology** (**Pre-requisite:** Computer Networks)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide students with a comprehensive understanding of the fundamental concepts, architectures, and protocols used in sensor networks.
- To enable students to design and implement sensor networks for various applications
- To introduce students to the latest developments and emerging trends in the field of sensor networks

Course Outcomes: At the end of the course, the student should be able to

CO1: analyze and evaluate the performance of sensor networks based on various metrics
CO2: design and implement sensor networks using various hardware and software platforms
CO3: identify and solve the challenges and issues related to sensor network design
CO4: apply the knowledge and skills in sensor networks to real-world problems and applications

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1											3	
CO2	2	2	3	1										3	
CO3	2	2	3	1										3	
CO4	2	3	3	1										3	

Syllabus

Unit I
Introduction to Sensor Networks- Introduction to sensor networks: definitions, applications, and characteristics; Sensor network architecture and components: sensors, microcontrollers, communication modules, and power sources; Communication protocols and standards for sensor networks: IEEE 802.15.4, ZigBee, and LoRaWAN; Energy-efficient design principles for sensor networks: power management, duty cycling, and sleep/wake scheduling: Data collection and processing in sensor networks: data aggregation, compression, and filtering.

Unit II
Sensor Network Design and Implementation - Sensor network topology and deployment: star, mesh, and tree topologies; Localization and tracking in sensor networks: triangulation, trilateration, and fingerprinting; Security and privacy in sensor networks: encryption, authentication, and key management; Programming and development tools for sensor networks: Arduino, Contiki, and TinyOS; Hands-on lab sessions: designing and implementing a sensor network using wireless sensor nodes and microcontrollers.

Unit III
Advanced Topics in Sensor Networks- Emerging trends and applications in sensor networks: smart cities, precision agriculture, and healthcare; Big data analytics and machine learning for sensor networks: data mining, classification, and prediction; Cloud-based sensor networks: architecture, services, and platforms; Integration of sensor networks with other systems and technologies: Internet of Things (IoT), Cyber-Physical Systems (CPS), and Wireless Sensor-Actuator Networks (WSANs); Final project: developing a sensor network application for a specific domain or problem.

Textbook(s)

1. Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks: An Information Processing Approach,
2. N. Sastry and S. Shakkottai, "Building Wireless Sensor Networks: Theoretical and Practical Perspective,
3. Chiara Buratti, Marco Stango, and Roberto Verdone "Sensor Networks with IEEE 802.15.4 Systems: Distributed Processing, MAC, and Connectivity"

Reference(s)

1. Wenbo Mao, Wei Li, and Sushil Jajodia, "Security in wireless sensor networks"
2. Ali H. Al-Bayatti, Azween Abdullah, and Mazin Abed Mohammed, "Machine learning for wireless sensor networks: A comprehensive survey"

Electronics System Design and Automation

23EAC340	**Digital Controller Design and Embedded Systems** (**Pre-requisite:** Microprocessors and Microcontrollers)	**L-T-P-C: 3-0-0-3**

Course Objectives

1. To understand digital controller design techniques and their application in embedded systems
2. To designing and implementing digital controllers for real-time control systems
3. To analyze, optimize, and troubleshoot digital control systems implemented in embedded systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the principles and concepts of digital controller design.
CO2: design and implement digital controllers for real-time control applications.
CO3: understand and work with different components of embedded systems.
CO4: analyze, optimize, and troubleshoot digital control systems implemented in embedded systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1	1	1										3		3
CO2	2	2	3	1									3		3
CO3	2	2	3	1									3		3
CO4	2	3	3	1									3		3

Syllabus

Unit I
Introduction: Digital control systems: digital control, discrete-time systems, Z-transform, control applications; Digital controller design: PID controllers, state-space controllers, adaptive controllers, control algorithms; Stability analysis: Routh-Hurwitz criterion, root locus, frequency response, stability analysis methods; Digital control system implementation: implementation techniques, hardware/software co-design, real-time control.

Unit II
Embedded systems: Embedded Systems Architecture, embedded systems definition, characteristics, applications, real-time systems; Embedded system components: microcontrollers, microprocessors, memory, I/O devices, peripherals; Real-time operating systems (RTOS): RTOS, scheduling algorithms, task scheduling, synchronization; Sensor and actuator interfacing: sensor interfaces, actuator interfaces, input/output interfacing

Unit III
Embedded System Design and Optimization: Embedded system design methodologies, top-down design, hardware/software co-design, design principles; Real-time control in embedded systems: real-time control, task scheduling, synchronization, communication; Power-aware design: power management techniques, power optimization, energy efficiency; Testing and debugging: testing techniques, debugging tools, embedded system debugging; Performance optimization: code optimization, memory optimization, power optimization, performance tuning.

Textbook(s):

1. "Digital Control System Analysis and Design" by Charles L. Phillips and H. Troy Nagle.
2. "Embedded Systems: Design, Analysis, and Verification" by Daniel D. Gajski, Samar Abdi, Andreas Gerstlauer, and Gunar Schirner.
3. "Embedded Systems: Real-Time Interfacing to Arm Cortex-M Microcontrollers" by Jonathan W. Valvano.
4. "Real-Time Systems: Design Principles for Distributed Embedded Applications" by Hermann Kopetz.

Reference(s):

1. "Embedded Systems: Architecture, Programming, and Design" by Raj Kamal.
2. "Real-Time Concepts for Embedded Systems" by Qing Li and Caroline Yao.
3. "Digital Control of Dynamic Systems" by Gene F. Franklin, J. David Powell, and Abbas Emami-Naeini.

Course Objectives:

23EAC341	Advanced Microcomputer System Design (**Pre-requisite:** Microprocessors and Microcontrollers)	L-T-P-C: 3-0-0-3

1. To understand advanced microcomputer system architecture and design principles.
2. To design and implement complex microcomputer-based systems.
3. To analyze, optimize, and troubleshoot advanced microcomputer-based systems.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the architecture and design principles of advanced microcomputer systems.
CO2: design and implement complex microcomputer-based systems.
CO3: apply advanced techniques for interfacing peripherals and devices to microcomputer systems.
CO4: analyze, optimize, and troubleshoot advanced microcomputer-based systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1										3		3
CO2	2	2	3	1									3		3
CO3	2	2	3	1									3		3
CO4	2	3	3	1									3		3

Syllabus

Unit I

Introduction: Advanced Microcomputer System Architecture, Microcomputer system fundamentals: microprocessors, memory, I/O, bus architecture, system components; Advanced microcomputer architectures: superscalar, pipelining, RISC, CISC, parallel processing; Memory systems: cache memory, virtual memory, memory management techniques; Bus protocols and standards: PCI, USB, I2C, SPI, Ethernet; Microcomputer system design considerations: performance, power consumption, reliability

Unit II

Complex Microcomputer System Design: System-on-Chip (SoC) design: integration, components, chip design, hardware integration; Hardware description languages (HDL): VHDL, Verilog, FPGA, design tools; Design methodologies: complex system design, design approaches, system-level design; Integration of peripherals and devices: UART, ADC, DAC, timers, external memory; System-level design challenges: power management, thermal management, system integration

Unit III

Advanced Techniques for Microcomputer Systems: Advanced interfacing techniques: DMA, interrupts, memory-mapped I/O, direct I/O; Real-time operating systems (RTOS) for microcomputer systems: RTOS, scheduling, real-time constraints; Embedded software development and debugging techniques: software development, debugging tools, firmware; Performance analysis and optimization of microcomputer systems: performance metrics, optimization techniques; Troubleshooting and debugging: system debugging, fault diagnosis, troubleshooting techniques

Textbook(s):

1. "Computer Organization and Design: The Hardware/Software Interface" by David A. Patterson and John L. Hennessy.
2. "Embedded Systems Design: An Introduction to Processes, Tools, and Techniques" by Arnold S. Berger.
3. "Advanced Microprocessors and Peripherals" by Bhurchandi and A. K. Ray.
4. "Microprocessor Architecture, Programming, and Applications with the 8085/8080A" by Ramesh S. Gaonkar.

Reference(s):

1. "Embedded Systems: Real-Time Interfacing to Arm Cortex-M Microcontrollers" by Jonathan W. Valvano.
2. "Advanced Microcontroller Bus Architecture and System Design" by G. Jack Lipovski.
3. "Digital Design and Computer Architecture" by David Harris and Sarah Harris.

23EAC342	Robotics and Automation (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide foundation on robotics design
- To provide fundamentals of trajectory and control
- To enable design exploration for various applications

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the required engineering in robotics design
CO2: configure and classify robots
CO3: design the trajectory and control
CO4: design and robot for some specific application

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											3	3		3
CO2	3	2	2									3	3		3
CO3	3	2	2									3	3		3
CO4	3	2										3	3		3

Syllabus

Unit I

Introduction: Robotics; Types of Robots- Manipulators, Mobile Robots-wheeled &Legged Robots, Aerial Robots; Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom; Robot configurations-PPP, Classification of robots based on motion control methods and drive technologies; 3R concurrent wrist; Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection and design considerations of grippers in robot; Direct Kinematics-Rotations-Fundamental and composite Rotations, Homogeneous coordinates, Translations and rotations, Composite homogeneous transformations, Screw transformations, Kinematic parameters, The Denavit-Hartenberg (D-H) representation, The arm equation, direct kinematics problems (upto 3DOF) Inverse kinematics- general properties of solutions, Problems (upto 3DOF) Inverse kinematics of 3DOF manipulator with concurrent wrist; Tool configuration Jacobian, relation between joint and end effector velocities.

Unit II

Trajectory Planning and control: Trajectory planning Tasks, Path planning, Joint space trajectory planning- cubic polynomial, linear trajectory with parabolic blends, trajectory planning with via points; Cartesian space planning, Point to point vs continuous path planning. Obstacle avoidance methods- Artificial Potential field, AI algorithms; The control problem, Single axis PID control-its disadvantages, PD gravity control, computed torque control. Motion Control (Kinematic Control), Open loop control (trajectory-following), Feedback control.

Unit III

Industrial Applications: Material handling, welding, Spray painting, Machining. Case study for robotic applications including robot selection considerations for a typical industrial application- number of axes, work volume, capacity & speed, stroke & reach, Repeatability, Precision and Accuracy, Operating environment. foreg – the robotic configuration for pick and place robot, spot welding robot in a car manufacturing industry, peg in hole assembly. Applications in the medical, mining, space, defence, security, domestic, entertainment.

Textbook/References

1. Robert. J. Schilling , “Fundamentals of robotics – Analysis and control”, Prentice Hall of India 1996.
2. Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
3. Introduction to Robotics by S K Saha, Mc Graw Hill Education
4. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi, 2003.

23EAC343	**Industrial Automation** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide foundation on industrial automation
- To provide fundamentals knowledge on programmable logic controller and its applications
- To provide the concept and foundation on distributed control systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the need and components for industrial automation
CO2: understand and apply PLC design concept
CO3: apply PLC and SCADA for automation
CO4: understand and design simple distributed control systems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											3	2		3
CO2	3	2	2									3	2		3
CO3	3	2	2									3	2		3
CO4	3	2										3	2		3

Syllabus

Unit I

Introduction: Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: modbus & profibus. Role of computers in measurement and control. Automation components: Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

Unit II

Programmable logic controllers: Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

Unit III

SCADA and DCS: SCADA, Distributed Control System: Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

Textbook/References

1. JOHN WEBB: Programmable Logic Controllers Principles & applications, PHI.
2. D. PATRANABIS: Principles of Process Control, TMH

23EAC345	**ASIC and SOC** (**Pre-requisite:** VLSI Design)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide an introduction to the types of ASIC and typical ASIC design Flow
- To provide an understanding of HDL coding guidelines and synthesizable HDL constructs
- To introduce the SoC design, optimization, and programming.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the different types of ASICs and design flows.
CO2: synthesize the given design by considering various constraints and optimizing the same.
CO3: demonstrate an ability to identify, formulate and treat complex issues in the field of SoC.
CO4: improve the performance of SoC-based design with various advanced techniques.

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3											3	3		
CO2	3	2	2									3	3		
CO3	3	2	2									3	3		
CO4	3	2										3	3		

Syllabus

Unit I
ASIC Design Methodology & Design Flow: Implementation Strategies for Digital ICs: Custom IC Design- Cell-based Design Methodology – Array-based implementation approaches - Traditional and Physical Compiler-based ASIC Flow. HDL Coding style – Guidelines and Recommendation - FSM Coding Guideline and Coding Style for Synthesis.

Unit II
RTL synthesis Flow – Synthesis Design Environment & Constraints – Architecture of Logic Synthesizer - Technology Library Basics– Components of Technology Library –Synthesis Optimization- Technology independent and Technology dependent synthesis. The architecture of the present-day SoC - Design issues of SoC- Hardware-Software Co-design – Core Libraries – EDA Tools SoC Design Flow – guidelines for design reuse.

Unit III
Introduction- Efficiency of application-specific hardware- Target architectures for HW/SW partitioning -System Integration, Embedded memories – design methodology for embedded memories. Co-Specification- System Partitioning- Co-simulation, Co-synthesis & Co-verification. SoC Interconnection Structures- Bus-based Structures- AMBA Bus. Network on Chip - NoC Interconnection Structures-Topologies- routing- flow control- network components (router/switch, network interface, Links).

Textbook(s)

3. Himanshu Bhatnagar, Advanced ASIC Chip Synthesis, Kluwer Academic Publisher, Second Edition, 2012.
4. Michael J. Flynn, Wayne Luk, Computer System Design: System on chip, Wiley-Blackwell, First Edition, 2011.

Reference(s)

3. Erik Brunvand, Digital VLSI Chip Design with Cadence and Synopsys CAD Tools, Addison Wesley, First Edition, 2010
4. Jose L. Ayala, Communication Architectures for Systems-on-Chip, CRC Press, First Edition, 2011.

23EAC346	**Electronic Packaging** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To introduce the concept and fundamentals of electronic packaging
- To provide foundation on chip level packaging and relevant technology
- To introduce the issues and necessity of testing in the process

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the basic principles and concept of electronic system packaging for different applications
CO2: understand different chip level technology and packaging
CO3: design PCB with required standard
CO4: test and analyse various issues in packaging and PCB design process

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											3	3		
CO2	3	2	2									3	3		
CO3	3	2	2									3	3		
CO4	3	2										3	3		

Syllabus

Unit I

Electronic systems and needs, physical integration of circuits, packages, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends and Challenges, boards and complete electronic systems; system applications like computer, automobile, medical and consumer electronics with case studies and packaging levels, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates.

Unit II

Chip level packaging and PCB design: IC Assembly - Purpose, Requirements, Technologies, Wire bonding, Flip Chip, Wafer Level Packaging; Single chip packaging: functions, types, materials processes, properties, characteristics, trends. Multi chip packaging: types, design; System – in - package (SIP); Passives: discrete, integrated, and embedded. CAD tools for PCB design, Standard fabrication, Board Assembly: Surface Mount Technology, Through Hole Technology. Thermal Management, Heat transfer fundamentals.

Unit III

Issues and testing: Electrical Issues of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Transmission Lines, Clock Distribution, Noise Sources, Digital and RF Issues; Design Process Electrical Design: Interconnect Capacitance, Resistance and Inductance fundamentals; Packaging roadmaps - Hybrid circuits - Resistive, Capacitive and Inductive parasitics; Reliability, Environmental interactions. Thermal mismatch and fatigue – failures – thermo mechanically induced –electrically induced; Electrical Testing: System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability.

Textbook/References

1. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw Hill, NY, 2001
2. Rao R Tummala & Madhavan Swaminathan, Introduction to System-on-Package, McGraw Hill, 2008 3.
3. R S Khandpur, Printed Circuit Boards, McGraw Hill, 2006

23EAC347	System Engineering (Pre-requisite: Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce system engineering concepts and development methods
- To provide knowledge on requirement analysis and modelling
- To enable understanding of system integration, validation and testing

Course Outcomes: At the end of the course, the student should be able to

CO1: describe processes, methods, and practices of systems engineering
CO2: apply systems engineering practices and methods to relevant examples.
CO3: develop requirements, architectures, specifications, verifications, and tests.
CO4: analyze systems using systems engineering approaches to increase performance.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3									2	3	2
CO2	3	3	3	3									2	3	2
CO3	3	3	3	3									3	3	2
CO4	3	3	3	3									3	3	2

Syllabus

Unit I
Introduction- System Engineering overview- origin, uses and applications of systems engineering, system of systems, value of system engineering; System Building Blocks and Interfaces- Systems Engineering through the System Life Cycle, The Systems Engineering Method, Testing throughout System Development, Managing System Development and Risks Organization of Systems Engineering

Unit II
Concept Development- Need analysis, Originating a New System, Operations Analysis, Functional Analysis, Feasibility Definition, Needs Validation, System Operational Requirements, Developing the System Requirements, Operational Requirements Analysis, Performance Requirements Formulation, Implementation of Concept Exploration, Performance Requirements Validation Process, System Modeling Languages: Unified Modeling Language (UML) and Systems Modeling Language (SysML), Model-Based Systems Engineering (MBSE), System Functional Specifications.

Unit III
Implementing the System Building Blocks, Requirements Analysis, Functional Analysis and Design, Component Design, Design Validation, Integration, testing and evaluating total system; Test planning and preparation, system integration, Developmental and operational test and evaluation, Engineering for production, transition from development to production, Production operations, Installation, maintenance and upgrading, Installation testing, In-service support, Upgrades and modernization.

Textbooks and references

1. Alexander Kossiakoff William N. Sweet Samuel J. Seymour Steven M. Biemer, System Engineering: Principles and Practices, 2nd Edition, John Wiley and Sons, 2010.
2. Cathleen Shamieh, System Engineering for Dummies, IBM limited edition, Joh Wiley and Sons, 2012

23EAC348	Mixed Signal System Design (**Pre-requisite:** VLSI Design)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the concept and impact of signals and filters in mixed signal systems.
- To provide knowledge on data converter principles, architectures, and design considerations
- To provide foundation on designing a mixed signal system

Course Outcomes: At the end of the course, the student should be able to

CO1: understand basic analog and digital filters used in mixed signal systems.
CO2: understand the design considerations of different data converters.
CO3: understand the impact of noise in mixed signal systems.
CO4: gain proficiency in designing mixed-signal systems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											3	3		
CO2	3	2	2									3	3		
CO3	3	2	2									3	3		
CO4	3	2										3	3		

Syllabus

Unit I
Signals, Filters and Tools: Sinusoidal signal - Comb filters and representation of signals. Sampling and Aliasing: Impulse Sampling – Decimation- K-Path Sampling Sample-and-Hold- Track-and-Hold Implementation of S/H- Discrete Analog Integrator. Analog Filters: Integrator building blocks, MOSFET-C Integrator gm-C Integrators, Discrete-time Integrators, Filtering topologies, Bilinear and Biquadratic Transfer function.

Unit II
Digital Filters: SPICE Models for DACs and ADCs-Sinc Shaped digital filters-Bandpass and Highpass sinc Filters-Filtering topologies-FIR Filter-Concept of Stability and Overflow. Data Converter SNR: Quantization noise- Signal-to-Noise Ratio (SNR). Concept of Spectral Density-Clock Jitter reduction techniques- Improving. SNR using Averaging and Feedback. Data Convertor Design: One-bit ADC and DAC-Passive Noise Shaping- Improving SNR and Linearity, Improving Linearity using Active Circuits.

Unit III
Noise Shaping Data Converters: First Order Noise Shaping-Second order noise shaping, noise shaping topologies-Cascaded Modulators. Bandpass Data Converters: Continuous Time bandpass noise shaping-Active and Passive component bandpass modulators-switched capacitor bandpass modulator, Digital I/Q Extraction to bandpass. High-Speed Data Converters: Topologies-path settling time- implementation-generation of clock signals and comparators- Clocked comparators.

Text Book(s)

1. Baker Jacob R, “CMOS Mixed signal Circuit Design,” Wiley IEEE press.
2. R. Jacob Baker, “CMOS Circuit Design, Layout and Simulation”, Wiley India Pvt. Ltd, Third Edition.

3. B. Razavi, “Principles of Data Conversion System Design”, John Wiley and Sons, 1995

Reference(s)

1. B. Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 2001.
2. B. Razavi, “RF Microelectronics”, Prentice Hall, 2011.

23EAC349	Data Acquisition System Design	L-T-P-C: 3-0-0-3
	(**Pre-requisite:** Microprocessor and Microcontroller)	

Course Objectives

- To introduce the concepts of acquiring the data from transducers.
- To provide foundation on data interfacing and analysis.
- To enable develop and design instrumentation systems

Course Outcomes: At the end of the course, the student should be able to

CO1: elucidate the elements of data acquisition techniques.
CO2: design and simulate signal conditioning circuits.
CO3: explain various data transfer techniques
CO4: understand the components of the data acquisition system

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											3		2	3
CO2	3	2	2									3		2	3
CO3	3	2	2									3		2	3
CO4	3	2										3		2	3

Syllabus

Unit I
Analog and digital data acquisition, Sensor/Transducer interfacing, unipolar and bipolar transducers, Sample and hold circuits, Interference, Grounding and Shielding.

Unit II
Operational Amplifiers, CMRR, Slew Rate, Gain, Bandwidth. Zero crossing detector, Peak detector, Window detector. Difference Amplifier, Instrumentation Amplifier AD 620, Interfacing of IA with sensors and transducer, Basic Bridge amplifier and its use with strain gauge and temperature sensors, Filters in instrumentation circuits.

Unit III
Serial data transmission methods and standards RS232-C: specifications connection and timing, 4-20 mA current loop, GPIB/IEEE-488, LAN, Universal serial bus, HART protocol, Foundation Fieldbus, Modbus, Zigbee and Bluetooth. Single channel and multichannel, Graphical Interface (GUI) Software for DAS, RTUs, and PC-Based data acquisition systems.

Textbook(s)

4. Coughlin, R.F., Operational Amplifiers and Linear Integrated Circuits, Pearson Education (2006).
5. Mathivanan, N., Microprocessor PC Hardware and Interfacing, Prentice Hall of India Private Limited (2007).

Reference(s)

1. Ananad, M.M.S., Electronic Instruments and Instrumentation Technology, Prentice Hall of India Private Limited (2004).

2. Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India Private Limited (2006).

23EAC350	Smart Sensor Technology	L-T-P-C: 3-0-0-3
	(**Pre-requisite:** Nil)	

Course Objectives

- To provide the concept of various physical phenomena of different types of sensors and micro systems.
- To provide foundation on design of basic circuit building blocks of sensors and understating their materials with interface as a complete system
- To provide the concept and understanding on the sensors fabrication process and their applications

Course Outcomes: At the end of the course, the student should be able to

CO1: understand various physical phenomena behind the operation of different types of sensors and microsystem.
CO2: understand the building blocks and designing of sensors with complete interface circuit.
CO3: know the different materials for sensors and microsystem.
CO4: understand the process of MEMS fabrication.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										3	2	2	
CO2	3	2	2									3	2	2	2
CO3	3	3	2									2	2	2	2
CO4	3	2										2	2	2	2

Syllabus

Unit I
Sensor Characteristics and Physical Principles of Sensing- Example of Smart Sensors in nature (Vision –Hearing –touch -and smell)-Classification and Terminology of sensors-Measurands - Physical principles of sensing-electric charges-fields-and potentials Capacitance-magnetism-Induction-resistance-Piezoelectric effect - pyroelectric effect - Hall effect - Seebeck and Peltier effects.
Unit II

Acoustic Sensors-Magnetic Sensors and Mechanical Sensors - Acoustic waves, piezoelectric materials - Acoustic sensing, saw sensor - Sensor applications and future trends - Magnetic sensors - effects and materials -Integrated Hall sensors – Magnetotransistors - other magnetics transistor and future trends, Mechanical sensors - piezoresistivity - Piezoresistive sensors - Capacitive sensors. Radiation Sensors Thermal Sensors and Chemical Sensors - Radiation basics - HgCdTe infrared sensors - Visible-light color sensors - high-energy photodiodes - Heat transfer - thermal structures – Thermal sensing elements - Thermal and temperature sensors - Interaction of gaseous species at semiconductor Surfaces - Catalysis - the acceleration of chemical reactions - Thin-film sensors - FET devices for gas and ion sensing.

Unit III
Micro-and Nanotechnologies of Sensors - Fundamentals of MEMS fabrication- introduction and description of basic processes - MEMS fabrication technologies-bulk micromachining-Surface micromachining-High-aspect ratio (LIGA and LIGA-Like) technology- microfluidics microsystem components Microfluidics microsystem components- product prospects - application trends procedures and techniques - the making of ultrathin films creation of lateral nanostructures - clusters and Nano crystalline materials.

Textbook(s)
1. Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs, and Applications”, Springer; 4th ed. 2010. S. M. Sze, “Semiconductor Sensors”, Wiley-Interscience, 1994.

2. Tai-Ran Hsu, MEMS and Micro systems Design and Manufacture, Tata McGraw Hill, 2002.
3. GK Anantha Suresh, et. al, Micro and Smart Systems, Wiley-India, 2010.

Reference(s)

1. Reference(s) Gerard Meijer, "Smart sensor systems", Wiley, 2008. W Gopel, J. Hesse, J. N. Zemel, "Sensors A Comprehensive Survey", Vol. 9, Wiley-VCH, 1995.

23EAC351	Automotive Electronics for Electrical Vehicles (**Pre-requisite:** Embedded Systems)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the concept of automotive vehicle
- To provide foundation and fundamentals of CAN and other controls
- To enable students to gain auxiliary systems in and outside vehicle and their controls

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the basic principles and concept of automotive vehicle
CO2: understand various controls and embedded controller in vehicle
CO3: analyze the performance of CAN, LIN and other data transfer buses
CO4: understand data transfers towards auxiliaries and controls

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											3	3		3
CO2	3	2	2									3	3		3
CO3	3	2	2									3	3		3
CO4	3	2										3	3		3

Syllabus

Unit I

Automotive Systems Overview: Automotive Vehicle Technology, Overview of Vehicle Categories, Various Vehicle Sub Systems. Future Trends in Automotive Embedded Systems: Hybrid Vehicles, Electric Vehicles. Motronic engine management system, Lighting technology, Electronic stability program, Adaptive cruise control, Infotainment System.

Unit II

Automotive networking -Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, coupling of networks, CAN bus - Applications, Topology, Data transmission system, CAN protocol, data transfer sequence, standardization, characteristics. LIN bus: Overview, Applications, Data transfer, Bus access, LIN protocol, network management, Lighting system: Lighting fundamentals Lighting circuits, Gas discharge and LED lighting, Case studies, Diagnosing lighting system faults, Advanced lighting technology, New developments in lighting systems

Unit III

Auxiliaries in vehicles - Windscreen washers and wipers, signaling circuits, Other auxiliary systems, Case studies, Diagnosing auxiliary system faults Advanced auxiliary systems technology, new developments in auxiliary systems Chassis Electrical systems - Anti-lock brakes, Active suspension, Traction control , Automatic transmission, Other chassis electrical systems, Case studies, Diagnosing chassis electrical system faults, Advanced chassis systems technology, New developments in chassis electrical systems

Textbook/References

1. William B. Ribbens, "Understanding Automotive Electronics-An Engineering Perspective", Seventh edition, Butterworth-Heinemann Publications.
2. Robert Bosch GmbH, "Bosch Automotive Electrics and Automotive Electronics", 5th Edition. John Wiley & Sons Ltd, 2007.
3. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier, 2003.
4. Tom Denton: "Automobile Electrical and Electronic Systems", 3rd Edition, Elsevier Butterworth-Heinemann Publication, 2004.

VLSI

23ECE331	Analog IC Design (**Pre-requisite:** Electronics Circuits II)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide students with a fundamental understanding of MOS amplifier configurations.
- To enable students to analyze and design Cascode connections, with consideration of gain, bandwidth, and input/output impedance modification.
- To equip students with the skills necessary to analyze and design feedback systems, and compensation of amplifiers.

Course Outcomes: At the end of the course, the student should be able to

CO1: analyze the basic characteristics of single and multi-stage amplifier configurations.
CO2: analyze the design of multi-stage amplifiers.
CO3: evaluate and apply the different principles in amplifier design.
CO4: analyze the design of feedback systems for amplifiers.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2										3		
CO2	3	3	3										3		
CO3	3	3	3										3		
CO4	3	3	3										3		

Syllabus

Unit 1

Common Source - Single pole amplifiers, frequency and step response, input pole, input capacitance, active load. Common Gate and Source Follower Review – Single-ended Differential Pair – Active Current Mirrors - Widlar Current Source - Low Current Bias Circuit - Cascode self-biased source.

Unit II
MOS Op-amp - Single stage op-amp review. Two-stage op-amp frequency response- Feedback, Stability, Compensation, Common mode and differential gain. RHP zero from Cc - RHP zero- Current mirror pole/zero doublet - Supply-independent biasing.

Unit III
Telescopic and Folded cascode – Folded Cascode Biasing - Switched capacitors- ADCs, DACS, Programmable Gain Amplifiers . MOS switch regulators - StrongArm latch - Charge injection - rail-to-rail input and output - Ri, Ro and feedback noise; Circuit synthesis using AI/ML Techniques.

Textbook(s)
1. B. Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2017.
2. P. Allen and D. Holberg, "CMOS Analog Circuit Design", Oxford University Press, Second Edition, 2012.

Reference(s)
1. Sedra/Smith, "Microelectronic circuits", 7th edition, Oxford University Press, 2015.
2. P. Gray, P. Hurst, S. Lewis, and R.G. Meyer, "Analysis and Design of Analog Integrated Circuits", John Wiley and Sons, Fourth Edition, 2001.

23ECE332	Digital IC Design (Pre-requisite: Digital Electronics)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide an understanding of basic building blocks of mixed logic digital circuits
- To understand the optimizing techniques available for combinational logic functions.
- To optimize the delay analysis in the sequential and combinational logic function

Course Outcomes: At the end of the course, the student should be able to

CO1: realize the mixed logic building block and optimized logic function.
CO2: understand the optimizing concepts of arithmetic building blocks.
CO3: understand the basic testing of the combinational circuits.
CO4: analysis the synchronous sequential state machine.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											2		
CO2	3	2	2										2		
CO3	3	2	2										2		
CO4	3	2	2										2		

Syllabus

Unit I
Mixed logic circuits - Entered variable K-map Minimization - Multiple output Minimization-Multilevel Minimization and Optimization - Resubstitution – Decomposition – Factorization - Adders -Carry Look Ahead adder - Carry Save adder.

Unit II
Hazards- Propagation delay & Timing defects in combinational logic - Lumped Path Delay Diagram - Binary Decision Diagram (BDD)- Ordered BDD – LPDD – Testing: Fault Detection and Analysis in Combinational Systems: Path Sensitizing Method– Boolean Difference Method; Fault Detection and Analysis using AI/ML Techniques.

Unit III
Static Timing Analysis (STA) design flow – STA Concepts – Standard Cell Library-Synchronous State Machines (FSM) - Design & analysis of simple state machines - state assignment - state reduction techniques - Asynchronous State Machine- Analysis of simple state machines - Detection and elimination of output races – glitches

Textbook(s)

1. Richard F. Tinder, “Engineering Digital Design”, Academic Press, 2000.
2. Eugene Fabricius, “Modern Digital Design & Switching Theory”, CRC Press, 1992.

Reference(s)

1. Samuel C. Lee, “Digital Circuits and Logic Design”, Prentice Hall India Private Limited, 2006.
2. Zvi Kohavi and Niraj K Jha, “Switching and Finite Automata Theory”, Third Edition, Cambridge University, Press, 2009.

23ECE333	**Functional Verification** (**Pre-requisite:** VLSI Design)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide a practical approach for verification of VLSI circuits.
- To introduce hardware design languages for functional verification.
- To enable the need and use of reusable verification environments.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the process of functional verification and its different methodologies.
CO2: apply methodologies to design a verification environment using System Verilog.
CO3: analyze the device under test and to write test-benches using System Verilog.
CO4: analyze the verification process by use of assertion-based techniques.

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	3												3		
CO2	3	2											3		
CO3	3	3	3										3		
CO4	3	3	3										3		

Syllabus

Unit I
HDL Review - Need for Functional Verification - ASIC Verification Concepts - Verification Tasks - Verification Plan - Linear Test Bench - Linear Random Test Bench – Self-Checking Test Benches - Test Coverage - System Verilog for Design - Data Types and Literals - Procedures and Procedural Statements - Operators - User-Defined Data Types - Hierarchy and Connectivity.

Unit II
System Verilog for Verification - Tasks - Functions - Interfaces - Verification Blocks Transaction Level Modeling - System Verilog Classes - Random Stimulus - Class-Based Randomization - Functional Coverage - Queues - Dynamic Arrays - Inter-Process Synchronization - System Verilog Assertions (SVA) - Assertion-Based Verification (ABV) - Boolean Expressions - Single and Multiple Clock Definitions - Implication Operators - System functions - Nested Implications - Immediate Assertions - Concurrent Assertions - Boolean Assertions - Sequences - Sequence Composition.

Unit III
Building a Test bench with Threads and Inter-Process Communication - Functional Coverage Strategies - Parameterized Cover Groups - Coverage Data Analysis - Coverage Statistics Measurement - Complete System Verilog Test Bench Design - FSM Modeling with System Verilog - Verification of a Four Port Router: Case Study - Opportunities for AI-Powered Verification and Machine Learning in Formal Verification.

Textbook(s)

1. Chris Spear, “SystemVerilog for Verification: A Guide to Learning the TestBench Language Features,” Third Edition, Springer, 2012.

2. Sutherland, Stuart, Davidmann, Simon, Flake, Peter, "SystemVerilog for Design: A Guide to Using SystemVerilog for Hardware Design and Modeling", Second Edition, Springer Science & Business Media, 2006.

Reference(s)

1. Faisal Haque, Jonathan Michelson, Khizar Khan, "The Art of Verification with System Verilog Assertions", First Edition, Verification Central, 2006.
2. S Halsoun and T Sasao, "Logic Synthesis and Verification", Kluwer Academic publishers, 2002.

23ECE334	**Physical Design of ICs** (**Pre-requisite:** VLSI Design)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide an understanding of the physical design process
- To provide an understanding of the partitioning, floor planning and placement techniques.
- To provide an understanding of the routing algorithms and generation of GDS II file.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the steps by step process involved in the Physical design cycle.
CO2: analyze the different partitioning and floor planning methodologies used in the physical design of ICs.
CO3: analyze the different placement and routing methodologies used in the physical design of ICs.
CO4: generation of GDS II file after RC extraction.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	2	2										3		
CO3	3	2	2										3		
CO4	3	2	2										3		

Syllabus

Unit I

Physical IC Design–Objectives–VLSI Physical Design Cycle-Layout and design rules- basic algorithmic concepts for physical design- physical design processes and complexities. Partition: Kernigham- Lin's algorithm and Fiduccia Mattheyes algorithm - multilevel partition techniques; Optimal Partitioning using AI/ML Techniques.

Unit II

Floor-Planning: Hierarchical design - wire length estimation-slicing and non-slicing floor plan-polar graph representation and operator concept. Stockmeyer algorithm for floor planning. Placement: Design types – ASICs – SoC - microprocessor RLM. Placement Techniques: Simulated annealing-partition-based-analytical- Hall's quadratic- Timing and congestion considerations.

Unit III

Routing: Detailed- global and specialized routing- channel ordering- channel Routing problems and constraint graphs-routing algorithms- Yoshimura and Kuh's method-zone scanning and net merging- boundary terminal problem- minimum density spanning forest problem- topological routing- cluster graph representation. Parasitic Extraction (RC Extraction)–Chip Finishing Overview–Final Validation– Net List Output–GDS2 Output.

Textbook(s)

1. Naveed Sherwani, ―Algorithms for VLSI physical design Automation‖, 2nd Edition, Kluwer Academic Publisher, 1999.
2. Christophn Meinel and Thorsten Theobold, ―Algorithm and Data Structures for VLSI Design‖, KAP, 2002.
3. Sarrafzadeh, M. and Wong, C.K., "An Introduction to VLSI Physical Design", 4th Ed., McGraw-Hill. 1996

Reference(s)

1. Sait, S.M. and Youssef, H., "VLSI Physical Design Automation: Theory and Practice", World Scientific. 1999
2. Sherwani, N.A., "Algorithm for VLSI Physical Design Automation", 2^{nd} Ed., Kluwer.
1999
3. Lim, S.K., "Practical Problems in VLSI Physical Design Automation", Springer.
2008

23ECE335	Mixed Signal IC Design	L-T-P-C: 3-0-0-3
	(Pre-requisite: Electronics Circuits II)	

Course Objectives

- Understand the concept and impact of electrical noise on circuit performance.
- Gain knowledge of data converter principles, architectures, and design considerations.
- Develop skills to design and apply fully-differential output op-amps and CMFB in mixed-signal circuits.

Course Outcomes: At the end of the course, the student should be able to

CO1: develop a comprehensive understanding of electrical noise.
CO2: understand the design considerations of different data converters.
CO3: gain proficiency in designing mixed-signal circuits.
CO4: develop the skills to use switched-capacitor CMFB for op-amp design.

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2										3		
CO2	3	3	3										3		
CO3	3	3	3										3		
CO4	3	3	3										3		

Syllabus

Unit I
Feedback and Topologies Review; Introduction to electrical noise- noise measurements, thermal noise, simulating MOSFET noise, noise equivalent bandwidth, kT/C noise, signal-to-noise ratio (SNR), noise figure (NF), white noise, shot noise, flicker noise, noise and feedback, op-amp noise modeling.

Unit II
Data converter fundamentals - DAC architectures: resistor string, R-2R, and current steering topologies. Cyclic and pipeline DACs. ADC architectures including flash and two-step - successive approximation (charge redistribution) ADCs - segmentation, calibrating DAC offsets and gains, topologies without an op-amp, op-amps in data converters - bottom-plate sampling - S/H and Cyclic (algorithmic) converter - pipeline ADC.

Unit III
Fully-differential output op-amps - biasing for power and speed - diff-amps and CMFB - op-amp design for mixed-signal circuits - switched-capacitor CMFB - Op-Amp Design Using Switched-Capacitor CMFB; Circuit Optimization using AL/ML techniques.

Textbook(s)

6. R. Jacob Baker, “CMOS Circuit Design, Layout and Simulation”, Wiley India Pvt. Ltd, Third Edition.
7. B. Razavi, “Principles of Data Conversion System Design”, John Wiley and Sons, 1995

Reference(s)

3. R. Jacob Baker, “CMOS Mixed Signal Circuit Design”, Wiley India Pvt. Ltd, 2008
4. B. Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 2001.
5. B. Razavi, “RF Microelectronics”, Prentice Hall, 2011.

23ECE336	VLSI Testing and Testability	L-T-P-C: 3-0-0-3
	(Pre-requisite: Digital Electronics**)**	

Course Objectives

- To provide an understanding of the concepts of VLSI Testing and fault models
- To provide an understanding of the logic and fault simulation methods.
- To provide an understanding of the challenges involved in scan design and design for test

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the fault equivalence and dominance collapsing for digital circuits
CO2: analyse the given fault as detectable or not using logic and fault simulation algorithms.
CO3: generate the test vector using combinational ATPG algorithms.
CO4: understand the scan and logic BIST architectures.

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3												3		
CO2	3	2	2										3		
CO3	3	2	2										3		
CO4	3												3		

Syllabus

Unit I
Introduction to VLSI Testing- Need for VLSI Testing - Fault Modelling – Defects, Errors and Faults- Functional Vs Structural Testing- Levels of Fault Models - Glossary of fault models - Single stuck-at fault – Equivalence and Dominance - Checkpoint theorem.

Unit II
Logic and fault simulation – Simulation for Design Verification and Test Evaluation - Modeling circuits for simulation - Algorithms for true value simulation and fault simulation - Combinational ATPG Algorithms- Redundancy Identification - Roth's D-algorithm – PODEM Algorithm; Fault detection using AI/ML Techniques.

Unit III
Design for Testability– Digital DFT and Scan Design – Ad-Hoc DFT methods – Scan Design – Logic BIST- Test pattern generation – Exhaustive Testing – Pseudo Random Testing – Pseudo Exhaustive Testing – Output Response Analysis – Signature Analysis- Logic BIST architecture.

Textbook(s)

1. Vishwani D. Agrawal and Michael L. Bushnell, "Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits", Kluwer Academic Publishers, 2005.
2. Parag K. Lala, "An Introduction to Logic Circuit Testing", Morgan &Claypool Publishers, 2009.

Reference(s)

1. LaungTerng Wang, Cheng Wen Wu and Xiaoqing Wen, "VLSI Test Principles and Architectures – Design for Testability", First Edition, Morgan Kaufmann Publishers, 2006.
2. Parag K. Lala, "Digital Circuit Testing and Testability", Academic Press, 1997.

23ECE337	**System on Chip** **(Pre-requisite:** VLSI Design**)**	**L-T-P-C: 3-0-0-3**

Course Objectives

- To introduce ARM System on chip
- To introduce the NoC in advanced digital systems
- To introduce the concept of system-level design and transaction-level modelling

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concept of ARM System on a chip.
CO2: understand the interconnect topologies in ARM SoC.
CO3: understand the basic concepts of SystemC.
CO4: understand the basics of electronic system transaction Level Modelling.

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2											3		
CO2	3	2											3		
CO3	3	2	2										3		
CO4	3	2	2										3		

Syllabus

Unit I
Digital System and VLSI Design-Why design Integrated Circuits-Integrated Circuit design Techniques-IP based Desgin-Introduction to System-on-Chip-Socs Design Flow-Soc Technology- Soc I/O blocks- Processor, Memory and IP blocks.

Unit II
Soc InterConnect- Interconnect Requirements- Basic Interconnect Topologies- Simple Packet-Switched Interconnect-Network-on-Chip- Advanced Interconnect Topologies- Interconnect Building Blocks- Long-distance Interconnects-Serialiser and Deserialiser: SERDES- Automatic Topology Synthesis.

Unit III
Electronic System-Level Modelling- Modelling Abstractions- Interconnect Modelling- SystemC Modelling Library-Transaction-level Modelling- Processor Modelling with Different Levels of Abstraction- ESL Modelling of Power, Performance and Area; Optimal SoC design using AI/ML Techniques.

Textbook(s)

1. Wayne Wolf, "Modern VLSI Design: SOC Design,-IP based design" Pearson Education, 2002.
2. Prakash Rashnikar, Peter Paterson and Lenna Singh, "System On a Chip Verification Methodology & Techniques," Kluwer Academics Publishers, 2001.

Reference(s)

1. Farzad Nekoogar and Faranak Nekoogar, "From ASICs to SOCs: A Practical Approach," Prentice Hall, 2003.
2. David J. Greaves" Modern System-on-Chip Design on Arm" , Arm education media
3. G. De Micheli, R. Ernst, and W. Wolf, "Readings in Hardware/Software Co-Design," Morgan Kaufmann, 2001

23ECE338	VLSI Fabrication Technology (**Pre-requisite:** VLSI Design)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the preparation of wafer and cleanroom concept
- To provide the understanding of doping methods, oxidation and pattering of micro devices
- To provide the understanding of thin films deposition and etching techniques

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the wafer preparation and impurities doping mechanisms and its importance.
CO2: understand the growth of oxide and lithography process to pattern microdevices.
CO3: understand the lithography and pattering process of microdevices.
CO4: understand the different methods of film deposition and wet and dry etching processes.

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2											3		
CO2	3	3											3		
CO3	3	3											3		
CO4	3	3											3		

Syllabus

Unit I
Brief History of Semiconductor technology. Scaling Trends and Scaling Methodologies - Scaling Challenges, ITRS Roadmap. Silicon structure and properties- Czochralski and Float Zone crystal growth, dopant distribution, and wafer preparation, Crystalline defects and their effects. Basic fabrication steps and their importance- Concepts of Clean room and safety requirements- Concepts of Wafer cleaning processes.

Unit II
Diffusion and ion implantation- Types of diffusion- Ficks laws, junction depth, stopping mechanisms, Gaussian implantation profile, variations to predicted distribution, implantation damage, and annealing. Oxidation technologies- Plasma and Rapid Thermal Processing. Characterization of oxide films- High and low k dielectrics. Lithography. Photolithography, E-beam lithography and minimum resolvable feature sizes, UV sources, photoresists.

Unit III
Deposition requirements and techniques – Physical- Evaporation and sputtering techniques. Failure mechanisms in metal interconnect - multilevel metallization schemes. Chemical Vapor Deposition- CVD techniques for deposition of polysilicon - silicon dioxide, silicon nitride and metal films. Epitaxial growth of silicon- PECVD.
Etching - wet chemical etching techniques. Plasma etching and RIE techniques- Chemical Mechanical Polishing, Process integration and characterization techniques.

Textbook(s)

1. Plummer, J. "Silicon VLSI Technology: Fundamentals, Practice and Modeling", 3rd Ed., Prentice Hall, 2000.
2. Gandhi, S. K., "VLSI Fabrication Principles: Silicon and 1996 Gallium Arsenide", John Wiley and Sons, 2003.
3. S. M. Sze, VLSI Technology, TATA, McGraw-Hill, 1999.

Reference(s)

1. Peter Van Zant, "Microchip Fabrication: A Practical Guide to Semiconductor Processing", McGraw- Hill Professional, Sixth Edition, 2014.
2. Chang, C.Y. and Sze, S.M., "ULSI Technology", McGraw Hill, 1999.
3. Campbell, S.A., "The Science and Engineering of Microelectronic Fabrication", 4th Ed., Oxford University Press, 1999.

23ECE339	Semiconductor Memories **(Pre-requisite:** VLSI Design**)**	L-T-P-C: 3-0-0-3

Course Objectives

- To learn & understand the Memory hierarchy and array structure in the system.
- To learn various types of architecture for semiconductor memories in detail to understand their limitations and available solutions to improve them.
- To learn and understand memory cell structures, various parameters associated with them, and various aspects of reliability.

Course Outcomes: At the end of the course, the student should be

CO1: understand the SRAM cell structures with its advantages & disadvantages.
CO2: understand the variations in DRAM with its advantages & disadvantages.
CO3: understand other types of semiconductor memories to implement EEPROM and Flash memories etc.
CO4: understand MRAMs and FRAMs types of memories.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2		1							2	3		
CO2	3	3	2									2	3		
CO3	3	3	2									2	3		
CO4	3	2										2	3		

Syllabus

Unit I
Random Access Memory Technologies: SRAM Cell structures, MOS SRAM Architecture, Advanced SRAM architectures and technologies, Application specific SRAMs.

Unit II
CMOS DRAM, DRAM cell theory and cell structures, BICMOS DRAM, DDR, Non-volatile Memories: Masked ROMs, High density ROM, PROM, CMOS PROMS, EPROM, Floating gate EPROM cell, One-time programmable EPROM, EEPROM, Flash Memories, Advanced Flash memory architecture- RAM fault modeling - BIST techniques for memory.

Unit III
Radiation effects, Single Event Phenomenon (SEP), Radiation Hardening Process and Design Issues, FRAMs, GaAs FRAMs, Magneto resistive RAMs (MRAMs), Memory MCM testing and reliability issues, Memory cards, High Density Memory Packaging; Optimal memory cell design, detection and classification of defects using AI/ML techniques.

Textbook(s)

1. Ashok K. Sharma, "Semiconductor Memories: Technology, Testing, and Reliability", Wiley, 2013.
2. Betty Prince, "Emerging Memories: Technologies and Trends ", Kluwer Academic, 2002.
3. Tegze P Haraszti, "CMOS Memory Circuits", Kluwer Academic, 2001.
4. Brent Keeth and R Jacob Baker, "DRAM Circuit Design: A Tutorial", Wiley – IEEE Press, 2000.

Reference(s)

1. Kevin Zhang, "Embedded Memories for Nano- Scale VLSIs", Springer, 2009
2. Santosh K. Kurinec and Krzysztof Iniewski, "Nanoscale Semiconductor Memories: Technology and Applications", CRC press, 2013.
3. Koichi Ishibashi and Kenichi Osada, "Low Power and Reliable SRAM Memory Cell and Array Design", Springer, 2011.
4. Saraju P. Mohanty and Ashok Srivastava, "Nano-CMOS and Post-CMOS Electronics: Circuits and Design", Vol 2., (IET) The institution of Engineering and Technology, 2015

23ECE340	FPGA based System Design **(Pre-requisite:** Digital Electronics**)**	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce programmable logic devices (PLDs).
- To understand the organization and implementation of an FPGA-based digital system.
- To familiarize the design of advanced digital hardware systems targeting FPGAs.

Course Outcomes: At the end of the course, the student should be able to

CO1: design digital circuits using programmable logic devices.
CO2: understand the architectures and features of various technology-based FPGAs.
CO3: comprehend the different phases of FPGA design flow and timing constraints.
CO4: understand advanced architectures of FPGA.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3									3	3		
CO2	3	2	3									3	3		
CO3	3	2	3									3	3		
CO4	3	2	3									3	3		

Syllabus

Unit I
Programmable Logic Devices - PROM - PAL - PLA - CPLD - Gate Arrays – MPGA. Introduction to FPGAs – Design flow – Circuit Fabrics – LUTs and IO Blocks. FPGA Technology overview – Digital Design for FPGAs, FPGA Programming Technologies – Antifuse - EPROM - EEPROM - FLASH – SRAM. FPGA Fabric - Configurable Logic Block - LUT - Slice – Slicem. Programmable Interconnects - Input Output Blocks - Keeper Circuit - Xilinx 7 Series Architecture.

Unit II
FPGA Design Flow and Abstraction Levels - Verilog Design for Synthesis - One Hot Encoding - Memory Blocks - Block Memory Generator (BRAM/BROM) - Single Port Memory - Dual Port Memory - FIFO - Distributed RAM - Synthesis Pitfalls - Latch Inference - Static Timing Analysis - Speed Performance - Timing Constraints - Clock Management - Clock Buffers - Clock Tree Routing.

Unit III
Introduction to SoC Design - Hard Macros - Multipliers - DSP Block - Hard Core Processors - Interface Circuits - Configuration Chain - JTAG Interface - Zynq7000 Architecture**;** Case Study: FPGA implementation of AI/ML algorithms.

Textbook(s)

1. Wayne Wolf, “FPGA-Based System Design”, Prentice Hall India Pvt. Ltd., 2005.
2. Amano, Hideharu, “Principles and Structures of FPGAs”, First Edition, Springer, 2018.
3. Readler, Blaine C.,” Verilog by example: a concise introduction for FPGA design”, Full Arc Press, 2011.

Reference(s)

1. Zainalabedin Navabi, “Embedded Core Design with FPGAs, First Edition”, McGraw Hill, 2008.
2. Xilinx Inc, “Vivado Design Suite User Guide, 2021.
3. Michael D. Ciletti, “Advanced Digital Design with Verilog HDL”, Second Edition, Pearson Higher Education, 2011.

23ECE341	Hardware Security and Trust (**Pre-requisite:** VLSI Design)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce Hardware Trojan taxonomy
- To familiarize Trojan insertion methods and detection approaches at various levels of abstraction
- To introduce VLSI design flow incorporating trust at different levels

Course Outcomes: At the end of the course, the student should be able to

CO1: understand typical hardware security vulnerabilities at various phases of VLSI Design flow
CO2: understand fundamental approaches used in Trojan insertion
CO3: understand different approaches for Trojan and Piracy detection and analysis
CO4: analyze the ways in which trust can be incorporated in VLSI Design flow

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
CO1	3												2		
CO2	3												2		
CO3	3	3											2		
CO4	3	2											2		

Syllabus

Unit I
Review of VLSI Design Flow - Hardware Trojan –Trojan taxonomy - Case study - Trojan detection – Classification of Trojan detection - Challenges in Trojan detection.

Unit II
Design for hardware trust – Delay-based methods – Shadow registers – Ring oscillators - Dummy scan Flip-Flop insertion - Trojan activation time analysis - Trojan detection and isolation flow – Architectural approaches; AI-based Hardware trojan detection techniques.

Unit III
Security and testing – Scan-based testing – Scan-based attacks and countermeasures - System-on-chip test infrastructure - Emerging areas of test security. Trojan prevention: Built-in self-authentication - BISA structure and insertion flow - Analysing BISA structure - Trusted design in FPGAs.

Textbook(s)

1. Mohammad Tehranipoor and Cliff Wang (Eds.), "Introduction to Hardware Security and Trust", Springer, New York, 2012.
2. Mohammad Tehranipoor, Hassan Salmani and Xuehui Zhang, "Integrated Circuit Authentication - Hardware Trojans and Counterfeit Detection", Springer International Publishing, Switzerland 2014.

Reference(s)

1. Nicolas Sklavos, Ricardo Chaves, Giorgio De Natale, Francesco Regazzoni (Eds), "Hardware Security and Trust: Design and Deployment of Integrated Circuits in a Threatened Environment", Springer, 2017.
2. Prabhat Mishra, Swarup Bhunia, Mark Teharanipoor (Eds), "Hardware IP Security and Trust", Springer, 2017.

23ECE342	VLSI System Design (**Pre-requisite:** Digital Electronics)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the various modeling styles for Hardware Description Languages (HDLs).
- To introduce Register Transfer Level (RTL) abstraction for HDL based design flow.
- To understand the behavioral HDL modeling of combinational and sequential subsystems.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the basic constructs of Verilog.
CO2: design digital blocks using Gate level and Data flow modeling style of Verilog.
CO3: design digital blocks using behavioral modeling and also synthesizable constructs in the same.

CO4: analyze the working and designing of standard VLSI System building blocks.

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2									2	3		
CO2	3	3	3									2	3		
CO3	3	3	3									2	3		
CO4	3	3	3									2	3		

Syllabus

Unit I
Review of VLSI Design Flow - Introduction to HDLs - Verilog modeling styles – Gate Level, Structural - Dataflow - Register Transfer Level (RTL) abstraction for HDL-Based Design Flow.

Unit II
Behavioral Verilog Modeling of Combinational and Sequential Subsystems: Multiplexer – Decoder – Encoder – adders – Multipliers – Counters - Shift Registers - State Machines.

Unit III
Logic Synthesis with Verilog HDL and their constructs, Impact of Logic Synthesis, Basics of Timing - Speed of a Digital system - Design Case Studies - Simple Processor – FIFO - Circular Buffer - DSP Blocks – LFSR; Case Study: Design the AI/ML algorithms using Verilog.

Textbook(s)

1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Second Edition, Pearson, 2003.
2. Michael D Ciletti, "Advanced Digital Design with the Verilog HDL", Second Edition, Pearson, 2017.

Reference(s)

1. T. R. Padmanabhan and B. Bala Tripura Sundari, "Design through the Verilog HDL", First Edition, Wiley Interscience, 2004.

Devices and Circuits

23ECE351	Design of ICs for Optical Communication (Pre-requisite: Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide an understanding of a general optical system and random binary data
- To provide a foundation to design and analyse optical active and passive devices and circuits
- To provide an overview of design challenges and performance analysis of optical devices and systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the design challenges in transmission of random binary data in optical communication system
CO2: design optical communication related circuits and systems
CO3: analyze and characterize optical communication related circuits and systems
CO4: carry out the performance evaluation of an optical communication system

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1											3		
CO2	2	3	2										3		

CO3	2	3	3										3		
CO4	2	3	3		3								3		

Syllabus

Unit I
Optical Communication System: General Optical System – Design Challenges – State of the Art Random Binary Data – Properties – Generation – Data Formats – Effect of Bandwidth Limitation – Effect of noise – Phase noise and jitter – Transmission Lines; Optical Devices: Laser Diodes – Optical Fibers - Photodiodes – Optical Systems

Unit II
Transimpedance Amplifiers: General Considerations – Open Loop TIA – Feedback TIA – Supply Rejection – Differential TIA – High Performance Techniques – Automatic Gain Control – Development in TIA Design with case studies; Limiting Amplifiers and Output Buffers: General Considerations – Broadband Techniques - Output Buffers – Distributed Amplification, Oscillators: Ring Oscillators - LC Oscillators – Inductors – Varactors – Quadrature Oscillator – Distributed Oscillator - Voltage Controlled Oscillators

Unit III
PLL - Charge-Pump PLLs - Nonideal Effects in PLLs - Delay-Locked Loops, Clock and Data Recovery: General Considerations - Phase Detectors for Random Data - Frequency Detectors for Random Data - CDR Architectures - Jitter in CDR Circuits, Multiplexers and Laser Drivers: Multiplexers - Frequency Dividers - Laser and Modulator Drivers - Design Principles - Laser Driver Design, Burst-Mode Circuits: Burst-Mode TIAs - Burst-Mode CDR Circuits; Design optimization of high-speed laser driver IC using support vector regression (SVR), Deep Neural Network for anomaly detection in high-speed laser driver circuits.

Textbook(s)
1. Behzad Razavi, "Design of Integrated Circuits for Optical Communications", 2nd Edition, Wiley, 2012.
2. Behzad Razavi, "Design of CMOS Phase Locked Loops", Cambridge University Press, 2020.

Reference(s)
1. Eduard Säckinger, "Analysis and Design of Transimpedance Amplifiers for Optical Receivers" Wiley, 2017.
2. Ofer Aluf, "Advance Elements of Laser Circuits and Systems: Nonlinear Applications in Engineering", 1st Edition, 2021.

23ECE352	**Optoelectronic Integrated Circuit Design** (**Pre-requisite:** Electronic Devices and Circuits)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide an understanding of the optical semiconductor materials and device mechanisms
- To develop the fundamental knowledge on optoelectronic devices
- To understand the MOS dynamic effect, LED materials and configuration

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the working principle of the optical devices
CO2: use the optical materials for different applications
CO3: design simple optoelectronics device
CO4: understand the behavioral characteristics of optical devices

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3		

CO2	2	3											3		
CO3	2	3											3		
CO4	2	3			3								3		

Syllabus

Unit I

Introduction -Optical mechanism in semiconductors, E-H pair generation and recombination, absorption and radiation in semiconductor, deep level transitions, Auger recombination, luminescence and time resolved photoluminescence, optical properties of photonic band-gap materials; Junction photodiode: PIN, heterojunction and avalanche photodiode; Comparisons of various photodetectors, measurement techniques for output pulse.

Unit II

Photovoltaic effect, V-I characteristics and spectral response of solar cells, heterojunction and cascaded solar cells, Schottky barrier and thin film solar cells, design of solar cell, Generative Adversial Network (GAN) to optimize nanostructure design for solar cells. Modulated barrier, MS and MSM photodiodes; Wavelength selective detection, coherent detection; Microcavity photodiode, Support Vector Regression (SVR) and particle swarm optimization (PSO) algorithms to optimize design parameters of microcavity photodiode.

Unit III

Dynamic effects of MOS capacitor, basic structure and frequency response of charge coupled devices, buried channel charge coupled devices. Electroluminescent process, choice of light emitting diode (LED) material, device configuration and efficiency; LED: Principle of operation, LED structure, frequency response, defects, and reliability.

Textbook(s)

1. Horst Zimmermann "Silicon Optoelectronic Integrated Circuits" 2nd edition, Volume 13, Springer Series in Advanced Microelectronics
2. Jianjun Gao "Optoelectronic Integrated Circuit Design" 1st edition, 2011, Wiley

Reference(s)

1. O. Wada "Optoelectronic Integration: Physics, Technology and Applications" 1994
2. Ginés Lifante "Integrated Photonics Fundamentals" 2003. Wiley

23ECE353 **Optoelectronic Materials and Devices** **L-T-P-C: 3-0-0-3**

(**Pre-requisite:** Electronic Devices and Circuits)

Course Objectives

- To provide an understanding of the optical semiconductor materials and device mechanisms
- To develop the fundamental knowledge on optoelectronic devices
- To understand the MOS dynamic effect, LED materials and configuration

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the working principle of the optical devices
CO2: use the optical materials for different applications
CO3: design simple optoelectronics device
CO4: understand the behavioral characteristics of optical devices

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	2											3		
CO3	3	2											3		
CO4	3	2											3		

Syllabus

Unit I

Introduction -Optical mechanism in semiconductors, E-H pair generation and recombination, absorption and radiation in semiconductor, deep level transitions, Auger recombination, luminescence and time resolved photoluminescence, optical properties of photonic band-gap materials; Junction photodiode: PIN, heterojunction and avalanche photodiode; Comparisons of various photodetectors, measurement techniques for output pulse.

Unit II

Photovoltaic effect, V-I characteristics and spectral response of solar cells, heterojunction and cascaded solar cells, Schottky barrier and thin film solar cells, design of solar cell; Modulated barrier, MS and MSM photodiodes; Wavelength selective detection, coherent detection; Microcavity photodiode;

Unit III

Dynamic effects of MOS capacitor, basic structure and frequency response of charge coupled devices, buried channel charge coupled devices. Electroluminescent process, choice of light emitting diode (LED) material, device configuration and efficiency; LED: Principle of operation, LED structure, frequency response, defects, and reliability; Deep learning for the development of optoelectronic devices.

Textbook(s)

1. Sze, S.M., and Ng, K.K., “Physics of Semiconductor Devices”, 3rdEd. Wiley-Interscience, 2006.
2. Liao, S.Y., “Microwave Devices and Circuits”, 4thEd., Pearson Education, 2002.

Reference(s)

1. Golio, M., “RF and Microwave Semiconductor Devices Handbook”, CRC Press, 2002.
2. Rebeiz, M.G., “R.F. MEMS: Theory, Design and Technology”, 2ndEd., Wiley-Interscience, 2003.

23ECE354	**Radio Frequency Integrated Circuits** (**Pre-requisite**: Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide an overview of RF CMOS device characterization
- To enhance design capability for the RF IC designs
- To enrich the skills of computations by introducing modern engineering tools necessary for evaluating RF circuits.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand RF CMOS device characteristics and its importance in RF ICs
CO2: apply RF computational techniques to design actively loaded RF amplifiers
CO3: design and analyze two port networks
CO4: evaluate the characteristics of RF CMOS sub blocks from top-level specifications and to model circuits using circuit simulators

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3		
CO2	3	2	2										3		
CO3	3	3	2										3		
CO4	3	3	2		3								3		

Syllabus

Unit I

Introduction- Review of RF and communication systems concepts, Basic Concepts in RF Design - General Considerations, Effects of Nonlinearity, Noise, and Sensitivity and Dynamic Range. RF systems – basic architectures, Parallel RLC - Series RLC - Impedance Transformers - L-Pi-T-Type. Higher Order Matching - Transmission Lines - Driving Point Impedance. Small Signal RF CMOS Model - Noise Sources Transceiver Architectures- Basic and Modern Heterodyne Receivers, Direct-Conversion Receivers. Low-IF Receivers and Heterodyne Transmitters. Low-Noise Amplifiers- General Considerations, Problem of Input Matching, and LNA Topologies

Unit II

Mixers- General Considerations, Passive Down conversion Mixers, Active Down conversion Mixers, and Active Mixers with High IP2, Up conversion Mixers. Two Port Network - S-Parameters - Maximum Stable Gain - Reflection Coefficients - Stability - Non-Linearity - 1-dB Gain Compression Point - Inter-Modulation -Receiver Architecture - Direct Conversion - Super Heterodyne - Hartley Architecture - CMOS sub blocks - Low Noise Amplifier - Inductive Source Degeneration - Cascode and Differential Configurations - Inductive Peaking - Current Reuse.

Unit III

Oscillators- Cross-Coupled Oscillator, Voltage-Controlled Oscillators, Low-Noise VCOs. Phase-Locked Loops- Type-I PLLs, Type-II PLLs, and PFD/CP Nonidealities. Power Amplifiers- Classification, High-Efficiency Power Amplifiers, Cascode Output Stages, and Basic Linearization Techniques. Doherty Power Amplifier, Polar Modulation, and Out phasing; ML based linearization techniques.

Textbook(s)

1. RF Microelectronics by Behzad Razavi. Second Edition, Pearson, 2012 (Indian Edition 2013 by Dorling Kindersley).
2. The Design of CMOS Radio-Frequency Integrated Circuits by Thomas H. Lee. Cambridge University Press, 2004.

Reference(s)

1. SorinVoinigescu, High-Frequency Integrated Circuits, Cambridge University Press, 2013, South Asian Paperback edition of 2018.
2. Michael Steer, Microwave and RF Design - A Systems Approach, SciTech Publishing, 2010, Indian Reprint by Yesdee Publishing, 2012.

23ECE355	IC Design for Sensor Systems (**Pre-requisite**: Electronic Circuits-II)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide an understanding of sensor interface circuits and smart sensor systems
- To understand the fundamentals of precision and dedicated sensor circuits and systems
- To provide foundation on design MOS based sensor circuits for smart sensing applications

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concepts of design and calibration of sensor interface circuits and sensor interface system
CO2: apply the design principles on precision instrumentation amplifiers and dedicated sensor systems
CO3: analyze CMOS based sensor circuits and their characteristics
CO4: evaluate the performance of MOS based sensor interface circuits and systems using simulation tools

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2											3	2	
CO2	2	3	2										3	2	
CO3	2	3	2										3	2	
CO4	2	2	3		3								3	2	

Syllabus

Unit I

Sensor Interface Circuits – Sensor Signal Normalization **–** Analog Data Acquisition Circuits in Integrated Sensing System **–** Integrated Interface Circuits for Capacitive Micromechanical Sensors **–** Interfaces for Microsensor Systems - Sensor Interface Systems – Smart Sensor Systems **–** Smart Sensor Design **–** Calibration and Self-Calibration of Smart Sensors

Unit II

Precision Instrumentation Amplifiers – Three- OpAmp Instrumentation Amplifier, Current-Feedback Instrumentation Amplifiers **-**Auto-Zero OpAmps and InstAmps **-** Chopper OpAmps and InstAmps **-** Chopper Stabilized OpAmps and InstAmps **-** Chopper Stabilized and AZ-Chopper OpAmps and InstAmps, Dedicated Impedance-Sensor Systems **-** Capacitive-Sensor Interfaces using Square-Wave Excitation Signals **-** Dedicated Measurement Systems – Detection of Microorganisms – Water Content Meaurements– Blood Impedance Characterization

Unit III

CMOS Based Sensors – DNA Microarrays –Functionalization – Electrochemical Readout Techniques **-** Image Sensors – Impact of CMOS Scaling – CMOS Pixel Architectures – Photon Shot Noise – A/D Converters for CMOS Image Sensors – Light Sensitivity – Dynamic Range – Global Shutter Circuit Platforms for Smart Sensors **–** mm Scale Sensor Platform for future IOT Applications – Deep Neural Networks and Reinforcement Learning to optimize design of sensor system for power consumption and data accuracy-Smart Sensor Microsystem-Decision Trees and Genetic Algorithm to optimize design of smart sensor microsystem for performance and power consumption; Application-Dependent Design and Integration Approaches – Energy Efficient RRAM Crossbar-based Approximate Computing for Smart Cameras **-** NVRAM-Assisted Optimization Techniques for Flash Memory Management in Embedded Sensor Nodes

Textbook(s)

Gerard Meijer, Michiel Pertijs, Kofi Makinwa "Smart Sensor Systems: Emerging Systems and Applications" 1st edition, Wiley, 2014

Reference(s)

1. Chong-Min Kyung, Hirrota Yassura, "Smart Sensors and Systems" Springer, 2017
3. Willy Sansen, Johan H Huijsing "Analog Circuit Design Mixed A/D Circuit Design, Sensor Interface Circuits and Communication Circuits" Springer Science, 1999

23ECE356	**Microelectromechanical Devices** **(Pre-requisite**: Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To understand the Microelectromechanical **(**MEMS) system and MEMS materials
- To understand different MEMS micro sensor and actuators principle and mechanism
- To introduce the fabrication process involved in microsystem and packaging

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the MEMS devices and MEMS materials used in fabrication
CO2: understand the different MEMS micro sensor principles and micro actuators mechanism
CO3: understand the engineering science of microsystem
CO4: understand the mechanism and fabrication process of microsystem and packaging

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	3	
CO2	2	3	-	-	-	-	-	-	-	-	-	-	3	3	
CO3	2	2	2	-	-	-	-	-	-	-	-	-	3	3	

CO4	2	2	1	3	-	-	-	-	-	-	-	-	3	3	

Syllabus

Unit I

Overview of MEMS and Microsystem, MEMS Materials: Silicon, Polymer: Polymers in MEMS– Polimide, SU-8, Liquid Crystal Polymer (LCP), PDMS, PMMA, Parylene; Microsensor-Working principles of different microsensors-acoustic, BioMEMS, Chemicals, Optical, Pressure, and Thermal, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors. Micro-actuators-different actuations mechanisms- Thermal force, Shape memory alloy, Piezoelectric materials, Electrostatic force, Applications of micro actuators.

Unit II

Engineering science for microsystem design: Engg. Mechanics of microsystem: Design-static bending of thin plates, mechanical vibration, thermomechanical, fracture mechanics, thin film mechanics, and finite element analysis, thermofluidic and microsystem design- characteristic of moving fluid, continuity and momentum equations, Laminar fluid flow, and heat conduction, miniaturization laws.

Unit III

Microsystem fabrication process-photolithography, ion-implantation, diffusion, oxidation, thin films deposition methods-chemical vapor deposition, physical vapor deposition, epitaxy deposition, Etching- Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reactive Ion Etching (DRIE) – Isotropic Wet Etching- Gas Phase Etchants; Micromanufacturing: Bulk micromachining, surface micromachining, and LIGA process; Assembly of 3D MEMS, Microsystems packaging and materials- Artificial Intelligence applications for MEMS Sensors and actuators and applications of MEMS devices.

Textbook(s)

1. Tai-Ran Hsu, MEMS and Micro systems Design and Manufacture, Tata McGraw Hill, 2002.
2. Chang Liu, Foundation of MEMS, International Edition, 2nd edition, 2006.
3. GK Anantha Suresh, et. al, Micro and Smart Systems, Wiley-India, 2010.

Reference(s)

1. Stephen D Senturia, Microsystem Design, Springer Publication, 2000.
2. Julian W.Gardner, Vijay K Varadhan, "Microsensors, MEMS and Smart devices", John Wiley & sons, 2001.

23ECE357	Energy Harvesting Technologies and Circuits	L-T-P-C: 3-0-0-3
	(**Pre-requisite**: Nil)	

Course Objectives

- To understand the different energy harvesting methods
- To understand the fundamentals and circuit model of energy harvesting technologies
- To understand the energy harvesting interfacing and power conditioning circuits

Course Outcomes: At the end of the course, the student should be able to

CO1: understand various energy sources available in the environment
CO2: understand the fundamentals of energy harvesting technologies and methods
CO3: understand about the low power and high-power energy harvesting technologies and their model
CO4: understand different conditional circuits used for energy harvesting devices

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO															
CO1	3												3		
CO2	3	2											3		
CO3	3	2	2										3		
CO4	3	3	2			2							3		

Syllabus

Unit I

Introduction-Energy sources, energy harvesting based sensor networks, photovoltaic cell technologies, generation of electric power in semiconductor PV cells, Thermoelectric energy harvesting- design and effecinecy, piezoelectric energy harvesting, types of Piezoelectric materials, Transducers. Micro scale harvesting, Strategy for Enhancing the generated power.

Unit II

Piezoelectric Electromechanical modeling of Lumped parameter model and coupled distributed parameter models and closed from solution. Performance Evalution, Electromagnetic-Basic priciple, micro fabricated coils and magnetic materials, scaling, power maximization, micro and macro scale implementations. Non-linear techniques, vibration control & steady state cases. Power sources for WSN, Power generation, conversion, examples – case studies.

Unit III

Harvesting circuits- Schottky diode, MOSFET as a diode, PWM and transistor switching, Interface/power conditioning circuit: linear DC-DC converters, Buck-boost Convertor, AC-DC boots rectifiers, Voltage Multipliers, and LT Spice Analysis of Power Conditioning Circuit; Role and application of AI/ML in energy systems.

Textbook(s)

1. Carlos Manuel Ferreira Carvalho, Nuno Filipe Silva Veríssimo Paulino, “CMOS Indoor Light Energy Harvesting System for Wireless Sensing Applications", springer, 2016.
2. Shashank Priya, “Energy Harvesting Technologies, “Springer, 2009.

Reference(s)

1. Danick Briand, Eric Yeatman, Shad Roundy, “Micro Energy Harvesting”, 2015

23ECE358	**FinFET Technology**	**L-T-P-C: 3-0-0-3**
	(**Pre-requisite**: Electronic Circuit-1)	

Course Objectives

- To introduce MOSFET scaling challenges, Multi Gate MOS system, and FinFET region of operation
- To introduce the understanding of the physical effect, leakages, and parasitic of the FinFET
- To familiarize with materials, fabrication process, and challenges to FinFET process and devices

Course Outcomes: At the end of the course, the student should be able to

CO1: know the challenges of MOSFET scaling, oxide defects, and importance of FinFET
CO2: understand the MOS System, region of operation, physical effect of FinFET Technology
CO3: understand the different types of leakages and parasitic resistances in FinFET
CO4: know the fabrication materials, process and various fabrication challenges

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	2											3		
CO3	3	2											3		
CO4	3	2											3		

Syllabus

Unit I

Introduction-Moore's Law, MOSFET Scaling, Challenges, and Physics-Leakage Current, Variability, FinFET- Single and Multigate, Multigate MOS Capacitor, Oxide Charges, Effect of Oxide Charges on Energy Band, Multigate MOS Capacitor Systems, Fin-FET-Operation, Basic Features, Drain Current Formulation-Derivation of Electrostatic Potential, Continuous Drain Current, Equation, Regional Drain Current Equations.

Unit II
Physical Effect and Leakage and Parasitic- Short Channel Effect on Threshold, Quantum Mechanical Effect, Surface Mobility, Subthreshold, Gate induced Drain and Source, Gate induced Source, Source Drain P-N Junction leakages, and Gate Oxide Tunneling leakages, Impact Ionization Current, Source-Drain Parasitic Resistance, Gate Resistance, Source Drain-P-N Junction Capacitances,

Unit III
FinFET-Fabrication-material, well formation, Fin pattering, Alternative well formation, Gate Definition, Source-Drain Extension, Raised Source-Drain, replacement metal gate formation, Challenges to FinFET Process-Lithography, Process Integration, Dopant Implantation, and Etching, Device Technology and FinFET circuit Design Challenges; Role of Al/ML in FinFET optimization and fabrication.

Textbook(s)
1. Samar K. Saha, "FinFET Devices for VLSI Circuit and Systems," CRC Press, 2021.
2. Yogesh Singh Chauhan, "FinFET Modelling for IC Design and Simulation, Academic Press, 2015.

Reference(s)
Jean-Pierre Colinge, "FinFETs and Other Multi-gate Transistors," Springer, 2008.

23ECE359	**Nano Electronics**	**L-T-P-C: 3-0-0-3**
	(Pre-requisite: Semiconductor Physics**)**	

Course Objectives

- To study deep sub-micron effects of MOSFETs and understand the latest trends in the technology and principles of nano-electronics
- To introduce the mathematical methods applied for advanced material based MOSFET models and familiarize new material devices and their performances
- To provide a unified applied treatment of fundamental mathematics of quantum transport and use it for device modeling using the principles learnt above

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the deep sub-micron effects and limits of scaling on nano-electronic devices
CO2: use of wave – particle analysis in the development of transport properties
CO3: use mathematical methods for advanced nanomaterial studies
CO4: develop spice compatible models

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	3	-	-	-	-	-	2	2	2	2		-
CO3	2	2	-	-	-	-	-	-	-	2	2	2	2		-
CO4	2	2	3	-	-	-	-	-	2	2	2	2	2		-

Syllabus
Unit I
Deep Submicron Devices Limits to Scaling –Nano Devices – Quantum Effects– Atomic Scale Parameter Fluctuation – Nanoscale MOSFET –FINFETS –Vertical MOSFETS **-** Tunnel FETS **-** The Schrödinger Equation –Electrons in a Crystal

Lattice – Quantum Well– Wire and Dot Devices - Scattering Rates and Lifetimes in Electronic Devices - CVD and Other Processes in Fabrication of Nano Devices.

Unit II

Band-Structure and Transport Resonant Tunneling Transistors –Single Electron Transistors –and Spintronics Devices - Atoms–up Approaches – Transport in Molecular Structures – Molecular Systems as Schrodingers equation – Nanoscale and Quantum Devices –Single Electron Transistor – Quantum Wires - Quantum Dot Cellular Automata.

Unit III

Alternatives to Conventional Electronics – Drift Diffusion– Ballistic Transport –NEGF –Molecular Interconnects – Graphene–Carbon Nanotubes and Silicon Nanowire, Technology Devices and Circuits - 1 D transport - Reflection, Transmission and the non-equilibrium Green Function Formalism (NEGF) - Contacting the schodinger - Density of states – Hamiltonian - and Spice compatible modeling of carbon-based advanced nanomaterial channels for MOSFET devices.

Textbook(s)

1. S. Datta, "Lessons from Nanoelectronics", World Scientific, 2012.
2. S. Datta, "Quantum Transport: Atom to Transistor", Cambridge University Press, 2005.

Reference(s)

1. Gerhard Klimeck, "Nanoelectronics Modeling: From Quantum Mechanics and Atoms to Realistic Devices", https://nanohub.org/resources/8086, 2010.
2. Waser Ranier, "Nano Electronics and Information Technology: Advanced Electronic Materials and Novel Devices" Wiley VCH, 2003.

23ECE360	**Energy Materials** (**Pre-requisite**: Physics of Semiconductors)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To study solar cells and energy harvesting materials
- To introduce energy storage materials and synthesis methods of energy harvesting materials
- To provide a deep understanding of different characterization techniques of materials

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the applications of different solar cells
CO2: understand the new generation energy harvesting materials
CO3: know the different synthesis methods of materials
CO4: understand various methods to analyze and characterize the materials

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-		-
CO2	3	3	-		-	-	-	-	-	-	-	-	2		-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2		-
CO4	3	2		-	-	-	-	-		-	-	-	2		-

Syllabus

Unit I

Solar and Energy Harvesting Materials- First generation solar cell materials; single and polycrystalline Silicon, amorphous silicon, contact materials. Second generation solar cell materials: CdSe, CdTe, Copper Indium Gallium Selenide (CIGS), Gallium Arsenide for applications in photovoltaics, Materials for thin film solar cells, thin film processing, and properties. Contact materials for second generation solar cells. Third generation solar cell materials; Quantum Dots, Organic materials, Composites, Dyes, Perovskites and their synthesis, characterization and properties, Interface energetics, photoactive layers and their materials. Piezoelectric, Pyroelectric and Thermo-electrics materials, Electrostatic (capacitive)

Energy Harvesting and materials, energy from Magnetic Induction, Metamaterial, energy from atmospheric pressure changes, electroactive polymers (EAPs); Use of Machine Learning and Artificial Intelligence for Energy Materials.

Unit II

Energy Storage Materials-Electrochemistry and electro-chemical Battery materials, Hydrogen Storage materials for fuel cells: Metal hybrids, Nanostructured metal hydrides, Non-metal hydrides, Carbohydrates, Synthesis of hydrocarbons, Aluminum, Liquid organic hydrogen carriers (LOHC), Ammonia, Amine borane complexes, Nano borohydrides and nano catalyst doping, imidazolium ionic liquids, phosphonium borate, Carbonite substances, Metal Organic frameworks, Activated Carbons, Carbon nanotubes, Clathrate hydrates, Glass capillary arrays; **Physical Materials Synthesis Methods:** Vacuum Evaporation, Electron beam evaporation Sputtering, Cathodic Arc Deposition, Chemical Vapour Deposition, Atomic Layer Deposition, Pulsed Laser Deposition, Molecular Beam Epitaxy, Lithography and their types; Al/Ml in material Process and manufacturing.

Unit III

Physical Materials Synthesis Methods: Sol-Gel technique, self-assembly, colloidal method, hydro-thermal method, coprecipitation method, solid state synthesis, microwave method, micro-emulsion method; **Materials Characterization Methods:** Electron beam instruments: Transmission electron and scanning electron microscopes, Auger electron spectroscope, x-ray spectrometers, Analysis of micrographs in TEM, SEM, and HRTEM, Interpretation of analytical data: EDS, WDS, Auger, EELS, ESCA, SIMS. Bulk averaging techniques: Thermal analysis, DTA, DSC, TGA, resistivity/conductivity. Optical spectroscopy: atomic absorption spectroscopy, infrared spectroscopy and Raman spectroscopy; Scanning Tunneling and Atomic Force Microscopy.

Textbook(s)

1. Advanced Energy Materials, Ashutosh Tiwari & Sergiy Valyukh, J. Wiley & Sons, 2014.
2. Eco- and Renewable Energy Materials, Young Zho, Springer, 2013.

Reference(s)

Materials and Energy (Book Series), Leonard C Feldman (Ed. In Chief), World Scientific

23ECE361	**Thin Electronic Films** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide understanding of thin electronic film materials and its property
- To explain thin film applications
- To provide conceptual principles of design and processing of thin film materials for electronic applications

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the structure and fabrication of thin film materials used in electronics applications
CO2: understand the physics and technology behind electronic thin films materials used in engineering applications
CO3: understand the dependence of the electronic properties and characteristics on various parameters
CO4: understand the principles behind designing, and engineering of thin film materials for electronic applications

CO – PO Mapping:

CO/PO	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	3	2	1	-	-	-	-	-	-	-	-	-	2		
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2		
CO3	3	2	1	1	1	-	-	-	-	-	-	-	2		
CO4	3	2	1	2	1	-	-	-	-	-	-	-	2		

Syllabus

Unit I

Introduction - Bonding and crystal structure of electronic materials, thin film vs bulk material considerations, thin film formation and structure – Physical Vapor Deposition, Chemical Vapor Deposition, Introduction to Artificial Intelligence for Thin film Manufacturing; Epitaxy; Nucleation and Kinetics; Structure of thin films; Electrical conduction in thin metal films, Skin Effect, Resistivity vs thickness, Interconnects in Microelectronics, Electromigration; Thin film diodes and transistors; Role of Defects.

Unit II
Thin films for Dielectric and magnetic applications **-** Polarization Mechanisms in thin films, electric susceptivity and polarizability, Clausius Mossotti Equation, high and low K materials, frequency dependence, dielectric loss and Breakdown, Piezoelectric and Ferroelectric thin films; Magnetic properties of thin films, Hard and Soft magnetic materials, Anisotropic and Giant Magnetoresistance, Spintronics and magnetic sensors, Magnetic Recording, Superconducting thin films.

Unit III
Thin films for Optical and electromagnetic applications **-** Light Propagation in materials, Total Internal Reflection, Luminescence, Optical Anisotropy, LCDs, Optoelectronic devices – LEDs, LASERs, Solar Cells, Photodetectors, waveguides, Optical fibers; responses of materials to electromagnetic waves, metamaterials, materials for electromagnetic shielding, radars and antennas; smart materials, wide band gap materials.

Textbooks/References

1. Jianguo Zhu, Xiaohong Zhu, Hong Liu, Jie Xing, "*Thin Film Physics And Devices*: Fundamental Mechanism, Materials And Applications For Thin Films", **World Scientific**, 2021 (First Edition).
2. Jaydeep Sarkar, "*Sputtering Materials for VLSI and Thin Film Devices*", **Elsevier (William Andrew)** Inc., First Edition, 2014
3. S. O. Kasap, "*Principles of Electronic Materials and Devices*", Fourth Edition, **McGraw Hill Education**, 2018
4. Alfred Wagendristel and Yuming Wang, "*An introduction to Physics and Technology of Thin films*", **World Scientific**, 1994
5. L. Solymar, D. Walsh and R. R. A. Syms, "*Electrical Properties of Materials*", Ninth Edition, **Oxford University Press**, 2014
6. Rolf. E Hummel, "*Electronic Properties of Materials*", Fourth Edition, **Springer**, 2012

EMBEDDED SYSTEMS

23ECE431	Operating Systems (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide understanding of the structure and implementation of modern operating systems, virtual machines and their applications
- To provide understanding of techniques for achieving process synchronization and managing resources like memory and CPU in an operation system
- To enable compare and contrasts the common algorithms used for both pre-emptive and non-pre-emptive scheduling of tasks in operating systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the architecture and functionalities of modern OS.
CO2: understand and apply the algorithms for scheduling.
CO3: understand and apply the algorithms for resource management
CO4: apply semaphores and monitors for classical and real-world synchronization scenarios

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	1	1												3
CO2	2	2	3	1											3
CO3	2	2	3	1											3
CO4	2	3	3	1											3

Syllabus

Unit I

Introduction to Operating Systems: Overview - Types of systems - Computer system operations - Hardware Protection - Operating systems services - System calls - System structure - Virtual machines. Process Management: Process concepts - Process scheduling - Operations on Process - Cooperating process – Inter-process communication - Multithreading models - Threading issues - Thread types - CPU scheduling –scheduling algorithms.

Unit II

Process Synchronization: Critical section problem - synchronization hardware – Semaphores - Classical problems of synchronization - Critical regions – Monitors – Deadlocks - Deadlock characterization - Methods of handling deadlocks - Deadlock prevention – Avoidance - Detection and recovery.

Unit III

Storage Management: Memory management – Swapping - Contiguous memory allocation. Paging – Segmentation - Segmentation with Paging - Virtual memory - Demand paging - Process creation – page replacement - Thrashing. File Systems: Directory structure - Directory implementation - Disk scheduling. Case study: Threading concepts in Operating systems, Kernel structures.

Textbook(s)

1. Silberschatz and Galvin, "Operating System Concepts", Ninth Edition, John Wiley and Sons, 2012.

Reference(s)

1. Tannenbaum A S, "Modern Operating Systems", Third edition, Prentice Hall, 2007.
2. Stevens W R and Rago S A, "Advanced Programming in the Unix Environment", Second Edition, Addison-Wesley, 2008.
3. Gary Nutt, "Operating Systems", Third Edition, Addison Wesley, 2009.

23ECE432	**Real-Time Systems**	**L-T-P-C: 3-0-0-3**
	(**Pre-requisite**: Operating Systems)	

Course Objectives

- To provide foundations of real time systems
- To introduce concept of real time task-scheduling, and resource sharing and dependencies
- To enable real time communication using real time operating systems and develop real time systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the foundations of real time systems
CO2: apply the concept of real time task-scheduling, and resource sharing
CO3: perform real time communication using real time operating systems
CO4: develop real time systems using real time operating systems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2														3
CO2	3	2	2	2					2			2			3
CO3	3	3	2	2					2			2			3
CO4	3	2	3	3					3			2			3

Syllabus

Unit I

Introduction**:** Real-time and real time system, applications, models of real-time systems (RTS), characteristics, safety and reliability, types, timing constraints, examples of RTSs.; Global Times**:** time and order, time measurement, dense time vs sparse time, internal clock synchronization, external clock synchronization; Real-time model**:** components and messages, component state, gateway component, linking interface specification, component integration.

Unit II

Temporal relations: real-time entities, observations (untimed, indirect, state and event), real-time images and objects, temporal accuracy, permanence and idempotency, determinism; Real-time task scheduling: types of real-time tasks, task scheduling, concepts and classification, algorithms – clock driven scheduling, hybrid schedulers, event driven scheduling, EDF scheduling, rate monotonic algorithm, multiprocessor task allocation, dynamic allocation of tasks. Resource sharing and Dependencies: resource sharing, priority inversion, basic concepts of faults, errors, failures, anomaly detection, fault tolerance, robustness.

Unit III

Real-time communication: requirements, design issues, communication model, flow control, event triggered communication, rate constrained communication, time-triggered communication; Real-time operating systems: features, inter-component communication, task management, time as data, inter-task interactions, Process I/O, error detection, Unix as a RTOS, POSIX, Contemporary RTOSs like PSOS, RT Linux et, benchmarking real time systems.

Textbook(s)

Kopetz H. Real-time Systems: Design Principles for Distributed Embedded Applications. Springer Science & Business Media; 2011 Apr 15.

Reference(s)

1. Rajib Mall. Real-Time Systems: Theory and Practice, Pearson, First Edition; 2006.
2. Laplante PA. Real-time Systems Design and Analysis: An Engineer's Handbook. Wiley-IEEE Press; 1996 Nov 1.
3. Real-Time Systems - Course (nptel.ac.in)
4. Real Time Systems (iitpkd.ac.in)

23ECE433	**MIPS Architecture**	**L-T-P-C: 3-0-0-3**
	(**Pre-requisite:** Digital Electronics)	

Course Objectives

- To introduce to the MIPS architecture and its features
- To provide an understanding of the MIPS assembly language
- To enable design and implement basic MIPS programs using the assembly language

Course Outcomes: At the end of the course, the student should be able to

CO1: describe the MIPS architecture and its components
CO2: write basic MIPS assembly language programs
CO3: analyze and debug MIPS assembly language programs
CO4: design and implement simple embedded systems using the MIPS architecture

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3	3							2			2			3
CO3	3	2	3						2			2			3
CO4	3	2		3					2			2			3

Syllabus

Unit I

Introduction-Introduction to Computer Architecture, MIPS Architecture Overview, MIPS Instruction Set, MIPS Assembly Language Programming, Data Types and Addressing Modes

Unit II

MIPS Processor Design- MIPS Processor Architecture, MIPS Pipeline Design, MIPS Memory Hierarchy, Cache Memory and Virtual Memory, MIPS I/O System

Unit III
Advanced Topics in MIPS Architecture- Multithreading and Multicore Processing, Exception and Interrupt, Handling, MIPS Performance Analysis and Optimization, MIPS SIMD Architecture, MIPS Future and Emerging Trends.

Textbook(s)
1. Computer Organization and Design MIPS Edition: The Hardware/Software Interface (5th Edition) by David A. Patterson and John L. Hennessy
2. Advanced Computer Architecture: Parallelism, Scalability, Programmability (2nd Edition) by Hesham El-Rewini and Mostafa Abd-El-Barr

Reference(s)
1. MIPS Assembly Language Programming by Robert Britton
2. Computer Organization and Design: The Hardware/Software Interface, ARM Edition (1st Edition) by David A. Patterson and John L. Hennessy
3. Computer Architecture, Fifth Edition: A Quantitative Approach by John L. Hennessy and David A. Patterson.

23ECE434	Parallel and Pipelined based Computer Architecture (**Pre-requisite:** Computer Systems and Architecture)	L-T-P-C: 3-0-0-3

Course Objectives

- To learn different techniques to estimate, analyze, and enhance the performance of computing systems.
- To learn advanced hardware and software design principles of modern processors when going from single-core to multi-core systems
- To apply multi-processor memory management techniques to enhance the processor performance

.
Course Outcomes: At the end of the course, the student should be able to

CO1: interpret the performance of a processor based on different metrics
CO2: predict the challenges of realizing different kinds of and leverage them for performance advancement.
CO3: apply the concept of memory hierarchy for efficient memory design and virtual memory to overcome the memory wall
CO4: explore emerging computing trends, computing platforms, and design trade-offs

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3	3							2			2			3
CO3	3	2	3						2			2			3
CO4	3	2		3					2			2			3

Syllabus

Unit I
Design Space Exploration and Optimizations: Performance metrics and performance enhancement techniques, Basic concepts of parallel processing and pipelining, Power dissipation in processors, power metrics, and low-power design techniques. Instruction set architecture design: Instruction set design, implementation and performance perspectives, relative advantages of RISC and CISC instruction set, Data Path Design

Unit II
Instruction-level parallelism (ILP): Pipeline data-path, data-dependence. Challenges in ILP realization. Pipeline hazards and their solutions, out-of-order execution, branch prediction, and dynamic scheduling. VLIW and superscalar processors.

Unit III

Memory systems: Overview of memory hierarchy, Cache design considerations, instruction vs. data caches, write-policy and replacement policy, analysis of cache performance, and cache design for performance enhancement. Brief overview of memory technologies (SRAM, DRAM, and flash). Data Level Parallelism: Flynn Processor classification, SIMD, MIMD, GPU architectures, IO: types, models, protocols, Sockets, ISR.

Textbook(s)

1. J.L.Hennessy, D.A.Patterson, Computer Architecture: a quantitative approach, Morgan Kaufmann, 5th edition, 2011, ISBN: 978-1558605961.
2. William Stallings, Computer Organization and Architecture, Prentice Hall, 10th edition, 2015, ISBN-10: 013293633X, ISBN-13: 978-0132936330
3. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill, 3rd Ed, 2015

Reference(s)

1. Andrew S. Tanenbaum, Structured Computer Organization, Prentice Hall, 6th edition, 2012, ISBN: 978-0132916523.
2. Patterson, J.L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann, 5th edition, 2013, ISBN-13:9780124078864
3. C. Hamacher, Z. Vranesic and S. Zaky, Computer Organization, McGraw-Hill, 5th edition,2002, ISBN: 0072320869.
4. Advanced Computer Architecture (iitpkd.ac.in)
5. NPTEL
6. advanced-computer-architecture.pdf (abit.edu.in)

23ECE435	Parallel Computing (**Pre-requisite:** Operating Systems)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the fundamental concepts of shared and distributed memory, message passing, and synchronous/asynchronous send/receive algorithms
- To get familiarize with the network topologies that are used for parallel communication and the evaluating their performance using metrics, models and profiles
- To learn the designing of parallel codes, parallel I/O algorithms, bottlenecks, issues, and trends

Course Outcomes: At the end of the course, the student should be able to

CO1: understand significance of shared and distributed memory for parallel computing

CO2: understand parallel communication among the cores for carrying out the parallel computation

CO3: understand and analyze the parallel codes, and parallel I/O algorithms

CO4: develop efficient the parallel codes, and parallel I/O algorithms

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3	3							2			2			3
CO3	3	2	3						2			2			3
CO4	3	2		3					2			2			3

Syllabus

Unit I

Introduction: Parallel computing, Shared memory and distributed memory parallelism, Amdahl's law, speedup and efficiency, supercomputers. Message passing: MPI basics, point-to-point communication, collective communication, synchronous/asynchronous send/receive, algorithms for gather, scatter, broadcast, reduce.

Unit II

Parallel communication: Network topologies, network evaluation metrics, communication cost, routing interconnection networks, static and adaptive routing, process-to-processor mapping. Performance: Scalability, benchmarking, performance modeling, impact of network topologies, parallel code analysis and profiling.

Unit III

Designing parallel codes: Domain decomposition, communication-to-computation ratio, load balancing, adaptivity, AI/ML role in load balancing; case studies: weather and material simulation codes. Parallel I/O: MPI I/O algorithms, contemporary large-scale I/O architecture, I/O bottlenecks Job scheduling, RDMA, one-sided communication, NVM, extreme scale computing: issues and trends.

Textbook(s)

1. Peter S Pacheco, "An Introduction to Parallel Programming," Morgan Kaufmann, 2011.
2. DE Culler, A Gupta and JP Singh, Parallel Computer Architecture: A Hardware/Software Approach Morgan-Kaufmann, 1998.
3. A Grama, A Gupta, G Karypis, and V Kumar, Introduction to Parallel Computing. 2nd Ed., Addison-Wesley, 2003.

Reference(s)

1. Marc Snir, Steve W. Otto, Steven Huss-Lederman, David W. Walker and Jack Dongarra, "MPI - The Complete Reference, Second Edition," Volume 1, The MPI Core.
2. William Gropp, Ewing Lusk, Anthony Skjellum, Using MPI: portable parallel programming with the message-passing interface, 3rd Ed., Cambridge MIT Press, 2014.

23ECE436	**Embedded Systems for Robotics** (**Pre-requisite:** Embedded Systems)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide an overview of robotic systems
- To understand the design parameters involved in the design of robots
- To analyze different robot designs

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the concept of controllers in robotic systems
CO2: understand the different sensors and actuators required for robotic systems
CO3: analyse different types of robot designs
CO4: develop mobile robot application

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3	2										2			3
CO3	3	2	2									2			3
CO4	3	2										2			3

Syllabus

Unit I

Robots and Embedded Systems-Robots and Controllers: Mobile Robots-Embedded Controllers-Interfaces-Operating System, Robot operating system (ROS), Sensors, Actuators in Robots - Control - On-Off Control, PID Control, Velocity Control and Position Control, Recent Trends in Robotics

Unit II

Mobile Robot Design: Driving Robots- Single Wheel Drive- Differential Drive- Tracked Robots- Synchro-Drive-Ackermann Steering- Drive Kinematics, Omni-Directional Robots, Balancing Robots, Walking Robots

Unit III

Mobile Robots, Concepts of Localization, and path planning, Maze Exploration, Map Generation

Textbook(s)

Thomas Bräunl, *"Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems",* Third Edition, Springer-Verlag Berlin Heidelberg, 2008.

Reference(s)

1. R.K.Mittal and I.J.Nagrath, "Robotics and Control", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2003.
2. John J. Craig, "Introduction to Robotics: Mechanics and Control", Fourth Edition, Pearson, 2018.
3. Anis Koubaa, "Robot Operating System (ROS) The Complete Reference", First Volume, Springer, 2016.
4. K.S. Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics: Control, Sensing, Vision, and Intelligence", McGraw-Hill, New York, 1987.

23ECE437	Multi-Core Architecture	L-T-P-C: 3-0-0-3
	(**Pre-requisite:** Computer Systems and Architecture)	

Course Objectives

- To understand multi-core architectures and their design principles
- To introduce to the challenges and opportunities of multi-core architectures in embedded systems
- To equip with the necessary knowledge and skills on multi-core architectures

Course Outcomes: At the end of the course, the student should be able to

CO1: analyze and evaluate the performance of multi-core architectures
CO2: design and develop software for multi-core architectures using parallel programming paradigms and techniques
CO3: apply the knowledge of multi-core architectures to solve real-world problems in embedded systems
CO4: develop applications using multi-core architecture

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3	3										2			3
CO3	3	2										2			3
CO4	3	2										2			3

Syllabus

Unit I

Introduction to Multi-Core Architectures - Introduction to parallel computing and multi-core architectures - Characteristics and design principles of multi-core architectures - Challenges and opportunities of multi-core architectures in embedded systems - Case studies of multi-core architectures in industry and research

Unit II

Programming Multi-Core Architectures - Parallel programming paradigms and models - Synchronization and communication mechanisms for multi-core architectures - Performance analysis and optimization of parallel programs - Tools and libraries for programming multi-core architectures.

Unit III

Applications of Multi-Core Architectures in Embedded Systems - Multi-core architectures for real-time and safety-critical systems - Multi-core architectures for multimedia and signal processing applications - Multi-core architectures for Internet of Things (IoT) and Cyber-Physical Systems (CPS) - Case studies of multi-core architectures in embedded systems.

Textbook(s)

1. "Multi-Core Embedded Systems" by Georgios Keramidas and Stamatis Vassiliadis
2. "Programming Multi-Core and Many-Core Computing Systems" by Sabri Pllana and Fatos Xhafa
3. "Multi-Core Technologies: Foundations and Applications" by Jan F. Broenink, Henk Corporaal, and Sander Stuijk

Reference(s)

1. "Multi-Core Embedded Systems" edited by Georgios Keramidas and Stamatis Vassiliadis
2. "Parallel Computing: Principles and Practice" by Michael J. Quinn
3. "Parallel Programming in C with MPI and OpenMP" by Michael J. Quinn
4. "OpenMP: Portable Shared Memory Parallel Programming" by Barbara Chapman, Gabriele Jost, and Ruud van der Pas

23ECE438	**Embedded Automotive Systems** (**Pre-requisite:** Embedded Systems)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide an overview of an embedded automotive system
- To enable understanding of the architecture involved in the design of automotive technology
- To provide communication concepts and the software development phase in automotive embedded system

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the automotive architecture
CO2: understand the protocol functioning in the automotive network
CO3: understand the communication involved in automotive system
CO4: understand the software development process in automotive industry

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3	2										2			3
CO3	3	2	2									2			3

CO4	3	2										2			3

Syllabus

Unit I

Automotive Architectures: Vehicle Functional Domains and Their Requirements- Functional Domains-Standardized Components, Models, and Processes- Certification Issue of Safety-Critical In-Vehicle Embedded Systems, Application of the AUTOSAR Standard: Motivation- Mainstay of AUTOSAR: AUTOSAR Architecture - Main Areas of AUTOSAR Standardization-Methodology and templates, Intelligent Vehicle Technologies: Introduction: Road Transport and Its Evolution, New Technologies, Dependability Issues, Fully Autonomous Car: Dream or Reality?.

Unit II

Embedded Communications**:** A Review of Embedded Automotive Protocols: Automotive Communication Systems- In-Car Embedded Networks- Middleware Layer- Open Issues for Automotive Communication Systems, FlexRay Protocol: Introduction- FlexRay Communication- FlexRay Protocol- FlexRay Application, Dependable Automotive CAN Networks: Introduction- Data Consistency Issues- CANcentrate and ReCANcentrate- CANELy- FTT-CAN: Flexible Time-Triggered Communication on CAN- FlexCAN: A Deterministic, Flexible, and Dependable Architecture for Automotive Networks

Unit III

Embedded Software and Development Processes**:** Product Lines in Automotive Electronics: Introduction- Characteristics of Automotive Product Lines- Basic Terminology- Global Coordination of Automotive Product-Line Variability- Artifact-Level Variability, Reuse of Software in Automotive Electronics: A Challenge for Automotive OEMs- Requirements-Supporting the Reuse of Application Software Components in Cars- spplication example

Textbook(s)

Nicolas Navet, Francoise Simonot-Lion, "Automotive Embedded Systems Handbook", Industrial Information Technology Series, CRC Press, Taylor and Francis Group,

Reference(s)

1. Ronald K Jurgen : "Automotive Electronics Hand Book", 2nd Edition , McGraw- Hill, 1999
2. James D Halderman: "Automotive Electricity and Electronics", PHI Publication
3. Allan Bonnick: "Automotive Computer Controlled Systems Diagnostic Tools And Technology".Elsevier Science, 2001

23ECE439 **Real Time Operating Systems** **L-T-P-C: 3-0-0-3**

(**Pre-requisite:** Operating Systems)

Course Objectives

- To provide foundation on the fundamental concepts of real time operating systems (RTOS)
- To enable understanding of different aspects of task management
- To provide implementation knowledge and skills of real time applications using RTOS

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the basic concepts in real time systems
CO2: understand the RTOS architecture and kernel service
CO3: analyze various real-time scheduling algorithms
CO4: design and develop real time applications using RTOS

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3											2			2
CO2	3											2			2
CO3	3	3	2									2			2

CO4	3	3	3									2			2

Syllabus

Unit I

Overview of concepts of GPOS, GPOS functionalities, Evolution of operating systems. Introduction to real-time systems, RTOS basic architecture, RTOS vs. GPOS. Architecture of OS (Monolithic, Microkernel, Layered, Exokernel and Hybrid kernel structures). POSIX Standards. RTOS Kernel services.

Unit II

Task Management -tasks, process and threads, task attributes and types, preemption-context switching, task states and transition, task control block. Introduction to real-time task scheduling, clock-driven and priority-driven scheduling, uniprocessor scheduling algorithms- RM-response time analysis, DM, EDF-processor demand analysis, Least Laxity First (LLF), and introduction to multiprocessor scheduling concepts. Blocking, deadlock, priority inversion and solutions.

Unit III

Task Communication and Synchronization - Semaphores and Mutex, Mailbox, Queue, Pipes. Timer Management, Interrupt handling, Memory Management-Cache and virtual memory, Input-Output handling. Familiarization of Free RTOS – architecture, porting, Real time applications using RTOS.

Textbook(s)

1. Jane W.S. Liu, "Real -Time Systems", First Edition, Pearson Education, 2000.
2. Cheng, A. M. K., "Real-Time Systems: Scheduling, Analysis, and Verification", First Edition, Wiley, 2002.
3. Richard Barry, "Mastering the FreeRTOS™ Real Time Kernel A Hands-On Tutorial Guide", First Edition, Real Time Engineers Ltd., 2016.

Reference(s)

1. Krishna, C. M., Shin, K. G., "Real-Time Systems", First Edition, McGraw-Hill, 2017.

23ECE440	**FPGA based Embedded Systems**	**L-T-P-C: 3-0-0-3**
	(Pre-requisite: Embedded Systems**)**	

Course Objectives

- To provide in depth understanding of FPGA architecture and its features
- To enable the knowledge for the design of sub-systems, usage of existing sub-systems on FPGA
- To enable the understanding of FPGA based embedded system design

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the architecture and specifications of FPGA
CO2: understand synthesizable HDL modeling of digital subsystems
CO3: understand the design flow of embedded systems including design of the data path, control unit subsystems and interpreting reports
CO4: develop block-based embedded system using FPGA resources and I/O interfaces

CO-PO Mapping

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3											2	3		3
CO2	3	2	2									2	3		3
CO3	3	3	3									2	3		3
CO4	3	2	2									2	3		3

Syllabus

Unit I

Introduction to FPGAs – Design flow – Circuit Fabrics – LUTs and IO Blocks – FPGA Technology overview – Digital Design for FPGAs - High Level System Architecture and Specification: Behavioural modelling and simulation - Hardware description languages.

Unit II

FPGA based embedded design flow - Design of data path and controller subsystems – FIFOs - Memory controllers – DSP blocks – FPGA Block RAMs - Case Study of RTL Design for FPGAs – Interpreting Synthesis and Implementation reports of RTL Designs - Synthesis issues.

Unit III

FPGA processor fabrics and bus interfaces – ADC interface, DAC interface, I/O interfaces - Block-based design flow – System Level synthesis from high level languages - Case study of design of FPGA based embedded systems.

Textbooks/References

1. Michael D. Ciletti, “Advanced Digital Design with Verilog HDL”, Second Edition, Pearson Higher Education, 2011.
2. Samir Palnitkar, “Verilog HDL, A Guide to Digital Design and Synthesis”, Second Edition, Pearson Education, 2003.
3. T. R. Padmanabhan and B. Bala Tripura Sundari, “Design Through Verilog HDL”, Wiley Interscience, 2004.
4. Wayne Wolf, “FPGA-Based System Design”, Prentice Hall India Pvt. Ltd., 2005.

Signal Processing

23ECE441	**Agent based Modeling** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To introduce the concept of artificial agents
- To provide an understanding of the features and design considerations for developing a multi-agent system
- To provide an overview of the applicability of data mining techniques for design of intelligent agents

Course Outcomes: At the end of the course, the student should be able to

CO1: apply the concepts of data mining for designing a simple agent based model
CO2: analyze and formulate an agent-based solution
CO3: design a simple multi-agent system model to solve complex engineering problems
CO4: implement artificial agents using agent based modeling software

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3													2
CO2		3	2		3							3			3
CO3		2	3	2	3							3			3
CO4	2	2	2	2	3							3			3

Syllabus

Unit I

Introduction to Agents – Features - Classification of agents. Multi Agent Systems (MAS) and properties – Agent communication ontology - Agent communication languages. Internal structure of MAS: Shell – Reasoning engine-MAS development methodology - Agent behavior - Agent action - Knowledge diffusion in MAS – Application level -behavior level and evolutionary agent communities.

Unit II

Data mining techniques for intelligent Agents - Association rule mining – A priori, DHP, DIC, κ-Profile- Clustering – K-means, PAM, EM, Classification- ID 3, C4.5, CLS, σ-FLNMap Evolutionary algorithms-Genetic Algorithm, Particle Swarm optimisation-Ant Colony Optimization.

Unit III

Applying data mining to agents - Study of available agent-based modeling software NetLogo-Implementation of agent-based models using NetLogo- Case studies - Application level - behavior level and evolutionary agent communities.

Textbook(s)

1. A. L. Symeonidis, P. A. Mitkas, "Agent Intelligence through Data Mining", Springer, 2005.
2. Uri Wilensky, William Rand, "An Introduction to Agent-Based Modeling", MIT Press, 2015.

Reference(s)

1. M. Mohammadian, "Intelligent Agents for Data Mining and Information Retrieval," Idea Group Publishing, 2003
2. D. L. Poole, A. K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents," Cambridge University Press, 2010.

23ECE442	**Computer Vision**	**L-T-P-C: 3-0-0-3**
	(**Pre-requisite:** Image Processing)	

Course Objectives

- To introduce the fundamental concepts and techniques in basic image formation models.
- To familiarize with various feature extraction models.
- To familiarize with concepts of camera geometry models.

Course Outcomes: At the end of the course, the student should be able to

CO1: Understand the basics concepts of image formation models.
CO2: Understand the various feature extraction models.
CO3: Understand and apply the calibration and geometry models.
CO4: Use simulation tools to develop applications using computer vision techniques.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										3			2
CO2	3	3			3							3			3
CO3	3	3										3			3
CO4	3	3			3							3			3

Syllabus

Unit I

Image Formation: Geometric image formation, Photometric image formation - Camera Models and Calibration: Camera Projection Models – Orthographic, Affine, Perspective, Projective models. Projective Geometry, Transformation of 2D and 3D, Internal Parameters, Feature Detection and Matching – points and patches, edges, lines, Feature-Based Alignment - 2D, 3D feature based alignment, pose estimation, Image Stitching, Dense motion estimation – Optical flow - layered motion, parametric motion, Structure from Motion.

Unit II

Local Feature Detectors and Descriptors: Hessian corner detector, Harris Corner Detector, LOG detector, DOG detector, SIFT, PCA-SIFT, GLOH, SURF, HOG, Pyramidal HOG, PHOW-Calibration Methods: Linear, Direct, Indirect and Multiplane methods - Pose Estimation.

Unit III

Stereo and Multi-view Geometry: Epipolar Geometry, Rectification and Issues related to Stereo, General Stereo with E Matrix Estimation, Stratification for 2 Cameras, Extensions to Multiple Cameras, Self-Calibration with Multiple Cameras, 3D reconstruction of cameras and structures, Three View Geometry.

Textbook(s)

1. Forsyth and Ponce, “Computer Vision – A Modern Approach”, Second Edition, Prentice Hall, 2011.
2. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer, 2011.

Reference(s)

1. Olivier Faugeras, “Three Dimensional Computer Vision”, MIT Press, 1993.
2. Emanuele Trucco and Alessandro Verri, “Introductory Techniques for 3-D Computer Vision”, Prentice Hall, 1998.

23ECE443	**Biomedical Signal Processing**	**L-T-P-C: 3-0-0-3**
	(**Pre-requisite:** Signal Processing)	

Course Objectives

- To introduce the origin and characteristics of biomedical signals
- To provide an understanding of the application of signal processing concepts in analyzing biomedical signals
- To enable implementation of algorithms for various biomedical signal-processing tasks

Course Outcomes: At the end of the course, the student should be able to

CO1: understand techniques for various levels of tasks in biomedical signal analysis
CO2: adopt appropriate algorithms according to the nature of the signal and acquisition characteristics
CO3: develop contemporary algorithms to address complex problems
CO4: implement biomedical signal processing algorithms using appropriate tools

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		3				3			3			3
CO2	2	3	2	2	3				3			3			3
CO3	2	-	3	3	3				3			3			3
CO4	2				3				3			3			3

Syllabus

Unit I

Introduction to Biomedical Signals- Action Potential and Its Generation- Origin and Waveform Characteristics of Basic Biomedical Signals - Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG)- Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis

Unit II

Cardiological and Neurological signal Analysis-Data Acquisition- ECG signals -Basic electrocardiography, ECG lead systems, ECG signal characteristics- Filtering for Removal of Artifacts in ECG – Algorithms for QRS Detection – Morphological Analysis of ECG, Arrhythmia analysis-Heart sounds and Murmurs- Data acquisition -EEG Rhythms - Waves and Transients – Correlation Analysis of EEG Channels.

Unit III

Data Compression Techniques: Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms; The Fourier transform, Correlation, Convolution, Power spectrum estimation, Frequency domain analysis of the ECG – Applications. – Adaptive noise canceller – cancellation of 50 Hz signal in ECG – Cancellation of maternal ECG in foetal electrocardiography– Muscle artifact (noise) Cancellation from EEG signals.

Textbook(s)

1. Rangaraj M Rangayyan "Biomedical Signal Analysis – A case study approach" IEEE press series in biomedical engineering, First Edition, 2002.
2. Willis J Tompkins, "Biomedical Digital Signal Processing", Prentice Hall India Private Limited, First Edition, 2006.

Reference(s)

1. Reddy, D.C, "Biomedical signal processing: principles and techniques". McGraw-Hill, 2005
2. Begg R, Palaniswami M and Lai D T H, "Computational Intelligence in Biomedical Engineering", CRC Press, 2007.

23ECE444	**Natural Language Processing** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To introduce the leading trends and systems in Natural Language Processing.
- To enable understanding of the basic representations used in syntax, the semantics of NLP
- To familiarize with the models used for word/sentence representations for various NLP applications.

Course Outcomes: At the end of the course, the student should be able to

CO1: Generate word representation to solve NLP problems
CO2: Implement machine learning models for NLP
CO3: Implement sequence-to-sequence models for NLP
CO4: Assess NLP models using various evaluation metrics

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		3				2			3			3
CO2	3	2	2		3				3			3			3
CO3	3	3	2		3				3			3			3
CO4	3	3	2	2	3				3			3			3

Syllabus

Unit I
Computational linguistics- Introduction, syntax, semantics, morphology, collocation and other NLP problems. Word representation: One-hot encoding, Bag-of-Words (BoW) Dictionary: Term Frequency – Inverse Document Frequency (TF-IDF), Embedding: Word2vec, Glove and Fasttext

Unit II
Language Model-n-gram, Sequences and sequential data: Part-of-Speech tagging-HMM and CRF, Named Entity Recognition, Dependency parsing. Evaluation metrics for NLP models- Precision, Recall, F score, ROUGE, BLEU scores and Visualization

Unit III
Machine learning and deep learning for NLP, Sequence to sequence modelling (Encoder decoder), Attention mechanism, Transformer Networks – BERT, A brief introduction to Reinforcement learning for NLP. NLP application introduction-Sentiment Analysis, Machine translation, Question Answering, Text summarization.

Textbook(s)

1. Christopher Manning and Hinrich Schütze, ‘Foundations of Statistical Natural Language Processing’, MIT press, 1999
2. Daniel Jurafsky, James H Martin, ‘Speech and language processing’ ,Prentice Hall, 2008

Reference(s)

1. Steven Bird, Ewan Klein and Edward Loper, ‘Natural Language Processing with Python’, O'Reilly Media, Inc.", 2009.
2. Douglas O'Shaughnessy, ‘Speech Communication’, University Press, 2001

23ECE445	**AI in Speech Signal Processing** (**Pre-requisite:** Signal Processing)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide understanding of acoustic theory behind human speech production and perception systems.
- To enable the analysis and estimation of the acoustic features from a speech signal.
- To enable the understanding of the AI-based algorithms used for speech modelling

Course Outcomes: At the end of the course, the student should be able to

CO1: explain the acoustics of speech production and perception
CO2: differentiate the characteristics of different speech sounds
CO3: analyse the time-domain and frequency-domain features of the speech signal
CO4: realize various algorithms on AI-based speech modelling

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		3							3			2
CO2	3	2	2		3							3			2
CO3	3	3	2		3				2			3			2
CO4	3	3	2	2	3				3			3			2

Syllabus

Unit I
Overview of Speech Processing Systems, Speech Production, Speech Perception, Speech Signal Characteristics-Stationarity, Non-stationarity, Properties of speech sounds – Elements of language -Phonemes – Vowels – Consonants-Fricatives- Stops.

Unit II
Short-time processing of speech - Windows – Rectangular, Hamming, Hanning-Time Domain parameters: Pitch, Short-time energy of speech, Zero crossing rate, Autocorrelation - Frequency domain parameters: Feature extraction for speech processing: Short term Fourier transform –Mel frequency cepstral coefficients (MFCC), Linear Prediction Analysis

Unit III
Basic applications in speech modelling - Speech Recognition- Basic speech models- Hidden Markov models (HMM) for acoustic modelling, Observation probability and model parameters - HMM as probabilistic automata - Viterbi algorithm, Deep neural network models: RNN, LSTM, DBN used for speech modelling, Speech synthesis: Linguistic processing - Acoustic processing - Text preprocessing - Grapheme to phoneme conversion – Rule based and decision tree approaches - Syntactic prosodic analysis - Prosodic analysis - Speech signal modelling -Speaker recognition introduction - popular approaches-Applications for speech based AI.

Textbook(s)

1. Thomas F Quatieri, ‘Discrete Time Speech Signal Processing’, Pearson Education Inc., 2004
2. L. Rabiner, R. W. Schafer, ‘Theory and applications of digital speech processing’, Pearson Education India,2010

Reference(s)

1. L. Rabiner, Biing-Hwang Juang and B. Yegnanarayana, ‘Fundamentals of Speech Recognition’, Pearson Education Inc, 2008.
2. Douglas O'Shaughnessy, ‘Speech Communication’, University Press, 2001

23ECE446	**Image Processing**	**L-T-P-C: 3-0-0-3**
	(**Pre-requisite:** Signal Processing)	

Course Objectives

- To enable analysis of images in time and frequency domain
- To enable implementation of various operations on images
- To familiarize with various applications of image processing

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the basic mathematical concepts used in image processing.
CO2: analyze different techniques adapted for image enhancement in spatial and frequency domain.
CO3: understand different morphological operations on images.
CO4: implement various image processing techniques.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		2							3			2
CO2	3	3	2		3							3			3
CO3	3	3	2		3							3			3
CO4	3	3	2		3							3			3

Syllabus

Unit I

Image processing- Introduction- Different types of images- Visual perception, Image sensing and Acquisition, Quantization, Sampling, Revision of Mathematical concepts for image processing, Image negatives, Log transformations, Histogram processing, Spatial filter: smoothing and Sharpening, Discrete Fourier transform, properties of 2-D DFT, Image smoothing and Sharpening in Fourier domain, Image restoration- Inverse filter, Weiner filter, Constrained Least squares filter.

Unit II

Morphological Image Analysis: Erosion, Dilation, Opening, Closing, Hit or Miss transformation, Application of Morphological operations- Boundary detection, Region filling, Connected components, Convex hull, Shape thinning and thickening, Skeletonization, Edge Detection: Gradient and Laplacian based edge detection, Diffusion based edge detection: Isotropic and anisotropic diffusion.

Unit III

Image segmentation: Thresholding, region-based Morphological Watersheds, Bayesian-based image segmentation, Image Compression: Spatial and Temporal redundancy, Basic image compression models, compression standards, basic compression methods: Huffman coding, Run-length coding, Block transform coding, Predictive coding.

Textbook(s)

1. Rafael C Gonzalez and Richard E Woods, “Digital Image Processing”, Pearson Education, New Delhi, 2009.

2. Anil K Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India, New Delhi, 2010.

Reference(s)

1. William K Pratt, “Digital Image Processing”, Wiley, 2010.
2. John W. Woods, “Multidimensional Signal, Image, and Video Processing and Coding”, Academic Publisher, 2012.

23ECE447	**Multirate Signal Processing and Wavelets** (**Pre-requisite:** Signal Processing)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide conceptual background in multi-rate filter banks, wavelets and multiresolution signal analysis
- To enable understanding of the principles behind device or algorithm based on structures
- To enable practical application of multi-rate signal processing and wavelets

Course Outcomes: At the end of the course, the student should be able to

CO1: understand Time-frequency decomposition of signals
CO2: understand Multi-rate filtering and filter banks
CO3: understand Multi-resolution analysis and its connection to filter banks
CO4: **demonstrate the applications of multi-rate signal processing and wavelets**

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			3				3			3			2
CO2	3	3	3		3				3			3			3
CO3	3	3	3		3				3			3			3
CO4	3	3			3				3			3			3

Syllabus

Unit I
Fundamentals of multi-rate digital signal processing, Up sampling, down sampling, interpolation, decimation, Polyphase decomposition, Multi-stage Interpolation and Decimation systems, Two-channel quadrature-mirror filter bank, Perfect reconstruction of two-channel FIR filter banks.

Unit II
Introduction to wavelets, Vector Space-Functions and function spaces, Continuous-time Fourier Transforms, Short time Fourier transforms, the uncertainty principle and time-frequency tiling, Discrete wavelet transforms, Scaling and Wavelet Functions, Filter Banks- Legendre Polynomials – Recurrence Formula – Laplace’s Integral Formula – Design of Orthogonal Wavelet Systems.

Unit III
Bi-orthogonal Wavelet – Introduction to Lifting Scheme – Dealing with Signal Boundaries – Multi Wavelet – Frequency Domain Approach-Applications of Wavelets- Data Compression, De-noising, Edge Detection, Object Isolation, Audio Coding, Communication Applications, Channel Coding, Speckle Removal, Image Fusion, Filter Design, Image Compression, AI based compression technique.

Textbook(s)
1. P.P Vaidyanathan “Multi-rate systems and filter banks”, Prentice Hall India, 1993

2. Soman K. P. and Ramachandran K. I., "Insight into Wavelets from Theory to Practice", Prentice Hall, third edition, 2010.

Reference(s)

1. J.G Proakis and D G Manolakis. "Digital signal processing: principles algorithms and applications", Pearson, 2014.
2. Stephane Mallat "A Wavelet Tour of Signal Processing: The Sparse Way", Academic Press Elsevier 2009.

23ECE448	Statistical Signal Processing (**Pre-requisite:** Signal Processing)	L-T-P-C: 3-0-0-3

Course Objectives

- To enable the understanding of discrete-time random process and fundamentals of signal models
- To provide the concepts of optimum filters
- To introduce various spectrum estimation methods

Course Outcomes: At the end of the course, the student should be able to

CO1: understand discrete-time random processes and various signal models
CO2: analyze and develop algorithms for linear filtering and adaptive filtering
CO3: understand spectral estimators and design solution for estimation problems
CO4: formulate and apply frequency estimation algorithms

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3		3							3			3
CO2	3	3	1		3							3			2
CO3	3	3	3	2	3							3			3
CO4	2	3	3	2	3							3			3

Syllabus

Unit I

Random processes- Gaussian Processes-Stationary processes- Autocovariance and Autocorrelation matrices, - Ergodicity - White noise - Power spectrum, Autoregressive moving average processes- Signal Modeling - The Least Squares method - Autocorrelation method - Covariance method - Autoregressive moving average models.

Unit II

Optimum Signal Estimation-Linear Mean Square Error Estimation-Optimum FIR and IIR filters- Linear Prediction-Fundamentals of Order Recursive Algorithms- Order-Recursive Algorithms for Optimum FIR Filters- Levinson-Durbin Recursion- Lattice filters - Wiener filtering-Least Squares FIR Filter

Unit III

Spectrum Estimation: Nonparametric methods – Periodogram - Barlett's method - Welch's method, Blackman and Tukey method of smoothing periodogram. Parametric methods-Autoregressive spectrum estimation - Moving average spectrum estimation - Frequency estimation - Eigen decomposition of Autocorrelation matrix - Detection of Harmonic signals - Pisarenko's method - MUSIC algorithm.

Textbook(s)

1. D.G Manolakis, Vinay K Ingle, Stephen M Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering, and Array Processing", Artech House , 2005

2. Steven Kay, Fundamentals of Statistical Signal Processing, Vol I: Estimation Theory, Vol II: Detection Theory, Prentice Hall, 1993/1998.

Reference(s)

1. Boaz Porat, "Digital Processing of Random Signals: Theory and Methods", Dover Books on Electrical Engineering, First Ed. 2008
2. Monson H. Hayes, Statistical Digital Signal Processing and Modelling, John Wiley, 1996.

23ECE449	Adaptive Signal Processing	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the adaptive filter for estimation and tracking
- To enable development of various adaptive algorithms for communication systems
- To enable practical application of adaptive signal processing theory

Course Outcomes: At the end of the course, the student should be able to

CO1: understand spectral estimators and design solution for estimation problems.
CO2: design filter to meet performance requirements derived from various real life applications
CO3: develop algorithms for the design of filters to track variations of non-stationary random process
CO4: demonstrate the applications of adaptive filters.

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	3	2	2		2							3			2
CO2	2	2	3		3							3			3
CO3	2	3	3		3							3			3
CO4	3	2	3		3							3			3

Syllabus

Unit I
Discrete time stochastic processes - Power spectral density – properties- Autocorrelation and covariance structures of discrete time random processes- Eigen-analysis of autocorrelation matrices-Spectrum Estimation - Non-parametric methods - Estimators and its performance analysis - periodogram estimators - signal modeling - parameter estimation using Yule-Walker Method.

Unit II
Newton's method - Steepest descent method –Convergence analysis -– Least Mean Square (LMS) filter– Convergence – Excess mean square error -Leaky LMS - Normalized LMS –Recursive least squares (RLS) algorithm for adaptive filtering of stationary process- Matrix inversion – Comparison with LMS – RLS for quasi-stationary signals- Exponentially weighted RLS- Sliding window RLS – RLS algorithm for array processing

Unit III
Kalman Filtering - Statistical filtering for non-stationary signals - Principles – Initialization and tracking – Scalar and vector Kalman filter – Extended Kalman filter algorithm- Unscented Kalman filter algorithm-Applications in signal processing – Adaptive equalization-Adaptive Noise Cancellation- Time varying channel estimation – Radar tracking.

Textbook(s)

1. Simon O. Haykin, "Adaptive Filter Theory", 5 th Edition, Pearson Education Limited, 2014.
2. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering, and Array Processing", McGraw-Hill, 2005.

Reference(s)

1. Monson H.Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc., Singapore, 2002.
2. Sopocles J. Orfanidis, "Optimum Signal Processing", McGraw Hill, 2007.

Common Electives

23ECE450	Deep Learning **(Pre-requisite:** Machine Learning)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the idea of artificial neural networks and their architecture
- To enable students to design an artificial neural network for classification
- To enable students to design and deployment of deep learning models for machine learning problems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the mathematics behind the functioning of artificial neural networks
CO2: design deep learning models for sequential and image data
CO3: carry out design and implementation of deep learning models for signal processing applications
CO4: design and deploy simple TensorFlow-based deep learning solutions to classification problems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			3							3			2
CO2		3	2		3				3			3			3
CO3		2	3	2	3				3			3			3
CO4	2	2	2	2	3				3			3			3

Syllabus

Unit I
Introduction to Deep Learning: Basics: Biological Neuron, Idea of computational units, McCulloch– Pitts unit and Thresholding logic, Linear Perceptron, Activation and Loss Functions, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm. Building small functions using perceptron model, Feedforward Networks: Multilayer Perceptron, Gradient Descent, Backpropagation, regularization.

Unit II
Convolutional Neural Network: Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization, Optimizers. LeNet, AlexNet. Visualisation of various layers in CNN- Image processing using CNN-examples and applications.

Unit III
Embedding and Representation Learning: Autoencoder Architecture-Implementing an Autoencoder in TensorFlow - Denoising- Sparsity in Autoencoders. Models for Sequence Analysis - Recurrent Neural Networks- Vanishing Gradients-

Long Short-Term Memory (LSTM) Units- TensorFlow Primitives for RNN Models -Augmenting Recurrent Networks with Attention.

Textbook(s)

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
2. Yoshua Bengio "Learning deep architectures for AI." Now publishers, 2009.

Reference(s)

1. N.D.Lewis, "Deep Learning Made Easy with R: A Gentle Introduction for Data Science", Createspace Independent, 2016.
2. Nikhil Buduma, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", O'Reilly, 2022.

23ECE451	Reinforcement Learning (**Pre-requisite:** Machine Learning)	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize mathematical foundations of reinforcement learning.
- To enable understanding of various reinforcement learning algorithms.
- To implementation of various reinforcement learning algorithms for practical applications.

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the mathematics behind reinforcement learning algorithms
CO2: implement probabilistic reinforcement learning algorithms
CO3: implement model free Reinforcement learning techniques
CO4: understand function approximation and deep learning-based reinforcement learning solutions

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3		2							3			2
CO2	3	3	3		3							3			3
CO3	3	3	3		3							3			3
CO4	3	2	3		3							3			3

Syllabus

Unit I

Introduction- Markov Decision Process: Markov property, Markov chains, Markov reward process (MRP). Bellman equations for MRPs, Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations, Overview of dynamic programing for MDP- principle of optimality, iterative policy evaluation, policy iteration

Unit II

Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling, Incremental Monte Carlo Methods for Model Free Prediction- TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.

Unit III

Function approximation methods- Gradient MC and Semi-gradient TD(0) algorithms, Control with function approximation, Least squares, Experience replay in deep Q-Networks-Policy Gradient methods - Log-derivative trick, Naive REINFORCE algorithm, actor-critic methods- Introduction to deep reinforcement learning methods and multi-agent reinforcement learning.

Textbook(s)

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2019
2. Wiering, Marco, and Martijn Van Otterlo. "Reinforcement learning. Adaptation, learning, and optimization 12", Springer 2012

Reference(s)

1. Russell, Stuart J., and Peter Norvig. "Artificial intelligence: a modern approach", Pearson Education Limited, 2016.
2. M. Wiering and M. van Otterlo, "Reinforcement Learning: State-of-the-Art", Springer, 2012

23ECE452	**Internet of Things**	**L-T-P-C: 3-0-0-3**
	(Pre-requisite: Introduction to IoT**)**	

Course Objectives

- To provide the foundation of IoT and major elements
- To enable understanding of various protocols and standards for IoT
- To provide foundation of designing and building IoT applications

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the fundamentals of IoT technology
CO2: visualize and appreciate the business opportunity and applications
CO3: understand the technology and standard for IoT
CO4: develop and design IoT networks for identified applications

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										3	3	3
CO2	3	2	2										3	3	3
CO3	3	3	2										3	3	3
CO4	3	3	2										3	3	3

Syllabus

Unit I

Introduction- IoT definition, use-cases and business Opportunities; IoT Architecture: Objects Layer, Object Abstraction Layer, Service Management Layer, Application Layer, Business Layer.

Unit II

IoT Elements- Identification, Sensing, Communication, Computation, Services, Semantics; IoT Common standards: ZigBee, BLE, WiFi, LoRa, LPWAN, IPV6, AMPQ, MQTT; Support to the IoT: Big Data Analytics, Cloud computing, and Fog computing;

Unit III

QoS Criteria: Reliability, Mobility, Performance, Scalability, Management, Interoperability; Security and Privacy in IoT: Confidentiality, Integrity, Availability, Privacy; IoT Applications: smart city, smart health, smart farming, smart manufacturer.

Textbooks and References

1. Hersent, O., Boswarthick, D. and Elloumi, O., 2011. The internet of things: Key applications and protocols. John Wiley & Sons.
2. Burbank, J.L., Andrusenko, J., Everett, J.S. and Kasch, W.T., 2013. Wireless networking: Understanding internetworking challenges. John Wiley & Sons.

23ECE453	Blockchain Technology	L-T-P-C: 3-0-0-3
	(Pre-requisite: Introduction to IoT/Computer Programming**)**	

Course Objectives

- To provide the foundation on security and blockchain technology
- To enable understanding of various evolution of blockchain technology
- To provide skill to develop blockchain for specified applications

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the fundamentals of blockchain technology
CO2: understand development and evolution of blockchain technology
CO3: understand the distributed technology and system and importance of blockchain
CO4: develop and design platform for blockchain for the specified applications

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2											2	2
CO2	3	2	2											2	2
CO3	3	3	2											3	2
CO4	3	3	2											3	2

Syllabus

Unit I

Introduction- Blockchain, Basic Cryptographic primitives used in Blockchain – Secure, Collison-resistant hash functions, digital signature, public key cryptosystems, zero-knowledge proof systems; Basic Distributed System concepts – distributed consensus and atomic broadcast, Byzantine fault-tolerant consensus methods.

Unit II

(Blockchain 1.0 and 2.0) – Concepts germane to Bitcoin and contemporary proof-of-work based consensus mechanisms, operations of Bitcoin blockchain, crypto-currency as application of blockchain technology; Blockchain 2.0 -blockchains with smart contracts and Turing complete blockchain scripting – issues of correctness and verifiability, Ethereum platform and its smart contract mechanism.

Unit III

Blockchain 3.0- Plug-and-play mechanisms for consensus and smart contract evaluation engines, Hyperledger fabric platform; Applications, limitation and research direction in blockchain.

Textbooks and references

1. Draft version of "S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, 'Blockchain Technology: Cryptocurrency and Applications', Oxford University Press, 2019.
2. Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.

23ECE454 Understanding ICT Standardization: Principles and Practices L-T-P-C: 3-0-0-3
(Pre-requisite: Nil)

Course Objectives

- To provide information on the purpose of standards and the basic concepts of the SDOs' processes
- To provide basic knowledge of the international, regional and national standardization landscape
- To identify the characteristics of formal and de facto standardization, and to be aware of the processes through which de facto standards are adopted by SDOs

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the purpose of ICT standards and SDOs process
CO2: understand landscape of national, regional and international standardization
CO3: understand and distinguish between formal and de facto standardization
CO4: learn the process of de facto standards get adopted by SDOs

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													3	2
CO2	3													3	2
CO3	3													3	2
CO4	3													3	2

Syllabus

Unit I
Introduction- Basic of standardization, standards in everyday life, formal standardization, standard development organization (SDO) standards, regulation; benefits and risks, standardization landscape, standardization process, standard development process, Characteristics of standard, standard development life cycle.

Unit II
Standard organizations-formal standardization and standrds development organizations, De facto standards, sonsortia and standardization, selecting relevant SDOs, identifying SDO documents, structure and formalism of the standards; standardization documents, classification and naming conventions.

Unit III
National, regional and international standardization – cooperation and coordination, geographical scope in standardization, guidance for the regional and national adoption of international standards; standards supporting regulation, legislation and policy.

Textbooks and references

3. Nizar Abdelkaf et al. “Understanding ICT Standardization: Principles and Practices. ETSI 2021.
4. https://standards.ieee.org/develop/

Course Objectives

23ECE455	Robotic System Design (Pre-requisite: Nil)	L-T-P-C: 3-0-0-3

- To introduce robotic design essential
- To provide mathematical foundations necessary to analyze and design
- To provide foundation on different controls and design aspects of robotic system

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the different terminology and mechanical subsystems
CO2: understand and analyze the controls involved in robotic system
CO3: use and apply necessary sensors and controls for robotic design
CO4: design a robot for a specific applications

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3											3	2	2	2
CO2	3	2	2									3	2	2	2
CO3	3	2	2									3	2	2	2
CO4	3	2										3	2	2	2

Syllabus

Unit I

Introduction: Classification of robots, Three laws, Robot terminologies: work volume, Degree of Freedom, resolution, accuracy, repeatability, dexterity, compliance, payload capacity, speed of response, Wrist assembly, Joint notations, Selection criteria of any robot, Industrial applications of robot, Industrial robot system, Types, Centralized robotics system controllers, decentralized robotics system controller. Real time communication and timing; Futuristic robotics; Types of drives – Hydraulic, Pneumatic and Electric, Comparison of all such drives, DC servo motors, Stepper motors, AC servo motor – salient features and applications, pulse count calculations End effectors **-** Types of Grippers – Mechanical, Magnetic, vacuum, pneumatic and hydraulic, selection and design considerations.

Unit II

Need for sensors, types of sensors used in Robotics, classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Robot Vision setup (RVS), block diagram, components, working of RVS, Human vision Vs Robot Vision, Gradient calculations, Applications of RVS; Mathematical details-Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, Homogeneous transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters.

Unit III

Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Forward Kinematics, Inverse Kinematics; Application specific robots.

Textbook/References

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
2. AsitavaGhoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
3. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
4. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)

Other Electives

23ECE461	Software Defined Networks (**Pre-requisite:** Computer Networks and Protocols)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the principles of software defined networks (SDN)
- To introduce modern software defined networking standards and practices
- To enable the appreciation for the strengths and limitations of various techniques and protocols in SDN

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the principles of software defined networking
CO2: understand standard protocols and practices in the data and control plane.
CO3: understand the concept of network function virtualization and provide examples of its usage.
CO4: understand the application of SDN in various scenarios and the challenges involved

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3											2			3
CO3	3											2			3
CO4	3	2										2			3

Syllabus

Unit I
Introduction – Packet switching, switch architecture, forwarding tables; Evolution of Switches and Networking – Data and control planes, cost and other constraints- Data center architecture and requirements, orchestration, virtualization- Evolution towards SDN, How SDN Works – Characteristics, operation, SDN switches and controllers, SDN Applications.

Unit II
OpenFlow – Overview and basics, OpenFlow 1.1-1.5, interoperability, limitations, and drawbacks of SDN, SDN via APIs and overlays- Network Function Virtualization – OPNFV, NFV vs. SDN, in-line network functions, Open Daylight and ONOS controller.

Unit III
Applications and Use Cases – Applications in data centers, WANs, ISPs, campus networks, optical networks, and mobile networks, reactive vs. proactive applications, internal vs. external applications.

Textbook(s)

1. Goransson P, Black C, Culver T, "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann, Second Edition, 2017.

Reference(s)

1. Gray K, Nadeau TD, Amsterdam Boston Heidelberg, Morgan Kaufmann, "Network Function Virtualization" 2016.

2. Nadeau TD, Gray K. SDN: "Software Defined Networks: [an Authoritative Review of Network Programmability Technologies]", 1. ed. Beijing: O'Reilly; 2013.

23ECE462	Information Security (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the cryptography algorithm suitable for information security
- To enable the understanding of firewall design for System Security
- To provide the knowledge about network layer security and embedded security design

Course Outcomes: At the end of the course, the student should be able to

CO1: identify and analyze various Cryptographic algorithms used in Information Security
CO2: analyze the firewall design and firewall characteristics for system security
CO3: understand the concept related to various network layers security
CO4: understand the various features related to physical cryptographic platform

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3										2			2
CO2	3	3	3									2			2
CO3	3	2										2			2
CO4	3	2										2			2

Syllabus

Unit I
Cryptography - Introduction to Cryptography: OSI Security Architecture - Security Services, Security Attacks, Security Mechanism. Introduction to Classical Cryptography. Modern Cryptography: Secret key Cryptography - DES, AES. Public key Cryptography - Diffie- Hellman, RSA, ECC. Introduction to Hash Algorithm, Introduction to Digital Signature, Introduction to PKI.

Unit II
System and Network Security-Introduction - Access Control, Intrusion Detection and Prevention. Firewalls: Firewall Design Principles - Firewall Characteristics, Types of Firewalls. Trusted System. Malicious Soft wares: Virus, Trojan Horse, Ad ware/ Spy ware, Worms, Logic Bomb. Cyber Law and Forensics - IT ACT 2000, Cyber Forensics; **Network Security** Introduction to Network Concepts, OSI Layers and Protocols, Network Devices, Network layer Security (IPSec) - IP Security Overview, IPSec Architecture, Authentication header, Encapsulating security Payload, Combining Security Associations, Key management. Transport Layer Security - SSL/TLS, SET. Application Layer Security - Authentication Applications, Kerberos, X. 509 Authentication Services. E-mail Security – PGP, S/MIME.

Unit III
Embedded Security -**I**ntroduction, Types of Security Features – Physical, Cryptographic, Platform. Kinds of Devices – CDC, CLDC. Embedded Security Design, Keep It Simple and Stupid Principle, Modularity Is Key, Important Rules in Protocol Design, Miniaturization of security, Wireless Security, Security in WSN

Textbooks
1. Cryptography and Network Security: Principles and Practice- William Stallings
2. Practical Embedded Security: Building Secure Resource Constrained Systems -Timothy Stapko, Publisher Newnes.

Reference(S)

1. Cryptography: Theory and Practice – 3rd Ed. SD Stinson, CRC Press.
2. Information Security for Technical Staff-SEI.
3. Guide to firewalls & network security: with intrusion detection & VPNs- HOLDEN, GREG.
4. CISSP: Certified Information Systems Security Professional Study Guide- Stewart, James Michael Et Al

23ECE463	Neuroengineering (Pre-requisite: Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the concepts of neurosciences for engineering applications
- To develop knowledge in biological realistic neural circuit-based procedure and bioengineering techniques
- To provide knowledge in designing and developing systems and learning models

Course Outcomes: At the end of the course, the student should be able to

CO1: understand aspects of neuroscience and bioengineering techniques for data-based modelling
CO2: adopt appropriate techniques to stimulate neural system
CO3: develop simple electronic for acquisition of brain signal
CO4: develop model for neuron and extracts the characteristics

CO – PO Mapping:

CO/PO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2
CO1	3	2	2	-	-	-	-	-	-	-	-	2	2	
CO2	3	2	2	2	-	-	-	-	-	-	-	-	2	2
CO3	3	-	2	2	-	-	-	-	-	-	-	-	2	2
CO4	2	-	-	-	-	-	-	-	-	-	-	-	2	2

Syllabus

Unit I

Introduction – Neuroscience and Brain Circuits - Brain, Spinal Cord, Pathways for Movement and Perception, Neurons, Synapses, Parts of the centra nervous systems, Nonlinearity of signals in the brain, Spikes, Synaptic potentials, Population signals, Local field potentials.

Unit II

Neuro-recording methods – EEG, single unit recording, Near-infrared spectroscopy, Transcranial direct-current stimulation (TDCS), Transcranial magnetic stimulation (TMS), Functional magnetic resonance imaging (fMRI).

Unit III

Mixed Signal Electronics in Neuroengineering - device-tissue interactions, bioelectronics recording/stimulation interface – experiments, hardware and methods; Computational Neuroscience – Membrane modelling, Single neurons, Excitatory and Inhibitory Synapses, Simple Neural circuits and models; Neuroscience to Artificial Intelligence – Models and circuits, Learning, Hebbian and backpropagation in biological circuits, reinforcement learning, Largescale models and abstractions.

Textbook(s)

1. Purves, D., Augustine, G. J., Fitzpatrick, D., Hall, W. C., LaMantia, A.-S., McNamara, J. O., & Williams, S. M. (Eds.). (2004). Neuroscience (3rd ed.). Sinauer Associates.
2. Akay M., Handbook of Neural Engineering, 2006, Wiley

Reference(s)

1. N. Aryan, Stimulation and Recording Electrodes for Neural Prostheses (2014), Springer, Available at https://link.springer.com/book/10.1007/978-3-319-10052-4
2. M. Nicolelis, Methods for Neural Ensemble Recordings (2008), CRC-Press Available at https://www.semanticscholar.org/paper/Methods-for-NeuralEnsemble-Recordings-Nicolelis/f5199d649d17cfa34a27c6e42e276eb722b17798

3. E. Kandel et al. Principles of Neural Science, McGraw-Hill Education / Medical; 6th edition (5 April 2021).

23ECE464	Control Systems (Pre-requisite: Nil)	L-T-P-C: 3-0 -0-3

Course Objectives

- To provide knowledge of the modeling of physical systems
- To enable performance analysis of physical systems
- To enable the use of control theory for the performance enhancement of physical systems

Course Outcomes: At the end of the course, the student should be able to

CO1: develop mathematical models of physical systems
CO2: analyze the time domain response performance of systems
CO3: analyze the frequency domain response performance of systems
CO4: design a control system for a given specification

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2*				2	2			2	2	2
CO2	3	2	2		2*				2	2		2	2	2	2
CO3	3	2	2		2*				2	2		2	2	2	2
CO4	3	3	3		2*				2	2			2	2	2

* To be assessed through Term Project

Syllabus**

Unit I
Introduction - Need for control systems, Objectives of analysis and design, Design process. Laplace transforms review, Transfer functions of Electrical, mechanical and electro-mechanical systems (DC motor). Linearization concept. Block diagram reduction, signal flow graphs, Mason's gain formula.

Unit II
Time response analysis. Transient performance, First order, second order, effect of addition of pole and zero. Steady state performance, static error constants. Stability, Routh Hurwitz criterion. Root locus technique. Transient response design via gain adjustment.

Unit III
Frequency response analysis. Need for Frequency response analysis. Representation, bode plot, polar plot, transfer function from bode plot. Nyquist stability criterion, gain margin and phase margin, obtaining GM and PM from bode plot. Frequency response specifications, obtaining closed loop performance specifications from open loop frequency response. Relation between frequency and transient response specifications, Design of compensators Lead, Lag. Introduction to PID controllers. Introduction to state space modelling of systems.

** all the concepts to be illustrated through MATLAB/SIMULNK/Hardware demonstrations

Textbook(s)
1. Norman Nise, "Control System Engineering", John Wiley & Sons, Inc., Eight Edition, 2019.

Reference(s)
1. Katsuhiko Ogata, **"Modern Control Engineering" 5th Edition, Prentice Hall Boston 2010**

23ECE465	Computer Networks and Protocols (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To provide an understanding of layered architecture of computer networks
- To provide fundamentals of internetworking
- To provide foundations on network protocols

Course Outcomes: At the end of the course, the student should be able to

CO1: understand layered architecture of computer networks
CO2: understand the concepts of addressing, switching, routing and reliable transport of data
CO3: understand the working of network protocols
CO4: analyze the qualitative aspects of protocols

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											3			3
CO2	3											3			3
CO3	3											2			3
CO4	3	2										2			3

Syllabus

Unit I
Computer Networks – Introduction: Network, Types of networks, Computer Networks, Types of computer networks, network topology. The Internet (the network of networks) - Protocol Layering: The OSI Model- TCP/IP Protocol suite. Circuit Switching- Packet Switching and Switches. PHY Layer and its functions, protocols; Data link layer and its functions-protocols, Frame, ARP - Error detection and correction - Medium Access control (MAC)- Random access- Controlled access- Ethernet.

Unit II
Network Layers and its functions- Network Layer major functions and its protocols, Internet Protocol- Routing Algorithms-Routing in the Internet-Broadcast and Multicast routing Data plane forwarding - Control plane routing- SDN approach.

Unit III
Transport Layer and higher layers – TCP, UDP, Flow Control-Congestion Control. Application Layer - WWW and HTTP - DNS.

Textbook(s)

1. Behrouz Forouzan, “Data Communication and Networking”, Tata McGraw Hill, 5th edition, 2012.
2. James Kurose and Keith Ross, “Computer Networking: A Top-Down Approach”, 6th Edition, Pearson Education Ltd., 2017.

Reference(s)

1. Andrew S Tannenbaum, David J. Whetheral, “Computer Networks”, Prentice Hall, 5th edition, 2010.
2. William Stallings, “Data and Computer Communications”, 8th edition, Pearson Education Asia, 2007
3. Larry L. Peterson and Bruce S. Davie, “Computer Networks - A Systems Approach”, Morgan Kaufmann, Fifth Edition, 2011.

23ECE466 **Cellular Mobile Communications** **L-T-P-C: 3-0-0-3**

(**Pre-requisite:** Data Communications and Networks)

Course Objectives

- To provide an overview of cellular systems
- To explore the performance analysis of multiple access techniques
- To introduce cellular standards

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the basic concepts of cellular systems
CO2: analyze the effect of interference and system capacity
CO3: analyze performance of multiple access techniques
CO4: understand the working principles of cellular standards

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3	2										2			3
CO3	3	2										2			3
CO4	3											2			3

Syllabus

Unit I
Introduction to cellular systems - Basic Cellular System - Cellular communication infrastructure: Cells – Clusters - Cell Splitting - Frequency reuse concept and reuse distance calculation - Cellular system components - Operations of cellular systems – Handoff / Handover - Channel assignment - Fixed and dynamic - Cellular interferences: Co-Channel and adjacent channel and sectorization.

Unit II
Channel Models: Properties of mobile radio channels - Intersymbol interference - Multipath and fading effects - Interleaving and diversity - Multiple access schemes (TDMA – FDMA – CDMA – SDMA – OFDMA) – Inter user interference - Traffic issues and cell capacity - Power control strategies.

Unit III
Introduction to modern cellular standards - GSM and CDMA – GPRS – UMTS – LTE – Introduction to 5G; AI/ML to improve channels and other functionalities of networks; Role of AI/ML in resource/channel allocation.

Textbook(s)

1. T.S. Rappaport, “Wireless Communication, Principles and Practice, Pearson Education”, Second Edition, 2010.
2. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005

Reference(s)

1. A Molisch, “Wireless Communications”, Wiley 2005.
2. D. Tse and P. Viswanath, “Fundamentals of Wireless Communications”, Cambridge University Press, 2005.
3. Haykin & Moher, “Modern Wireless Communications”, Indian Edition, Pearson 2011.
4. J. G Proakis, “Digital Communications”, McGraw Hill, New York, 1989.

23ECE467	Information Theory and Coding (**Pre-requisite:** Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the fundamental concepts of Information theory
- To explore different source coding algorithms to ensure efficient encoding of information.
- To explore different channel coding algorithms to ensure efficient error detection and correction

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the fundamental concepts of Information theory
CO2: apply the concepts of source entropy and efficient encoding of information
CO3: understand channel models and determine the channel capacity
CO4: understand error control coding schemes

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3	2										2			3
CO3	3	2										2			3
CO4	3	2										2			3

Syllabus

Unit I
Modeling of Information Sources – Measure of information- Entropy- Mutual Information-Source Coding - Prefix Codes- Kraft inequality- Shannon Fano Encoding Algorithm-Huffman algorithm- Arithmetic coding- Lempel Ziv coding.

Unit II
Channel Models- Channel Matrix, Joint probability Matrix-System Entropies, Channel Capacity, Channel coding theorem- Shannon-Hartley's law.

Unit III
Error Correction Codes – Introduction to Galois fields, polynomial arithmetic, linear block codes for error correction - Decoding – Standard array decoding and Syndrome decoding. Cyclic Codes – Introduction to Convolutional codes- distance properties – Trellis codes, Viterbi decoder. Case study - Machine learning based encoding and decoding.

Textbook(s)

1. Ranjan Bose, "Information Theory, Coding and Cryptography", Tata McGraw Hill, 2nd edition.
2. P.S. Satyanarayana, "Concepts of Information Theory and Coding", Dynaram Publication, 2005.

Reference(s)

1. Richard B. Wells, "Applied Coding and Information Theory for Engineers" Pearson Education, LPE 2004.
2. Shu Lin and Daniel Castello, "Error Control Coding – Fundamentals and Applications", second edition 2004

23ECE468	Signal Estimation and Detection (**Pre-requisite:** Foundations of Data Science)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the fundamental principles of decision making under uncertainty
- To enable mathematical formulation of practical estimation and detection problems arising in communication systems
- To provide exposure to classical and Bayesian solution approaches for signal estimation and detection

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the principles of optimal estimation and detection.
CO2: model specific problems in communication systems as standard estimation and detection problems
CO3: apply appropriate solution techniques
CO4: analyze the performance of estimation and detection techniques

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	3											2			3
CO2	3	2										2			3
CO3	3	2	2									2			3
CO4	3	2										2			3

Syllabus

Unit I
Review of probability and random processes; Applications of statistical estimation and detection techniques in communication systems; Classical estimation – Bias and variance, Cramer Rao lower bound, Sufficient statistic, MVUE, Fischer Neyman factorization theorem, Rao-Blackwell theorem.

Unit II
Maximum Likelihood (ML) estimation; Linear models – BLUE; Least Squares – consistency, efficiency and asymptotics; Bayesian estimation – MMSE and MAP estimation, Kalman and Weiner filtering; Introduction to channel and spectrum estimation.

Unit III
Detection theory - Bayesian and Neyman-Pearson detection, Minimax Detection, Composite hypothesis testing, GLRT, Sequential detection, Performance analysis by Monte Carlo method, Signal detection in continuous time, Karhunen Loève (KL) theorem, Detection of random signals in Gaussian noise; ML role in channel estimation.

Textbook(s)
S.M. Kay, “Fundamentals of Statistical Signal Processing”, Volume I and II, Prentice Hall Inc., 1998.

Reference(s)
1. H. V. Poor, “An Introduction to Signal Detection and Estimation”, 2nd Ed., Springer-Verlag, 1994.
2. H. L. Van Trees, “Detection, Estimation and Modulation Theory”, Part 1, 2nd Ed., John Wiley, 2013.
3. M. D. Srinath, P. K. Rajasekaran and R. Vishwanathan, “An Introduction to Statistical Signal Processing with Applications”, Prentice-Hall, 1996.

23ECE469	**Wireless Local Area Networks** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To introduce the principles behind modern wireless local area networking standards
- To enable performance analysis and optimization of wireless local area networks
- To provide exposure to research literature in this area

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the working of wireless local area networks
CO2: analyze the performance of wireless local area networks
CO3: understand techniques for optimization of its performance
CO4: understand research literature on specific topics

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2				2	2		2			3
CO2	3	3	2		2				2	2		2			3
CO3	3	2	2		2				2	2		2			3
CO4	3	2	2	2	2				2	2		2			3

Syllabus

Unit I
Overview of the IEEE 802.11; MAC Layer – Network Architecture, Frame Types and Formats, Distributed Channel Access, Medium Access Rules, Hidden Node Problem, EDCA, PCF, HCCA, AP Discovery, Connection Establishment and Termination, Fragmentation and Aggregation, Block ACK, Power Save Methods, PSMP, Interoperability, Roaming, AP Channel Switching.

Unit II
PHY Layer – OFDM, MIMO basics, High Throughput (HT), VHT, 802.11b, 802.11a, 802.11g, 802.11n, 802.11ac; Wi-Fi 6 – EHT, 802.11ax, OFDMA, Multiuser Operation, TWT, Ppatial Reuse; Implementation Issues – Hardware, Software, Algorithms, Regulatory Requirements, Introduction to Wi-Fi 6E and 802.11be.

Unit III
Applications and Case Studies – Intelligent techniques (AI/ML) to optimize Channel Access, Rate Adaptation, Frame Aggregation, PHY parameters, Beamforming, Multiuser Communication, Spatial Reuse, Channel Bonding, Multiuser MIMO, and Network Management.

Textbook(s)
1. Perahia, E., and Stacey, R., “Next generation wireless LANs: 802.11n and 802.11ac”, Cambridge university press, Second Edition, 2013.
2. Gulasekaran, S.R., and Sankaran, S.G., “Wi-Fi 6: Protocol and Network”, Artech House, 2021.

Reference(s)
- Selected Research papers.

23ECE470	Performance Evaluation of Networks and Computing Systems (Pre-requisite: Nil)	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the mathematical foundations required for modeling and analysis of computer networks and computing systems.
- To enable performance analysis and optimization of networks and computing systems
- To provide exposure to research literature in this area

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the necessary mathematical foundations.
CO2: apply mathematical tools to model and analyze networks and computing systems
CO3: carry out discrete event simulations of networks and computing systems
CO4: understand research literature on specific topics

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2				2	2		2			3
CO2	3	3	2		2				2	2		2			3
CO3	3	2	2		2				2	2		2			3
CO4	3	2	2	2	2				2	2		2			3

Syllabus

Unit I
Introduction – networks and computing systems as discrete event systems, mathematical and simulation tools for modeling and analysis, performance metrics; Selected Topics in Random Variables and Processes with applications to modeling of networks and computing systems – memoryless property, moment generating function; Laplace-Stieljes transform (LST), stationary- and independent-increment processes, Bernoulli, Poisson, Gaussian and Markov processes, discrete- and continuous-time Markov chains, renewal processes.

Unit II
Queueing Theory – Little's Law, PASTA, common queueing models (M/M/1, M/M/1/K, M/M/K/K, M/G/1, M/G/1/K, M/G/∞), multiclass queueing models, networks of queues, Discrete-Event Simulation of Queueing Systems.

Unit III
Applications to Computing Systems – availability analysis of web servers, CPU and I/O job scheduling in computing systems, shared and cache memories, multiprogramming and multiprocessor systems; Applications to Computer Networks – statistical multiplexing in links, packet buffering and queue overflows, Chernoff bound, dynamic channel allocation in circuit switched networks, throughput analysis of Wi-Fi MAC layer, coverage analysis in wireless sensor networks. ML based job scheduling.

Textbook(s)

1. Vidyadhar G. Kulkarni, Modeling and Analysis of Stochastic Systems. CRC Press, 2016.
2. Kishore S. Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, Second Edition, John Wiley and Sons, 2016.
3. Anurag Kumar, D. Manjunath, Joy Kuri, Communication Networking: An Analytical Approach, Morgan Kauffmann Publishers, 2004.

Reference(s)

1. Dimitri P. Bertsekas, and Robert G. Gallager, Data Networks. Prentice-Hall International, 1987
2. Selected Research papers.

23ECE471	**Quantum Information Theory** (**Pre-requisite:** Engineering Mathematics-II)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To introduce basic concepts and mathematical techniques of Quantum Information Theory
- To introduce the various mathematical tools in Quantum Information Theory
- To enable the understanding of communication over Quantum channels

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the extension of Shannon theory to quantum domain
CO2: understand the mathematical tools used for measurement and analysis
CO3: understand resources used in quantum communication
CO4: understand tradeoffs among the resources

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			3
CO2	3											2			3
CO3	3											2			3
CO4	3											2			3

Syllabus

Unit I
Review of Quantum theory: state vectors- qubits-Pauli matrices- unitary transformations-measurement- composite systems and tensor products- quantum gates and circuits- entanglement-and Bell inequalities, Noisy quantum states: ensembles and density matrices- POVMs and generalized measurements- separability and entanglement- Kraus maps and quantum instruments- noisy quantum channels- purifications. Unit quantum protocols: entanglement distribution- elementary encoding- superdense coding- quantum teleportation- Resource inequalities.

Unit II
Tools of Quantum Shannon Theory: distance measures- classical information and entropies- quantum information and entropies, Classical typicality: typical sets, typical sequences, Shannon compression, weak and strong typicality, joint typicality, conditional typicality. Quantum typicality: typical subspaces, bipartite and multipartite states, conditional quantum typicality, weak and strong quantum typicality, joint and conditional quantum typicality. Schumacher compression.

Unit III
Classical communication over noisy quantum channels: Holevo information, and classical capacity, Examples of quantum channels, Super additivity of classical capacity, Classical communication over entanglement-assisted quantum channels. Capacity theorem. Coherent communication with noisy resources: entanglement-assisted quantum communication, private classical communication, Quantum communication, The quantum capacity theorem, Resource trade-offs and trade-off coding, Non-additivity and other open problems. Introduction to quantum machine learning (QML).

Textbook(s)

1. Wilde, M. (2017). Quantum Information Theory (2nd ed.). Cambridge: Cambridge University Press. doi:10.1017/9781316809976

Reference(s)

1. Nielsen, Michael A.; Chuang, Isaac L. (2000). Quantum Computation and Quantum Information (1st ed.). Cambridge University Press.
2. Watrous, J. (2018), The Theory of Quantum Information. Cambridge: Cambridge University Press. doi:10.1017/9781316848142

23ECE472	Remote Sensing Systems **(Pre-requisite:** Nil**)**	L-T-P-C: 3-0-0-3

Course Objectives

- To congregate the basic concepts and fundamentals of physical principles of remote sensing
- To understand the working principle of remote sensing systems
- To understand the various applications of remote sensing systems

Course Outcomes: At the end of the course, the student should be able to

CO1: understand fundamental principles of remote sensing
CO2: understand interaction of electromagnetic radiation with homogeneous and multi-layered medium
CO3: understand the working principles of different remote sensing systems
CO4: understand the remote sensing data processing

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2		2	2
CO2	3	2			2							2		2	2
CO3	3	2										2		2	2
CO4	3	2			2							2		2	2

Syllabus

Unit I

Electromagnetics basis: Electromagnetic waves, Polarization, Spectra and Fourier transform, Doppler effect, Angular distribution of radiation, Thermal radiation, diffraction, Interactions of electromagnetic radiation: Propagation through homogeneous materials, Reflection and emission from real materials, Propagation through the atmosphere Molecular absorption and scattering, Radiative transfer equation

Unit II

Remote sensing system: Spectral Imagery, VIR imaging systems, Thermal infrared imagers, Passive Microwave Systems: Microwave Radiometry, Ranging Systems: Laser profiling, Radar altimetry

Unit III

Scattering Systems: LiDAR, Microwave Scatterometry, Synthetic Aperture Radar, Data Processing: Image Processing, Classification and Segmentation, Applications of Remote Sensing Systems; AI/ML role in radar image processing.

Textbook(s)

1. W. G. Rees, "Physical Principles of Remote Sensing", Cambridge University Press; 3rd edition, 2013.

References(s)

1. R. C. Olsen, "Remote Sensing from Air and Space", SPIE Press, 2007.

2. James B. Campbell, Randolph H. Wynne, "Introduction to Remote Sensing", 5th Edition, Guilford Press, 2011.

23ECE473	**Physical Chemistry of Materials and Processes** (**Pre-requisite:** Nil)	**L-T-P-C: 3-0-0-3**

Course Objectives

- To provide an understanding of physical properties of semiconductor materials
- To introduce the effect of defects on physical properties
- To understand the growth and processing of semiconductor materials

Course Outcomes: At the end of the course, the student should be able to

CO1: understand the physical properties of semiconductors
CO2: understand the impact of defects in semiconductors
CO3: understand growth of semiconductor materials
CO4: understand the processing of semiconductor materials

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											2			
CO2	3											2			
CO3	3											2			
CO4	3											2			

Syllabus

Unit I

Elemental and compound semiconductor materials, structural, electronic and optical properties, Defects in Semiconductors - Point Defects in Ionic Solids: Modelling the Electrical Conductivity of Ionic Solids by Point Defects, Mediated Charge Transfer, Point Defects and Impurities in Elemental Semiconductors, Vacancies and Self-Interstitials in Semiconductors with the Diamond Structure, Effect of Defect–Defect Interactions on Diffusivity: Trap-and-Pairing Limited Diffusion Processes, Light Impurities in Group IV Semiconductors: Hydrogen, Carbon, Nitrogen, Oxygen and Their Reactivity

Unit II

Growth of Semiconductor Materials - Growth of Bulk Solids by Liquid Crystallization, Growth of Si-Ge Alloys, Single Crystal Growth from the Vapour Phase - Epitaxial Growth of Single Crystalline Layers of Elemental and Compound Semiconductors, Growth of Poly/Micro/Nano-Crystalline Thin Film Materials- Growth of Nanocrystalline/Microcrystalline Silicon, Growth of Silicon Nanowires

Unit III

Semiconductor Materials Processing - Thermal Annealing Processes, Rapid thermal processing, Hydrogen Passivation Processes, Introduction to Gettering and Defect Engineering, Oxidation, Diffusion and ion implantation, Chemical and physical deposition methods, Wafer Bonding.

Textbook(s)

1. Sergio Pizzini, Physical Chemistry of Semiconductor Materials and Processes, 2015, John Wiley & Sons.
2. S. Cambell, The Science & Engineering of Microelectronic Fabrication, Oxford, 1996.

Reference(s)

1. S.P. Mauraka and M.C. Peckerar, Electronic Materials Science and Technology, Academic Press, 1989.

Courses offered under the framework of

Amrita Values Programmes I and II

22AVP201 Message from Amma’s Life for the Modern World

Amma’s messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma’s guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

22ADM211 Leadership from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

22ADM201 Strategic Lessons from the Mahabharata

Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

22AVP204 Lessons from the Upanishads

Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, SatyakamaJabala, Aruni, Shvetaketu.

22AVP205 Message of the Bhagavad Gita

Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

22AVP206 Life and Message of Swami Vivekananda

Brief Sketch of Swami Vivekananda’s Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji’s life.

22AVP207 Life and Teachings of Spiritual Masters India

Sri Rama, Sri Krishna, Sri Buddha, AdiShankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri RamanaMaharshi, Mata Amritanandamayi Devi.

22AVP208 Insights into Indian Arts and Literature

The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

22AVP209 Yoga and Meditation

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

22AVP210 Kerala Mural Art and Painting

Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

22AVP213 Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

22AVP214 Principles of Worship in India

Indian mode of worship is unique among the world civilizations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realization of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

22AVP215 Temple Mural Arts in Kerala

The traditional percussion ensembles in the Temples of Kerala have enthralled millions over the years. The splendor of our temples makes art enthusiast spellbound, warmth and grandeur of color combination sumptuousness of the outline, crowding of space by divine or heroic figures often with in vigorous movement are the characteristics of murals.

The mural painting specially area visual counterpart of myth, legend, gods, dirties, and demons of the theatrical world, Identical myths are popular the birth of Rama, the story of Bhīma and Hanuman, Shiva, as Kirata, and the Jealousy of Uma and ganga the mural painting in Kerala appear to be closely related to, and influenced by this theatrical activity the art historians on temple planes, wood carving and painting the architectural plane of the Kerala temples are built largely on the pan-Indians almost universal model of the Vasthupurusha.

22AVP218 Insights into Indian Classical Music

The course introduces the students into the various terminologies used in Indian musicology and their explanations, like Nadam, Sruti, Svaram – svara nomenclature, Stayi, Graha, Nyasa, Amsa, Thala,- Saptatalas and their angas, Shadangas, Vadi, Samavadi, Anuvadi. The course takes the students through Carnatic as well as Hindustani classical styles.

22AVP219 Insights into Traditional Indian Painting

The course introduces traditional Indian paintings in the light of ancient Indian wisdom in the fields of aesthetics, the Shadanga (Sixs limbs of Indian paintings) and the contextual stories from ancient texts from where the paintings originated. The course introduces the painting styles such as Madhubani, Kerala Mural, Pahari, Cheriyal, Rajput, Tanjore etc.

22AVP220 Insights into Indian Classical Dance

The course takes the students through the ancient Indian text on aesthetics the Natyasastra and its commentary the AbhinavaBharati. The course introduces various styles of Indian classical dance such as Bharatanatyan, Mohiniyatton, Kuchipudi, Odissy, Katak etc. The course takes the students through both contextual theory as well as practice time.

22AVP221 Indian Martial Arts and Self Defense

The course introduces the students to the ancient Indian system of self-defense and the combat through various martial art forms and focuses more on traditional Kerala's traditional KalariPayattu. The course introduces the various exercise technique to make the body supple and flexible before going into the steps and techniques of the martial art. The advanced level of this course introduces the technique of weaponry.

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY

23CHY240	COMPUTATIONAL CHEMISTRY AND MOLECULAR MODELLING	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: Get to understand the structure of molecules using symmetry.

CO2: Understanding Quantum mechanical approach to calculate the energy of a system.

CO3: Applying mathematical knowledge and quantum mechanical approach in finding out the characteristics-reactivity, stability, etc., of the molecule.

CO4: To get a brief idea about molecular mechanics based chemical calculations.CO5: To get an idea about general methodology of molecular modeling.

Syllabus

Unit 1

Introduction: Stability, symmetry, homogeneity and quantization as the requirements of natural changes - Born - Haber cycle – Energetic – kinetics - Principles of spectra.

Computational techniques: Introduction to molecular descriptors, computational chemistry problems involvingiterative methods, matrix algebra, Curve fitting.

Molecular mechanics: Basic theory - Harmonic oscillator – Parameterization - Energy equations - Principle ofcoupling - Matrix formalism for two masses - Hessian matrix - enthalpy of formation - enthalpy of reactions.

Introduction to Quantum mechanics - Schrodinger equation - Position and momentumMO formation - Operators and the Hamiltonian operator - The quantum oscillator Oscillator Eigen value problems - Quantum numbers - labeling of atomic electrons.

Unit 2

Molecular Symmetry: Elements of symmetry - Point groups - Determination of point groups of molecules.

Huckel's MO theory: Approximate and exact solution of Schrodinger equation - Expectation value of energy - Huckel's theory and the LCAO approximation - Homogeneous simultaneous equations - Secular matrix - Jacobi method - Eigen vectors: Matrix as operator - Huckel's coefficient matrix - Wheeland's method - Hoffmann's EHT method - Chemical applications such as bond length, bond energy, charge density, dipole moment, Resonance energy.

Unit 3

Self consistent fields: Elements of secular matrix - Variational calculations - Semi empirical methods - PPP self consistent field calculation - Slater determinants - Hartree equation - Fock equation – Roothaan - Hall equation - Semi empirical models and approximations.

Ab-initio calculations: Gaussian implementations – Gamess - Thermodynamic functions - Koopman's theorem - Isodesmic reactions, DFT for larger molecules - Computer aided assignments/mini projects with softwares - Introduction to HPC in Chemical calculations.

Molecular modelling software engineering - Modeling of molecules and processes

Signals and signal processing in Chemistry - QSAR studies and generation of molecular descriptors - Applications of chemical data mining - Familiarization with open source softwares useful for molecular modeling - Introduction tomolecular simulation - M.D. simulation.

TEXTBOOKS:

1. *K. I. Ramachandran, G Deepa and K Namboori, "Computational Chemistry and Molecular Modeling - Principles and Applications", Springer-Verlag, Berlin, Heidelberg, 2008, ISBN-13 978-3-540-77302-3.*
2. *Donald W Rogers, "Computational Chemistry Using PC", Wiley, (2003).*
3. *Alan Hinchliffe, "Chemical Modeling from atoms to liquids", Wiley, (2005).*

REFERENCES:

1. *James B Forseman and Aeleen Frisch-Gaussian, "Exploring Chemistry with Electronic Structure Method", Inc., Pittsburgh, PA, 2nd edition, (2006).*
2. *A C Philips, "Introduction to Quantum mechanics", Wiley, (2003).*
3. *Wolfram Koch, Max C. Holthausen, "A Chemist's guide to Density Functional Theory", Wiley, VCH, 2nd edition, (2001).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY241	ELECTROCHEMICAL ENERGY SYSTEMS AND PROCESSES	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: Understand the fundamental concepts of electrochemistry through electrode potential and reaction kinetics CO2: Learn the application of the electrochemical principles for the functioning and fabrication of industrial

batteries and fuel cells

CO3: Acquire knowledge in solving numerical problems on applied electrochemistry
CO4: Analysis and practical problem solving in fabrication of batteries and fuel cells
CO5: Application of concepts and principle in industrial electrochemical processes
CO6: Evaluation of comprehensive knowledge through problem solving

SyllabusUnit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen

electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicatorand ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler- Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafelplots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air, zinc-silver oxide batteries; lithium primary cells - liquid cathode, solid cathode and polymer electrolyte types and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: ARM (alkaline rechargeable manganese) cells, Lead acid and VRLA (valve regulated (sealed)lead acid), nickel-cadmium, nickel-zinc, nickel- metal hydride batteries, lithium ion batteries, ultra thin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Reserve batteries and Fuel cells: Reserve batteries - water activated, electrolyte activated and thermally activated batteries - remote activation - pyrotechnic materials. Fuel Cells: Principle, chemistry and functioning - carbon, hydrogen-oxygen, proton exchange membrane (PEM), direct methanol(DMFC), molten carbonate electrolyte (MCFC) fuel cells and outline of biochemical fuel cells.

Electrochemical Processes: Principle, process description, operating conditions, process sequence and applications of Electroforming – production of waveguide and plated through hole (PTH) printed circuit boards by electrodeposition; Electroless plating of nickel, copper and gold; Electropolishing of metals; Anodizing of aluminium; Electrochemical machining of metals and alloys.

TEXTBOOKS:

1. *Derek Pletcher and Frank C. Walsh, "Industrial Electrochemistry", Blackie Academic and Professional, (1993).*
2. *Dell, Ronald M Rand, David A J, "Understanding Batteries", Royal Society of Chemistry, (2001).*

REFERENCES:

1. *Christopher M A, Brett, "Electrochemistry – Principles, Methods and Applications", Oxford University, (2004).*
2. *Watanabe T, "Nano-plating: microstructure control theory of plated film and data base of plated film microstructure", Elsevier, Oxford, UK (2004).*
3. *Kanani N, "Electroplating and electroless plating of copper and its alloy", ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).*
4. *Lindon David, "Handbook of Batteries", McGraw Hill, (2002).*
5. *Curtis, "Electroforming", London, (2004).*

6. *Rumyantsev E and Davydov A, “Electrochemical machining of metals”, Mir, Moscow, (1989).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY242	FUELS AND COMBUSTION	L-T-P-C: 3-0-0-3

Course Objectives:

To provide the basic knowledge about fuels, rocket propellants and explosives.

Course Outcomes:

CO1: Understand the types of fuels and variation in their propertiesCO2: Able to analyze the fuel content

CO3: Obtain knowledge in identifying a proper fuel as per the requirement
CO4: Ability to know the preparation and working of propellants and explosives

SyllabusUnit 1

Fuels - Solid fuels - Classification, preparation, cleaning, analysis, ranking and properties - action of heat, oxidation, hydrogenation, carbonization, liquefaction and gasification.

Liquid fuels – Petroleum - origin, production, composition, classification, petroleum processing, properties, testing -flow test, smoke points, storage and handling.

Secondary liquid fuels - Gasoline, diesel, kerosene and lubricating oils. Liquid fuels - refining, cracking, fractional distillation, polymerization. Modified and synthetic liquid fuels. ASTM methods of testing the fuels.

Unit 2

Gaseous fuels - Types, natural gas, methane from coal mine, water gas, carrier gas, producer gas, flue gas, blast furnace gas, biomass gas, refinery gas, LPG - manufacture, cleaning, purification and analysis. Fuels for spark ignition engines, knocking and octane number, anti knock additives, fuels for compression, engines, octane number, fuels forjet engines and rockets.

Flue gas analysis by chromatography and sensor techniques.

Unit 3

Combustion: Stochiometry, thermodynamics. Nature and types of combustion processes - Mechanism - ignition temperature, explosion range, flash and fire points, calorific value, calorific intensity, theoretical flame temperature. Combustion calculations, theatrical air requirements, flue gas analysis, combustion kinetics – hydrogen - oxygen reaction and hydrocarbon - oxygen reactions.

Rocket propellants and Explosives - classification, brief methods of preparation, characteristics; storage and handling.

TEXTBOOK:

1. *Fuels and Combustion, Samir Sarkar, Orient Longman Pvt. Ltd, 3rd edition, 2009.*

REFERENCES:

1. *Fuels - Solids, liquids and gases - Their analysis and valuation, H. Joshua Philips, Biobliolife Publisher, 2008.*
2. *An introduction to combustion: Concept and applications - Stephen R Turns, Tata Mc. Graw Hill, 3rd edition, 2012.*
3. *Fundamentals of Combustion, D P Mishra, 1st edition, University Press, 2010*
4. *Engineering Chemistry - R. Mukhopadhyay and Sriparna Datta, Newage International Pvt. Ltd, 2007.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY243	GREEN CHEMISTRY AND TECHNOLOGY	L-T-P-C: 3-0-0-3

Course Objectives:

1. Understand the principles of green chemistry and its contribution to the development of sustainable products
2. Possess knowledge of the migration from a hydrocarbon-based economy to carbohydrate-based economy
3. Evaluate the deficiencies of traditional process and acknowledge the invent of new processes
4. Distinctly map the culmination of academic research to industrial chemistry

Course Outcomes:

CO1: Understand the evolving concept of Green Chemistry and its application to the manufacture of sustainableproducts

CO2: Appreciate the need for Renewable energy and Feed stock along with carbon sequestration through thefundamentals of Green Chemistry Techniques

CO3: Develop a coherence to evaluate systematic deficiencies in traditional Chemical science process and products CO4: Undertake a purposeful Journey through the microscopic domain of academic research to the macroscopic

domain of Industrial chemistry

SyllabusUnit 1

Our environment and its protection, chemical pollution and environmental regulations, environmental chemistry, pollution prevention strategies, challenges to the sustainability of chemical industry, Pollution Prevention Act 1990,USA, Green Chemistry and its 12 principles, toxicity of chemicals, material safety data sheet (MSDS), concept ofzero pollution technologies, atom economy, functional toxicity vs non-functional toxicity, alternative solvents, energy minimization, microwave and sonochemical reactions, renewable feed stock, carbon dioxide as a feed stock.

Unit 2

Greener strategies of the synthesis of ibuprofen synthesis, teriphthalic acid etc. phase behaviour and solvent attributes of supercritical CO2, use of supercritical carbon dioxide as a medium chemical industry, use of ionic liquids as a synthetic medium, gas expanded solvents, superheated water, etc. Synthesis of various chemicals from bio mass, polycarbonate synthesis and CO2 fixation, green plastics, green oxidations, etc.

Unit 3

Processes involving solid catalysts – zeolites, ion exchange resins, Nafion/silica nano composites and enhanced activity. Polymer supported reagents, green oxidations using TAML catalyst, membrane reactors. Green chemistry in material science, synthesis of porous polymers, green nanotechnology.

REFERENCES:

1. *Hand Book of Green Chemistry and Technology; by James Clarke and Duncan Macquarrie; Blakwell*

Publishing.

2. *Anastas, P. T., Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press Inc., New York, 1998.*
3. *Matlack, A. S. Introduction to Green Chemistry Marcel Dekker: New York, NY, 2001.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY244	INSTRUMENTAL METHODS OF ANALYSIS	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: To develop an understanding of principle and working of the range of instrumental methods in analyticalchemistry

CO2: To provide an understanding and skills in contemporary methods of separation and appropriate selection ofinstruments for the successful analysis of chemical compounds

CO3: To impart skills in the scientific method of planning, conducting, reviewing, reporting experiments andproblem solving in chemical analysis.

SyllabusUnit 1

Error Analysis and Sampling: Accuracy - Precision - Classification of Errors -Minimization of errors - Standard

deviation - Coefficient of variance - F-test - t-test - Significant figures. Sampling - Basis of sampling, Sampling andphysical state - Safety measures of sampling.

Separation Techniques: Brief out line of column, paper and thin layer chromatography - Ion exchange methods - principle and application – HPLC.

Unit 2

Gas chromatography - principle and applications – gel chromatography.

Electroanalytical techniques: Potentiometry - Potentiometric titration - determination of equivalence point - acidbase, complexometric, redox and precipitation titrations - merits and demerits. Voltammetry - Cyclic voltammetry -basic principle and application - Polarography - introduction - theoretical principles - migration current - residual current - half wave potential - instrumentation - analytical applications.

Unit 3

Spectro-chemical techniques: UV-VIS spetrophotometry - principle - Beer's Law application - photometric titration - single and double beam spectrophotometer - instrumentation of IR - sample handling - IR applications - H - NMR - Instrumentation and applications – principle - instrumentation - applications of atomic absorption spectroscopy.

Thermal and Diffraction techniques: Principles and applications of DTG - DTA DSC - X-ray - Electron DiffractionStudies - SEM, TEM.

TEXTBOOKS:

1. *Willard H W, Merritt J R, "Instrumental Methods of Analysis", 6th edition, Prentice Hall, (1986).*
2. *Skoog Douglas A, West Donald, "Fundamentals of Analytical Chemistry", 7th edition, New York Addison, Wesley, (2001).*

REFERENCES:

1. *"Vogel's Textbook of Quantitative Chemical Analysis", 5th edition, ELBS, (1989).*
2. *Kaur. H, "Instrumental Methods of Chemical Analysis", Goel Publisher, (2001).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY245	BATTERIES AND FUEL CELLS	L-T-P-C: 3-0-0-3

Course Objective:

To provide sound knowledge on the application of electrochemistry in energy storage systems.

Course Outcome

CO1: Understand the fundamental concepts of electrochemistry through electrode potential and reaction kinetics CO2: Learn the application of the electrochemical principles for the functioning and fabrication industrial batteries

and fuel cells

CO3: Analysis of practical problem solving in fabricating batteries and fuel cells
CO4: Evaluation of comprehensive knowledge through problem solving

SyllabusUnit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen

electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicatorand ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler- Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafelplots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air batteries; Lithium primary cells - liquid cathode, solid cathode and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultrathin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Fuel Cells: Description, working principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspects of the following types of fuel cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells.

Membranes for fuel cells: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments.

Fuels for Fuel Cells: Hydrogen, methane, methanol - Sources and preparation, reformation processes for hydrogen –clean up and storage of the fuels – use in cells, advantages and disadvantages of using hydrogen as fuel.

TEXTBOOKS:

1. *Dell, Ronald M Rand, David A J, 'Understanding Batteries', Royal Society of Chemistry, (2001).*
2. *M. Aulice Scibioh and B. Viswanathan 'Fuel Cells – principles and applications', University Press, India (2006).*

REFERENCES:

1. *Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, Metals Park,*

OH and Metal Finishing Publications, Stevenage, UK (2003).

2. *Curtis, 'Electroforming', London, (2004).*
3. *F. Barbir, 'PEM fuel cells: theory and practice', Elsevier, Burlington, MA, (2005).*
4. *G. Hoogers, 'Fuel cell handbook', CRC, Boca Raton, FL, (2003).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY246	CORROSION SCIENCE	L-T-P-C: 3-0-0-3

Course Outcome:

CO1: Development of skill in identifying the nature and type of corrosionCO2: Understanding the mechanism of various types of corrosion

CO3: Analysing the problem and find out a solution to combat corrosion in any sort of environment.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	-	-	-	-	-	-	-	-	-	-	3	1	-	-
CO2	-	3	1	2	-	-	-	-	-	-	-	1	1	2	-	-
CO3	-	3	3	3	2	3	3	-	-	-	-	1	3	2	3	-

SyllabusUnit 1

Basic principles: Free energy concept of corrosion - different forms of corrosion - Thermodynamic & Kinetic aspects of corrosion: The free energy criterion of corrosion possibility - Mechanism of Electrochemical corrosion - Galvanicand Electrochemical series and their significance.

Corrosion Control: Materials selection - metals and alloys - metal purification - non metallic - changing medium.

Unit 2

Anodic and cathodic protection methods - Coatings - metallic and other inorganic coatings - organic coatings - stray current corrosion - cost of corrosion control methods.

Corrosion protection by surface treatment: CVD and PVD processes - Arc spray - Plasma spray - Flame spray.Corrosion

Inhibitors: Passivators - Vapour phase inhibitor.

Unit 3

Stress and fatigue corrosion at the design and in service condition - control of bacterial corrosion.

Corrosion protection: Automobile bodies – engines – building construction.

TEXTBOOKS:

1. *Fontana and Mars G, "Corrosion Engineering", 3rd edition, McGraw Hill, (1987).*
2. *Uhlig H H and Reviees R W, "Corrosion and its Control", Wiley, (1985).*

REFERENCES:

1. *ASM Metals Handbook, "Surface Engineering", Vol. 5, ASM Metals Park, Ohio, USA, (1994).*
2. *ASM Metals Handbook, "Corrosion", Vol. 13, ASM Metals Park, Ohio, USA, (1994).*
3. *Brain Ralph, "Material Science and Technology", CRC Series, Boston, New York.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

PHYSICS

23PHY240	ADVANCED CLASSICAL DYNAMICS	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: Able to use the Lagrangian formalism to solve simple dynamical system

CO2: Able to understand Hamiltonian formalism and apply this in solving dynamical systems

CO3: Able to apply Lagrangian formalism in bound and scattered states with specific reference to Kepler's lawsand Scattering states

CO4: Able to solve problems in the Centre of Mass frame and connect it to Laboratory Frame of ReferenceCO5: Understand and solve problems in rigid body rotations applying of Euler's equations.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	0	0	0	0	0	0	0	1	0	0	0
CO2	3	3	1	1	0	0	0	0	0	0	0	1	0	0	0
CO3	3	3	3	1	0	0	0	0	0	0	0	1	0	0	0
CO4	3	3	3	1	0	0	0	0	0	0	0	2	0	0	0
CO5	3	3	3	2	0	0	0	0	0	0	0	2	0	0	0

SyllabusUnit 1

Introduction to Lagrangian dynamics

Survey of principles, mechanics of particles, mechanics of system of particles, constraints, D'Alembert's principle and Lagrange's equation, simple applications of the Lagrangian formulation, variational principles and Lagrange's equations, Hamilton's principles, derivation of Lagrange's equations from Hamilton's principle, conservation theorems and symmetry properties.

Unit 2

Central field problem

Two body central force problem, reduction to the equivalent one body problem, Kepler problem, inverse square lawof force, motion in time in Kepler's problem, scattering in central force field, transformation of the scattering to laboratory system, Rutherford scattering, the three body problem.

Rotational kinematics and dynamics

Kinematics of rigid body motion, orthogonal transformation, Euler's theorem on the motion of a rigid body.

Unit 3

Angular momentum and kinetic energy of motion about a point, Euler equations of motion, force free motion of rigid body.

Practical rigid body problems

Heavy symmetrical spinning top, satellite dynamics, torque-free motion, stability of torque-free motion - dual-spin spacecraft, satellite maneouvering and attitude control - coning maneuver - Yo-yo despin mechanism - gyroscopic attitude control, gravity- gradient stabilization.

TEXTBOOKS:

1. *H. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, 1980, (Second Edition)*
2. *H. Goldstein, Charles Poole, John Safko, Classical Mechanics, Pearson education, 2002 (Third Edition)*
3. *Howard D. Curtis, Orbital Mechanics for Engineering Students, Elsevier, pp.475 - 543*
4. *Anderson John D, Modern Compressible flow, McGraw Hill.*

REFERENCE BOOKS:

1. *D. A. Walls, Lagrangian Mechanics, Schaum Series, McGraw Hill, 1967.*
2. *J. B. Marion and S. T. Thornton, Classical dynamics of particles and systems, Ft. Worth, TX: Saunders, 1995.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY241	ELECTRICAL ENGINEERING MATERIALS	L-T-P-C: 3-0-0-3

Course Outcomes

CO1: To understand the nature of interaction between atoms in crystalline solid materials that determines their dielectric, magnetic and electrical properties.

CO2: Analyze the relation between the macroscopic dielectric constant and the atomic structure of an insulator.

CO3: Fundamental concepts of magnetic fields required to illustrate the magnetic dipoles. This forms the basis to understand the magnetic properties of dia, para, ferro, antiferro and ferri magnetic materials.

CO4: Fundamentals concerned with conduction mechanism in metals and superconductors.

CO5: Understand the basics for classification of materials based on its conductivity, nature of chemical bonds inSi and Ge, carrier density, energy band structure and conduction mechanism in intrinsic and extrinsic semiconductors.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1											1	-
CO2	2	2	2										1	-
CO3	2	2	2										2	-
CO4	2	2	2										2	-
CO5	2	2	2					2					1	-

SyllabusUnit 1

Conducting materials: The nature of chemical bond, crystal structure Ohm's law and the relaxation time, collisiontime, electron scattering and resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity.

Semiconducting materials: Classifying materials as semiconductors, chemical bonds in Si and Ge and it'sconsequences, density of carriers in intrinsic semiconductors, conductivity of intrinsic semiconductors, carrier densities in n type semiconductors, n type semiconductors, Hall effect and carrier density.

Unit 2

Magnetic materials: Classification of magnetic materials, diamagnetism, origin of permanent, magnetic dipoles in matter, paramagnetic spin systems, spontaneous magnetization and Curie Weiss law, ferromagnetic domains and coercive force, anti ferromagnetic materials, ferrites and it's applications.

Unit 3

Dielectric materials: Static dielectric constant, polarization and dielectric constant, internal field in solids and liquids, spontaneous polarization, piezoelectricity.

PN junction: Drift currents and diffusion currents, continuity equation for minority carriers, quantitative treatment of the p-n junction rectifier, the n-p-n transistor.

TEXTBOOK:

1. A J Decker, "Electrical Engineering materials", PHI, New Delhi, 1957.

REFERENCES:

1. *A J Decker, "Solid State Physics", Prentice Hall, Englewood Cliffs, N J 1957.*
2. *C Kittel, "Introduction to solid state Physics", Wieley, New York, 1956 (2nd edition).*
3. *Allison, Electronic Engineering materials and Devices, Tata Mc Graw Hill*
4. *F K Richtmyer E H Kennard, John N Copper, "Modern Physics", Tata Mc Graw Hill, 1995 (5th edition).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY242	PHYSICS OF LASERS AND APPLICATIONS	L-T-P-C: 3-0-0-3

Unit 1

Review of some basic concepts and principle of laser.

Introduction to light and its properties: Reflection, refraction, interference, diffraction and polarization. Photometry

– calculation of solid angle. Brewster's law. Snell's law and, its analysis.

Introduction to LASERS: Interaction of radiation with matter - induced absorption, spontaneous emission, stimulated emission. Einstein's co-efficient (derivation). Active material. Population inversion – concept and discussion about different techniques. Resonant cavity.

Unit 2

Properties of LASERS

Gain mechanism, threshold condition for PI (derivation), emission broadening - line width, derivation of FWHM natural emission line width as deduced by quantum mechanics - additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser and broadeningin gases due to isotope shifts. Saturation intensity of laser, condition to attain saturation intensity.

Properties – coherency, intensity, directionality, monochromaticity and focussibility. LASER transition – role of electrons in LASER transition, levels of LASER action: 2 level, 3 level and 4 level laser system.

Unit 3

Types of LASERS

Solid state LASER: (i) Ruby LASER – principle, construction, working and application. (ii) Neodymium (Nd) LASERS. gas LASER: (i) He-Ne LASER - principle, construction, working and application. (i) CO2 LASER - principle, construction, working and application.

Liquid chemical and dye LASERS. Semiconductor LASER: Principle, characteristics, semiconductor diode LASERS, homo-junction and hetero-junction LASERS, high power semi conductor diode LASERS.

Applications in Communication field:

LASER communications: Principle, construction, types, modes of propagation, degradation of signal, analogue communication system, digital transmission, fiber optic communication.

Applications of LASERS in other fields:

Holography: Principle, types, intensity distribution, applications. laser induced fusion. Harmonic generation. LASER spectroscopy. LASERS in industry: Drilling, cutting and welding. Lasers in medicine: Dermatology, cardiology, dentistry and ophthalmology.

REFERENCES:

1. *William T Silfvast, "Laser Fundamentals", Cambridge University Press, UK (2003).*

2. *B B Laud, "Lasers and Non linear Optics", New Age International (P) Ltd., New Delhi.*

3. *Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India (Distributors).*

4. *K R Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.*

5. *T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker (2004).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY243	CONCEPTS OF NANOPHYSICS AND NANOTECHNOLOGY	L-T-P-C: 3-0-0-3

Course Outcomes

CO1: Understand, Comprehend and acquaint with concepts of NanoPhysics

CO2: To familiarize the material's property changes with respect to the dimensional confinements.

CO3: Acquire knowledge on the modern preparation process and analysis involved in the nanomaterial's research CO4: To learn about the technological advancements of the nano-structural materials and devices in the engineering

applications

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3				3										
CO4						3	2					1		

Syllabus Unit 1

Introduction

Introduction to nanotechnology, comparison of bulk and nanomaterials – change in band gap and large surface to volume ratio, classification of nanostructured materials. Synthesis of nanomaterials - classification of fabrication methods – top down and bottom up methods.

Concept of quantum confinement and phonon confinement

Basic concepts – excitons, effective mass, free electron theory and its features, band structure of solids. Bulk to nano transition – density of states, potential well - quantum confinement effect – weak and strong confinement regime.

Electron confinement in infinitely deep square well, confinement in two and three dimension. Blue shift of band gap

- effective mass approximation. Vibrational properties of solids - phonon confinement effect and presence of surface modes.

Unit 2

Tools for characterization:

Structural – X-ray diffraction, transmission electron microscope,scanning tunneling microscope, atomic force microscope. Optical - UV – visible absorption and photoluminescence techniques, Raman spectroscopy.

Nanoscale materials – properties and applications:

Carbon nanostructures – structure, electrical, vibration and mechanical properties. Applications of carbon nanotubes

Unit 3

Field emission and shielding – computers – fuel cells – chemical sensors – catalysis – mechanical reinforcement. Quantum dots and Magnetic nanomaterials – applications.

Nanoelectronics and nanodevices:

Impact of nanotechnology on conventional electronics. Nanoelectromechanical systems (NEMSs) – fabrication (lithography) and applications. Nanodevices - resonant tunneling diode, quantum cascade lasers, single electron transistors – operating principles and applications.

TEXTBOOKS:

1. *Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, Nanoscale Science and Technology, John Wiley and Sons Ltd 2004.*
2. *W. R. Fahrner (Ed.), Nanotechnology and Nanoelectronics, Springer 2006.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY244	PHYSICS OF SEMICONDUCTOR DEVICES	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: Understand, comprehend and acquaint with the basics working principles and governing equations ofelectronic devices like diodes, Bipolar junction transistors, Mosfet and heterojunction transistors

CO2: Analyze and Solve physics problems pertaining to various process like charge conduction across semiconductor device.

CO3: Apply the knowledge for the development and design of new methods to determine semiconductorparameters and devices

SyllabusUnit 1

Introduction: Unit cell, Bravais lattices, crystal systems, crystal planes and Miller indices, symmetry elements. Defects and imperfections – point defects, line defects, surface defects and volume defects

Electrical conductivity: Classical free electron theory – assumptions, drift velocity, mobility and conductivity, drawbacks. quantum free electron theory – Fermi energy, Fermi factor, carrier concentration. Band theory of solids –origin of energy bands, effective mass, distinction between metals, insulators and semiconductors.

Unit 2

Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors, carrier concentration in intrinsic and extrinsic semiconductors, electrical conductivity and conduction mechanism in semiconductors, Fermi level in intrinsic and extrinsic semiconductors and its dependence on temperature and carrier concentration. Carrier generation - recombination, mobility, drift-diffusion current. Hall effect.

Theory of p-n junctions – diode and transistor:p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, current, electric field, barrier potential. V-I characteristics, junction capacitance and voltage breakdown.

Unit 3

Bipolar junction transistor, p-n-p and n-p-n transistors: principle and modes of operation, current relations. V-I characteristics. Fundamentals of MOSFET, JFET. Heterojunctions – quantum wells.

Semiconducting devices: Optical devices: optical absorption in a semiconductor, e--hole generation. Solar cells – p-n junction, conversion efficiency, heterojunction solar cells. Photo detectors – photo conductors, photodiode, p-i-n diode. Light emitting diode (LED) – generation of light, internal and external quantum efficiency.

Modern semiconducting devices: CCD - introduction to nano devices, fundamentals of tunneling devices, design considerations, physics of tunneling devices.

TEXTBOOKS:

1. *C Kittel, "Introduction to Solid State Physics", Wiley, 7th Edn., 1995.*
2. *D A Neamen, "Semiconductor Physics and Devices", TMH, 3rd Edn., 2007.*

REFERENCES:

1. *S M Sze, "Physics of Semiconductor Devices", Wiley, 1996.*
2. *P Bhattacharya, "Semiconductor Opto- Electronic Devices", Prentice Hall, 1996.*
3. *M K Achuthan & K N Bhat, "Fundamentals of Semiconductor Devices", TMH, 2007.*
4. *J Allison, "Electronic Engineering Materials and Devices", TMH, 1990.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY245	ASTROPHYSICS	L-T-P-C: 3-0-0-3

Course Outcomes:

After completion of the course students should be able to

CO1: Get a broad knowledge of scientific and technical methods in astronomy and astrophysics.CO2:Apply mathematical methods to solve problems in astrophysics.

CO3: Develop critical/logical thinking, scientific reasoning and skills in the area of modern astrophysics.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1		
CO2	2	2												
CO3	1	2												

SyllabusUnit 1

Historical introduction: Old Indian and western – astronomy - Aryabhatta, Tycho Brahe, Copernicus, Galileo - Olbers paradox - solar system – satellites, planets, comets, meteorites, asteroids.

Practical astronomy - telescopes and observations & techniques – constellations, celestial coordinates, ephemeris.

Celestial mechanics - Kepler’s laws - and derivations from Newton’s laws.

Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

Unit 2

Stellar astronomy: H-R diagram, color-magnitude diagram - main sequence - stellar evolution – red giants, white dwarfs, neutron stars, black holes - accretion disc - Schwartzchild radius - stellar masses Saha–Boltzman equation -derivation and interpretation.

Variable stars: Cepheid, RR Lyrae and Mira type variables - Novae and Super novae. Binary and multiple star system

- measurement of relative masses and velocities. Interstellar clouds - Nebulae.

Unit 3

Galactic astronomy: Distance measurement - red shifts and Hubble's law – age of the universe, galaxies – morphology

- Hubble's classification - gravitational lens, active galactic nuclei (AGNs), pulsars, quasars.

Relativity: Special theory of relativity - super-luminal velocity - Minkowski space - introduction to general theory ofrelativity – space - time metric, geodesics, space-time curvature. Advance of perihelion of Mercury, gravitational lens.

Cosmology: Comic principles, big bang and big crunch – cosmic background radiation - Nucleo-synthesis - planklength and time, different cosmic models - inflationary, steady state. Variation of G. anthropic principle.

REFERENCES:

1. *"Textbook of Astronomy and Astrophysics with elements of Cosmology", V. B. Bhatia, Narosa publishing 2001.*
2. *William Marshall Smart, Robin Michael Green "On Spherical Astronomy", (Editor) Carroll, Bradley W Cambridge University Press ,1977*
3. *Bradley W. Carroll and Dale A. Ostlie. "Introduction to modern Astrophysics" Addison-Wesley, 1996.*
4. *Bradley W. Carroll and Dale A. Ostlie, "An Introduction to Modern Astrophysics" Addison-Wesley*

Publishing Company,1996

5. *'Stellar Astronomy' by K. D Abhayankar.*
6. *'Solar Physics' by K. D Abhayankar.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

MATHEMATICS

23MAT240	STATISTICAL INFERENCE	L-T-P-C: 3-0-0-3

Syllabus

Unit 1

Introduction to Statistics: Data Collection and Descriptive Statistics, Populations and Samples, describing data sets, summarizing data sets, Normal Data Sets, Paired Data Sets and the Sample Correlation Coefficient. Review of Random Variables and Distributions, Distributions of Sampling Statistics, The Sample Mean, The Central Limit Theorem, The Sample Variance, Sampling Distributions from a Normal Population, Distribution of the Sample Mean, Joint Distribution of $\bar{X}$ and S^2, Sampling from a Finite Population.

Unit 2

Parameter Estimation: Introduction, Maximum Likelihood Estimators, Interval Estimates, Estimating the Difference in Means of Two normal populations, Approximate Confidence Interval for the Mean of a Bernoulli random variable, Confidence Interval of the Mean of the Exponential Distribution, Evaluating a Point Estimator, The Bayes Estimator. Hypothesis Testing: Introduction, Significance Levels, Tests Concerning the Mean of a Normal Population, Testing the Equality of Means of Two Normal Populations, Hypothesis Tests Concerning the Variance of a Normal Population, Tests Concerning the Mean of a Poisson Distribution.

Unit 3

Regression: Introduction, Least Squares Estimators of the Regression Parameters, Distribution of the Estimators, Statistical Inferences about the Regression Parameters, the Coefficient of Determination and the Sample Correlation Coefficient, Analysis of Residuals, transforming to Linearity, Weighted Least Squares, Polynomial Regression, Multiple Linear Regression, Predicting Future Responses, Logistic Regression Models for Binary Output Data.

TEXTBOOK:

1. Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, Elsevier Academic Press.

REFERENCES:

1. *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons Inc., 2005*
2. *Ravichandran, J. Probability and Statistics for engineers, First Reprint Edition, Wiley India, 2012.*
3. *Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, Pearson Education Asia, 2007.*

4. *Hogg, R.V., Tanis, E.A. and Rao J.M., Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23MAT241	INTRODUCTION TO GAME THEORY	L-T-P-C: 3-0-0-3

Syllabus

Unit 1

Elements of Game theory, examples, Strategic Games, 2 Player Strategy Games, payoffs, Minimax, Weak and Strong Domination, Saddle Points, Nash Equilibrium, Prisoner's Dilemma, Stag Hunt, Matching pennies, BOS, Multi NE, Cooperative and Competitive Games, Strict and Non Strict NE, Best response functions for NE.

Unit 2

Combinatorial games, Winning and losing positions, Subtraction Game, 3-Pile and K-Pile Games, Proof of Correctness, Variations of K-Pile Games, Graph Games, Construction, Proof of finiteness, SG theorem for sum ofgames.

Unit 3

Cournot's Oligopoly, Bertrand's Oligopoly, Electoral Competition, Median Voter Theorem, Auctions, role of knowledge, Decision making and Utility Theory, Mixed Strategy Equilibrium, Extensive Games with Perfect Information, Stackelberg's model of Duopoly, Buying Votes, Committee Decision making, Repeated Gmes, Prisoner's Dilemma, Supermodular Game and Potential games

TEXTBOOK:

1. *Martin Osborne, An Introduction to Game Theory, Oxford University Press.*

REFERENCES:

1. *Thomas Ferguson, Game Theory, World Scientific, 2018.*
2. *Stef Tijs. Introduction to Game Theory, Hindustan Book Agency.*
3. *Allan MacKenzie, Game Theory for Wireless Engineers, Synthesis Lectures On Communications.*

Evaluation Pattern

Assessment	Internal	End Semester

Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23MAT242	NUMERICAL METHODS AND OPTIMIZATION	L-T-P-C: 3-0-0-3

Syllabus

09 (a) Roots finding methods:

Roots of Transcendental and Polynomial Equations: Bisection method, Iteration methods based on first degree equation, Rate of convergence, system of nonlinear equations.

09 (b) Interpolations:

Interpolation and Approximation: Lagrange, Newton's Divided Difference, Newton's Forward and Backward interpolations.

07 (b) Multivariable optimization (2 Credits)

Optimality criteria – unidirectional search – direct search methods – gradient based methods. Lagrangian and Kuhn-Tucker conditions.

TEXTBOOK:

1. *Edwin K.P. Chong, Stanislaw H. Zak, "An introduction to Optimization", 2nd edition, Wiley, 2013.*
2. *M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical methods for scientific and Engineering computation, New Age International Publishers, 2007, 5th edition.*

REFERENCES:

1. *Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples, Prentice Hall, 2002.*
2. *S.S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, 1995.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	

*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAMCOMMON TO ALL PROGRAMS

23MNG331	FINANCIAL MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- Understand the overview of financial management
- Inculcate methods and concepts on valuation
- Familiarize with working capital management, financial analysis and planning

Course Outcomes

CO1: Understand and apply time value concept of money and use this for investment criteria decisions.

CO2: Evaluate the risk and return for various alternatives of investment.

CO3: Apply the capital budgeting techniques and evaluate the investment decisions.

CO4: Understand working capital management, cash and liquidity management and financial statements**. CO/PO**

Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3					1	1		3	3	1			
CO2	3	3					2	1		3	3	1			
CO3	3	2					1	1		3	3	1			
CO4	3	2			1		2	1	2	3	3	1			

SyllabusUnit 1

Introduction: Financial Management an overview – Financial Decisions in a firm – Goal of FM – Function of the financial system.

Unit 2

Fundamental Valuation Concepts:Time value of money – Risk and Return. Capital Budgeting: Techniques of capital budgeting investment criteria– NPV – Benefit Cost Ratio – IRR – Payback Period – ARR – Investment appraisal inPractice – Estimation of Project cost flows.

Unit 3

Working Capital Management: Current Assets – Financing Ruling – Profit Criterion. Cash and Liquidity Management. Working Capital Financing.

Financial Analysis and Planning**:** financial instruments, sources of long-term, intermediate term and short term finance. Analyzing Financial Performance – Break – even analysis and Leverages – Financial Planning and Budgeting.

Mergers and Takeovers-International trade.

TEXT BOOKS

1. *Chandra, P., 'Financial Management: Theory and Practice', 9e, TMH, 2017*.
2. *Denzil Watson & Antony Head, 'Corporate Finance- Principles and Practice', 2e, Pearson Education Asia, 2016.*
3. *R L Varshney& K L. Maheshwari, 'Managerial Economics', S Chand & Sons, 22e, 2014.*

REFERENCE BOOKS

1. *Stephen Blyth, 'An Introduction to Corporate Finance ',McGraw Hill Book Company, 2014.*
2. *Eugene F. Brigham & Louis C.Gapenski, 'Financial Management – Theory and Practice',14e, 2015.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MNG332	SUPPLY CHAIN MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- Understand the complexity and key issues in supply chain management.
- Describe logistics networks, distribution planning, routing design and scheduling models.
- Familiarize dynamics of supply chain and the role of information in supply chain.
- Understand the issues related to strategic alliances, global supply chain management, procurement andoutsourcing strategies.

Course Outcomes

CO1: Analyze the complexity and key issues in supply chain management

CO2: Evaluate single and multiple facility location problems, logistics network configuration, vehicle routing and scheduling models

CO3: Analyze inventory management models and dynamics of the supply chain

CO4: Develop the appropriate supply chain through distribution requirement planning and strategic alliances

CO5: Identify the issues in global supply chain management, procurement and outsourcing strategies

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1									1	3		
CO2	2	2	3	1						1	1	2	2		
CO3	3	3	3	3	2				3	1	1	3	2		
CO4	2	2	1	1						1	1	2	2		
CO5	3	3	3	1					3	1	1	3	2		

SyllabusUnit 1

Introduction: Introduction to SCM-the complexity and key issues in SCM – Location strategy – facility locationdecisions – single facility and multiple location models.

Logistics: Logistics Network Configuration – data collection-model and data validation- solution techniques-network configuration DSS – Transport strategy – Service choices: single service and inter modal services – vehicle routingand scheduling models – traveling salesman problems – exact and heuristic methods.

Unit 2

Inventory: Inventory Management and risk pooling-managing inventory in the SC. Value of Information-bullwhipeffect-lead time reduction.

Supply Chain Integration: Supply chain integration-distributed strategies-push versus pull systems. Distribution Requirements Planning – DRP and demand forecasting, DRP and master production scheduling. DRP techniques –time-phased order point – managing variations in DRP – safety stock determination-Strategic alliances-third partylogistics-distribution integration.

Unit 3

Issues in SCM**:** Procurement and outsourcing strategies – framework of e-procurement. International issues in SCM-regional differences in logistics. Coordinated product and supply chain design-customer value and SCM.

TEXT BOOK

Simchi-Levi,D.,Kaminsky,P.,Simchi-Levi,E., Shankar,R., 'Designing and Managing the Supply Chain: Concepts,Strategies, and Cases', Tata McGraw Hill, 2008.

REFERENCE BOOKS

1. *Christopher, M., 'Logistics and Supply Chain Management: Strtegies for reducing Cost and Improving Service', PH, 1999.*
2. *Ballou, M., 'Business logistics / Supply chain management', Pearson Education, 2003.*
3. *Vollmann, T.E., 'Manufacturing Planning and Control for Supply Chain Management', 5e, McGraw Hill, 2005.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MNG333	MARKETING MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objective

To educate the students to apply concepts and techniques in marketing so that they become acquainted with the duties of a marketing manager with an emphasis to make the students exposed to the development, evaluation, and implementation of marketing management in a variety of business environments.

Course Outcomes

On successful completion of the Course students will be able to:

CO1: Illustrate key marketing concepts, theories and techniques for analysing a variety of marketing situations

CO2: Identify and demonstrate the dynamic nature of the environment in which marketing decisions are taken and appreciate the implication for marketing strategy determination and implementation

CO3: Develop the ability to carry out a research project that explores marketing planning and strategies for aspecific marketing situation

CO4: Understand the need and importance of sales promotions and make use of advertising

CO5: Manage a new product development process from concept to commercialization.

CO6: Illustrate the importance of modern trends in retailing and marketing logistics

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			3	1								1			
CO2		1	3	3		2	1			2	2	2			
CO3	1	1	1	3	2	2	2		2	2	2	3			
CO4			2	2		2	1	1		3	3	3			

CO5	1	1	3	2		1	1			1	2	3			
CO6	1	1	3	2		1	1			1	2	3			

SyllabusUnit 1

Marketing Process: Definition, Marketing process, dynamics, needs, wants and demands, value and satisfaction, marketing concepts, environment, mix. Philosophies, selling versus marketing, organizations, industrial versus consumer marketing, consumer goods, industrial goods, product hierarchy.

Buying Behaviour and Market Segmentation: Major factors influencing buying behaviour, buying decision process, businessbuyingbehaviour. Segmenting consumer and business markets, market targeting.

UNIT 2

Product Pricing and Marketing Research: Objectives, pricing, decisions and pricing methods, pricing management. Introduction, uses, process of marketing research.

UNIT 3

Developing New Products - Challenges in new-product Development - Effective organizational arrangements - Managing the development Process: ideas - Concept to strategy - Development to commercialization – The consumer- adoption process.

Advertising Sales Promotion and Distribution: Characteristics, impact, goals, types, and sales promotions- point of purchase- unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing.

TEXT BOOKS

1. *Kolter, P.,'Marketing Management', Pearson Education 2001.*
2. *Ramasamy and Namakumari, 'Marketing Environment: Planning, implementation and control the Indian context', 1990.*

REFERENCE BOOKS

1. *Paul, G.E. and Tull, D., 'Research for marketing decisions', Prentice Hall of India, 1975.*
2. *Tull, D.S. and Hawkins, 'Marketing Research', Prentice Hall of Inida-1997.*
3. *Kotler, P. and Armstrong, G., 'Principles of Marketing' Prentice Hall of India, 2000.*
4. *Skinner, S.J., 'Marketing', All India Publishers and Distributes Ltd. 1998.*
5. *Govindarajan, M., 'Industrial marketing management', Vikas Publishing Pvt. Ltd, 2003.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MNG334	PROJECT MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- To discuss the project life cycle and build a successful project from pre-implementation to completion.
- To introduce different project management tools and techniques

Course Outcomes

CO1: Appraise the selection and initiation of individual projects and its portfolios in an enterprise.
CO2: Analyze the project planning activities that will predict project costs, time schedule, and quality.**CO3:** Develop processes for successful resource allocation, communication, and risk management.

CO4: Evaluate effective project execution and control techniques that results in successful project completion

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	1				2		3	1	2	3	2
CO2	2	3	3	2	2				3		3	2	2	3	3
CO3	1	2	3	2	2				2		3	2	1	2	3
CO4	1	1	2		1				2		3	1	1	1	2

SyllabusUnit 1

Overview of Project Management: Verities of project, Project Features, Project Life Cycle – S-Curve, J-C **Project Selection:** Project Identification and Screening – New ideas, Vision, Long-term objectives, SWOT Analysis (Strength, Weakness, Opportunities, Threats).

Project Appraisal – Market Appraisal, Technical Appraisal, Economic Appraisal, Ecological Appraisal, and Financial Appraisal – Payback, Net Present Value (NPV), Internal Rate of Returns (IRR).

Project Selection – Decision Matrix, Technique for Order Preference using Similarity to Ideal Solution (TOPSIS), Simple Additive Weighting (SAW).

Unit 2

Project Presentation: WBS, Project Network – Activity on Arrow (A-O-A), Activity on Node (A-O-N).**Project Scheduling:** Gant Chart, Critical Path Method (CPM), Project Evaluation & Review Technique (PERT).**(6hrs)**

Linear time cost trade-offs in project - Direct cost, indirect cost, Project crashingResource Consideration - Profiling, Allocation, Levelling.

Introduction to project management software: Primavera/ Microsoft project

Unit 3

Project Execution: Monitoring control cycle, Earned Value Analysis (EVA), Project Control – Physical control, Human control, financial control.

Organizational and Behavioral Issues: Organizational Structure, Selection-Project Manager, Leadership Motivation, Communication, Risk Management.

Project Termination: Extinction, Addition, Integration, Starvation.

TEXT BOOKS

1. *Jack R. Meredith and Samuel J. Mantel, Jr. - 'Project Management- A Managerial Approach' Eighth Edition - John Wiley & Sons Inc - 2012.*
2. *Arun Kanda – 'Project Management-A Life Cycle Approach' PHI Learning Private Limited - 2011*

REFERENCE BOOKS

1. *'A Guide to Project Management Body of Knowledge' PMBOK GUIDE, Sixth edition, Project management Institute – 2017*
2. *Ted Klastrorin - 'Project Management, Tools, and Trade-Offs' - John Wiley – 2011*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MNG335	ENTERPRISE MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- To impart knowledge on the fundamentals of costing, pricing methods and strategies.
- To give an overview of production operations planning.
- To summarize various quantitative methods of plant location, layout and lean manufacturing.
- To familiarize the concepts of e-commerce, e-purchasing, MRP and ERP in business

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the concepts of cost and pricing of goods and appraise project proposals

CO2: Design and analyze manufacturing and service processes and to measure the work performed.

CO3: Understand and analyze the key issues of supply chain Management

CO4: Understand the application of lean manufacturing tools and six sigma concepts

CO5: Select appropriate plant location and their layout methods

CO6: Create capacity plan, aggregate plan, schedule, ERP & MRP systems

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1							2	2			
CO2	2	1								1		2	1		1
CO3	2	1										2	1		1
CO4	2	1	1	1						1		2	1		1
CO5	2	1		1								2			
CO6	2	2	1	1							1	2	1		1

SyllabusUnit 1

Engineering Economics: cost concepts - types of costs - cost functions. Cost controls: reduction – tools & applications.Pricing policies – methods – problems.Process design and improvement – process capacity – process layout – process reengineering

– job design. Work standards – work measurement – work sampling – problems.

Unit 2

Supply Chain Management – Basic Concepts, SC dynamics, push-pull boundary, integrated supply chain, logistics, customer relationship, supplier relationship – selection, rating and development, procurement, SC metrics and performance measurement - problems. Lean Manufacturing – concepts, wastes – tools viz., pull system, standardized work, takt time, kanban system, JIT, kaizen, SMED, 5S, value stream mapping, benefits of lean and implementationissues. Introduction to Six Sigma. Plant Location – globalization, factors affecting location decisions, facility location- Break-even method, rectilinear, factor-rating and centre of gravity – problems. Plant Layout – types, process layout,product layout, Systematic layout planning (SLP), Line Balancing problems. Capacity Planning – Aggregate Planning

– importance, planning process, methods – problems.

Unit 3

Role of IT in business performance improvement – e-commerce – e-purchasing –Master Production Schedule, inventory lot sizing strategies, MRP basics – MRP explosion, Available to Promise(ATP) inventory – MRP calculations – MRP II – Scheduling – Gantt chart – Introduction to ERP – ERP software – ERP modules – ERP implementation.

TEXT BOOKS

1. *L J Krajewski, L.P.RitzmanMalhotra.M and Samir K. Srivastava, 'Operations Management: Processes and Value chains, 11e, Pearson, 2015.*
2. *R L Varshney& K L. Maheshwari, 'Managerial Economics', S Chand & Sons, 22e, 2014.*

REFERENCE BOOKS

1. *Richard B. Chase, Ravi Shankar, F. Robert Jacobs, 'Operations and Supply Chain Management' McGraw Hill Education (India) Private Limited.14e, 2017.*
2. *E S Buffa and R K Sariss, 'Modern Production/Operations Management', Wiley India Private Limited, 8e, 2007.*
3. *Harrison.B, Smith.C., and Davis.B.,, 'Introductory Economics', 2e Pr Macmillan, 2013.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports.

23MNG336	OPERATIONS RESEARCH	L-T-P-C: 3-0-0-3

Course Objectives

Familiarizing the students with quantitative tools and techniques, which are frequently applied in operational decisions

Course Outcomes

CO1: Formulate operations research models to optimize resources.

CO2: Solve transportation and assignment problems using suitable techniques.

CO3: Apply appropriate technique to analyze a project with an objective to optimize resources.

CO4: Solve operational problems using decision theory approaches.

CO5: Select suitable inventory model for effective utilisation of resources.

CO6: Solve Operations Research problems using software package

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		2						2	2	2		
CO2	3	2	2		2						2	2	2		
CO3	3	2	2		2						2	2	2		
CO4	3	2	2		2						2	2	2		
CO5	3	2	2		2						2	2	2		
CO6	3	2	2		2						2	2	2		

SyllabusUnit1

Linear Programming: Formulations - graphical solutions - Simplex Method - Duality, Dual simplex method.Transportation model: Assignment model – Travelling Salesman Problem.

Unit 2

Decision Theory: Decision Trees. Game theory - 2 person zero sum; mixed strategies; 2 x n and m x 2 games. Network Models- Project Networks- CPM / PERT- Project Scheduling – crashing networks and cost considerations-Resource leveling and smoothing - shortest route problem, minimal spanning tree problem, maximal flow problem.

Unit 3

Sequencing model – 2 machines 'n' jobs, 'm' machines 'n' jobs – n jobs 2 machines.

Inventory models: deterministic & probabilistic models. Quantity discounts. Selective Inventory Management Queuing models: Poisson arrival and exponential service times. Single server, multi-server. Queues -infinite and finite capacity queues.

Simulation –Monte Carlo simulation: simple problems

Lab session: Practicing case problems with excel solver/MatLab/LINGO package

TEXT BOOK

Hillier, F .S. and Lieberman, G .J, 'Operations Research', 9e, McGraw Hill, 2010

REFERENCE BOOKS

1. *Taha,H.A., 'Operations Research: an Introduction', 8e, Prentice Hall, New Delhi, 2008.*
2. *Ravindran, A., Phillips, D.J., and Solberg, J.J., 'Operations Research- Principles and Practice', John Wiley& Sons, 2005.*
3. *Wagner, H.M., 'Principles of Operations Research', Prentice Hall, New Delhi, 1998.*

4. *Hardley, G.,'Linear Programming', Narosa Book Distributors Private Ltd 2002.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
*Continuous Assessment(Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MEE321	INDUSTRIAL ENGINEERING	L-T-P-C: 3-0-0-3

Course Objectives

- To inculcate the concepts of work study and its application to industrial practice
- Impart skills to design, develop, implement, and improve manufacturing/service systems

Course Outcomes

At the end of the course, the student will be able to

CO1: Create value to organizations through the analysis, evaluation, and improvement of work systems using work study and method study

CO2: Develop work systems through motion economy principles

CO3: Apply work measurement techniques to improve productivity, fix wages and incentives

CO4: Apply systematic layout planning techniques and work station design principles based on ergonomics andmaterial handling.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1						1		3	2		
CO2	2	1	2	1	1					1		3	2		
CO3	1	2		1	1						1	3	2		
CO4	2	2		1	2						2	3	2		

SyllabusUnit 1

Work System: Elements of work, maintenance of machines, interaction, effect of working conditions and environment, physical and mental fatigue.

Productivity: Productivity, factors affecting production, Measurement of productivity.

Work Study: Definition and scope of work study; Areas of application of work study in industry; Human aspects ofwork study.

Method Study: Information collection, recording techniques, and processing aids; critical examination; development, installation and maintenance of improved methods.

Unit 2

Motion Economy and Analysis: Principles of motion economy; Motion analysis; Micromotion and Memomotion study; Therbligs and SIMO charts; Normal work area and design of work places; Basic parameters and principles ofwork design.

Work Measurement: Work measurement techniques; Calculation of standard time, work sampling and predetermined Motion time systems.

Wages and Incentive Schemes: Introduction, wage payment of direct and indirect labour, wage payment plans and incentives, various incentive plans, incentives for indirect labour

Unit 3

Plant Layout: Concept of plant layout, types of layout; factors affecting plant layout.

Ergonomics: Ergonomic Design of equipment and work place. work station design, factors considered in designing awork station, ergonomic design standards - Study of development of stress in human body and their consequences.Case Studies.Production planning and scheduling.

Material Handling: Introduction and functions of material handling equipment, selection of material handling equipment for different requirements, safety requirements.

Recent advances in Industrial Engineering.

TEXT BOOKS

1. *Barnes, R, "Motion and Time Study" - Design and Measurement of Work . NY: John Wiley and Sons, 8th Edition, 1985.*
2. *"Introduction to Work Study", 4ed, International Labor Office, Geneva, 2006.*

REFERENCE BOOKS

1. *Martand T. Telsang, 'Industrial Engineering and Production Management' S Chand; 2nd Rev Edn 2006.*
2. *Mahajan M., "Industrial Engineering and Production Management" Dhanpat rai and Sons Publishers, 2005.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continues Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MEE323	MANAGERIAL STATISTICS	L-T-P-C: 3-0-0-3

Course Objective

To impart the knowledge of basic statistical tools for analysis and interpretation of qualitative and quantitativedata for decision making

Course Outcomes

CO1: Apply basic probability and statistics concepts for various business problems

CO2: Perform test of hypothesis

CO3: Compute and interpret the result of regression and correlation analysis for forecasting

CO4: Solve real time problems by applying different decision making methods.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3		2	2						2	2	3		
CO2	3	3		2	2						2	2	3		
CO3	3	3		2	2						2	2	3		
CO4	3	3		2	2						2	2	3		

SyllabusUnit 1

Quantitative methods: Basic terminology in probability, probability rules, conditions of statistical dependence and independence, Bayes Theorem, Discrete Random Variables review of probability distributions, measure of central tendency.

Sampling and sampling distributions: Introduction to sampling, random sampling, design of experiments, introduction to sampling distributions

Estimation: point estimates, interval estimates and confidence intervals, calculating interval estimates of mean from large samples, using t test, sample size estimation.

Unit 2

Testing hypothesis: Introduction, basic concepts, testing hypothesis, testing when population standard deviation is known and not known, two sample tests.

Chi-square and analysis of variance: introduction, goodness of fit, analysis of variance, inferences about a population variation

Unit 3

Regression and correlation: Estimation using regression line, correlation analysis, finding multiple regression equation, modelling techniques,

Non parametric methods and time series and forecasting: Sign test for paired data, rank sum test, rank correlation, Kolmogrov – smirnov test, variations in time series, trend analysis, cyclic variation, seasonal variation and irregular variation. Decision theory**:** Decision tree analysis

TEXT BOOKS

1. *Levin R. I. and Rubin D. S. - 'Statistics for management' - Pearson Education – 2007 - 5th Edition*
2. *Montgomery D. C. and Runger G. C. - 'Applied Statistics and Probability for Engineers' - John Wiley & Sons - 2002 - 3rd Edition*

REFERENCE BOOKS

1. *Bain.L. J. and Engelhardt M. - 'Introduction to Probability and Mathematical Statistics' - Duxbury Press -*

March 2000 - 2nd Edition

2. *Hinkelmann K. and Kempthorne O. - 'Design and Analysis of Experiments : Volume I' - John Wiley & Sons, Inc. - December 2007 - 2nd Edition*
3. *Johnson R. A. and Wichern D. W. - 'Applied Multivariate Statistical Analysis' - Prentice-Hall, Inc. - December 2001 - 5th Edition*
4. *Myers R. H. - 'Classical and Modern Regression with Applications' - PWS-Kent Publishing Company - March 2000 - 2nd Edition*
5. *Devore J. L. - 'Probability and Statistics for Engineering and the Sciences' - Brooks/Cole Publishing Company - December 1999 - 5th Edition*
6. *Freund J. E. and Walpole R. E. - 'Mathematical Statistics' - Prentice-Hall Inc. - October 1986 - 4th Edition*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MEE323	TOTAL QUALITY MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objective

To impart knowledge on quality management principles, tools, techniques and quality standards for real lifeapplications

Course Outcomes

CO1: Evaluate the principles of quality management and to explain how these principles can be applied withinquality management systems.

CO2: Evaluate the performance measures using various quality and management tools

CO3: Apply the Quality Function Deployment, Taguchi principles, Total Productive Maintenance and Failure Mode and Effect Analysis concepts to solve industrial problems.

CO4: Practice the various quality system in industry.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2										2	2		
CO2	1	2										2	2		
CO3	2	2	2									2	2		
CO4	2	2	2	2								2	2		

SyllabusUnit 1

Definition of quality - dimensions of quality. Quality planning - quality costs. Total Quality Management: historical review and principles –leadership - quality council - quality statements - strategic planning - Deming philosophy.Barriers to TQM implementation

Unit 2

Customer satisfaction – Customer retention - Employee involvement - Performance appraisal - Continuous process improvement - Supplier partnership - Performance measures. Seven tools of quality.Statistical fundamentals - Control Charts for variables and attributes - Process capability - Concept of six sigma - New seven management tools

- Benchmarking.

Unit 3

Quality function deployment (QFD) - Taguchi quality loss function - Total Productive Maintenance (TPM) - FMEA.Need for quality systems - ISO 9000:2000 – Elements of quality systems (such as ISO 9000:2000). Implementation of quality system – documentation - quality auditing - QS 9000-ISO 14000

TEXT BOOK

Besterfiled D. H. - 'Total Quality Management' - Pearson Education Asia – 2015-4th Edition

REFERENCE BOOKS

1. *Evans J. R, and Lidsay W. M. - 'The Management and Control of Quality' - Southwestern (Thomson Learning) - 2002 - 5th Edition*
2. *Feigenbaum A. V. - 'Total Quality Management - Vol I &II ' – McGraw Hill - 1991*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MEE324	LEAN MANUFACTURING	L-T-P-C: 3-0-0-3

Course Objectives

- Understand Lean manufacturing principles and tools
- Inculcate the concepts of value stream mapping
- Familiarize lean implementation practices

Course Outcomes

CO1: Identify key requirements and concepts in lean manufacturing.

CO2: Initiate a continuous improvement change program in a manufacturing organization**CO3:** Analyze and improve a manufacturing system by applying lean manufacturing tools**CO4:** Build value stream map for improving the productivity

CO5: Improve productivity through lean practices

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2											2	2		
CO2	2	2	2	1					2	1		1	2		1
CO3	2	2	2	2	1				2	1		1	2	1	2
CO4	2	2	2	1	1	1	1			1		2	2	1	1
CO5	2	2	2	1	1	1	1			1		2	2	1	1

SyllabusUnit 1

Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods - The 7 Wastes, their causes and the effects - An overview of Lean Principles / concepts / tools - Stockless Production.

The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow –5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems.

Ford production systems – FPS gear model

Unit 2

Value Stream Mapping – Current state: Preparation for building a Current State Value Stream Map – Building a Current State Map (principles, concepts, loops, and methodology) – Application to the factory Simulation scenario.

Unit 3

Value Stream Mapping – Future State: Key issues in building the Future State Map – Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop – Example of completedFuture State Maps – Application to factory simulation

Implementation of lean practices - Best Practices in Lean Manufacturing.

TEXT BOOKS

1. *Womack, J.P., Jones, D.T., and Roos, D.,'The Machine that Changed the World', Simon & Schuster, New York, 2007.*
2. *Liker, J.K., 'Becoming Lean', Industrial Engineering and Management Press, 1997.*

REFERENCES BOOKS

1. *Womack, J.P. and Jones, D.T.,'Lean thinking', Simon & Schuster, USA, 2003.*
2. *Rother, M. and Shook, J., 'Learning to see', The Lean Enterprise Institute, Brookline, USA, 2003*.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23CSE321	SOFTWARE PROJECT MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- This course describes the key aspects of a software project.
- It introduces the basic principles of Engineering Software Projects. Most, if not all, students' complete projects as part of assignments in various courses undertaken. These projects range in size, subject and complexity but there are basic project essentials that need to be understood and practiced for successful team project outcomes.
- The course provides an understanding of the purpose, methods and benefits of process management by exposing the student to the concepts, practices, processes, tools and techniques used in process managementfor software development.

Course Outcomes

CO 1: To understand the basic concepts, terminologies and issues of software project management.

CO 2: To apply appropriate methods and models for the development of solutions.

CO 3: To analyze the cost-benefits of calculations so as to optimize the selection strategy**CO 4:** To evaluate methods, models and technologies towards achieving project success**CO 5:** To design and evaluate network planning models with criticality

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1								1		3	2
CO2	3	2	3						3	3		2	3	2
CO3	3	2	2	3	2	2	2	2	3	3	2	2	3	2
CO4	2	2	2	1	3	2	2	2	3	3		2	3	2
CO5	3	2	3	3	3	2	2	2	3	3		2	3	2

SyllabusUnit 1

Introduction to Software Project Management- Software Projects - ways of categorizing software projects – problems with software projects - Project Life Cycle– Management -Setting objectives –Stakeholders - Project Team- Step-wise

: An overview of project planning -project Evaluation –Selection Of Appropriate Project Objectives- Software Effort Estimation Techniques, Function Point Analysis-Object Point-COCOMO.

Unit 2

Activity planning-- project schedules - sequencing and scheduling projects - Network planning model – AON andAOA-identifying critical activities-Crashing And Fast Tracking-,Risk management—Categories , Risk planning, Management and Control - Evaluating risks to the schedule. PERT- Resource Allocation, Monitoring and Tracking -Monitoring and control - allocation - identifying resource requirements - scheduling resources - creating critical paths

- publishing schedule - cost schedules- sequence schedule.

Unit 3

Monitoring and control – Visualizing Progress, Earned value analysis, managing people and organizing teams-organizational structures- Planning for small projects. Case Study: PMBOK , Agile Development

TEXT BOOK(S)

Mike Cotterell, Bob Hughes. Software Project Management, Fifth Edition, Tata McGraw-Hill; 2012.

REFERENCE(S)

1. *Roger S. Pressman. Software Engineering – A Practioner's Approach, Eighth Edition, Tata McGraw-Hill publishers; 2014.*
2. *Jalote P. Software Project Management in practice, Second edition, Person Education; 2003.*

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CSE322	FINANCIAL ENGINEERING	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes

Course Objectives

- This course serves as an introduction to financial engineering including cash flows, financial decision making etc
- It gives a thorough yet highly accessible mathematical coverage of standard and recent topics of introductory investments: fixed-income securities, modern portfolio theory, optimal portfolio growth and valuation ofmulti-period risky investments.

Course Outcomes

CO1: Apply basic concepts to understand and evaluate cash flows

CO2: Evaluate and arrive at a financial investment decision employing the underlying knowledge of stocks andderivatives

CO3: Analyse and design Portfolio selection methods

CO4: Understand capital market theory for stock performance evaluation

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1			2								3	2
CO2	2	3	1										3	2
CO3	1	3			2								3	2
CO4	2	1											3	2

SyllabusUnit 1

Cash Flows and Fixed income securities: Investments and markets - Principal and interest - Present and future valuesof streams - IRR. Fixed income securities - Market value for future cash - Bond value - Bond details – Yields – Convexity – Duration - Immunization. Bond portfolio management - Level of market interest rates, Term structureof interest-rate theories.

Unit 2

Stocks and Derivatives: Common stock valuation - Present value of cash dividends - Earnings approach - Value versus price - Efficient markets theory - Technical analysis. Analysis of financial statements. Derivatives - futures and options

- Black Scholes formula - Utility functions - Applications in financial decision making.

Unit 3

Portfolio analysis and capital market theory: Covariance of returns – Correlation - Portfolio return - Portfolio standard deviation - Two asset case - Efficient frontier - Optimum portfolio. Capital market theory - Capital market line - Sample diversifications to reduce risk - Characteristic line - Capital asset pricing model. Arbitrage price theory - Stock performance evaluation.

TEXT BOOK(S)

1. *David Luenberger, Investment Science. Second Edition, Oxford University Press; 2013*
2. *Jack Clark Francis, Richard W. Taylor. Investments, Schaum’s Outlines, Tata McGraw Hill ;2006.*

REFERENCE(S)

1. Lyuu YD. Financial Engineering and Computation. Cambridge University Press; 2004.
2. Perry H. Beaumont. Financial Engineering Principles. John Wiley and Sons Inc, New Jersey; 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CSE323	ENGINEERING ECONOMIC ANALYSIS	L-T-P-C: 3-0-0-3

Course Objectives

- Prepare engineering students to analyze and understand the business, impact of economic environment onbusiness decisions

Course Outcomes

CO1: Understand and evaluate the economic theories, cost concepts and pricing policies and draw inferences forthe investment decisions for appraisal and profitability

CO2: Appraise the dynamics of the market and market structures and portray implication for profit and revenuemaximization

CO3: Employ operations research and allied techniques in managerial economics for an enhanced analysis anddecision making

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2		2		2			3	2	3	2
CO2	1	3	2	1		2		2			3	2	3	2
CO3	2	3	2	2		2		2			3	2	3	2

SyllabusUnit 1

Economics: Nature and scope of managerial economics. Economic theory and managerial economics, Cost Concepts: Types of costs - Cost functions. Cost controls: reduction – Tools & Areas. Pricing policies- methods. Capital budgeting

- cost of capital. Appraising project profitability

Unit 2

The essentials of demand and supply: The law of demand. Market demand curve. Other determinants of market demand. The law of supply. Determinants of market supply. The market mechanism. Price elasticity of demand, Profit and revenue maximization: Optimal input combination. Total revenue maximization.

Unit 3

Market structure: Perfect competition and monopoly. Characteristics of monopolistic competition. Oligopoly Operations Research techniques in managerial economics: Inventory models. Theory of games. Decision theory, Risk and Uncertainty, Measuring risk, Consumer behavior and risk aversion, Decision making under uncertainty with complete ignorance

TEXT BOOK(S)

Webster, T.J. Managerial Economics- Theory and Practice, Elsevier; 2004.

REFERENCE(S)

1. *Panneerselvam, R. Engineering Economics, Second Edition, PHI; 2013.*
2. *R L Varshney,K L. Maheshwari. Managerial Economics, S Chand & Sons;2014.*
3. *Harrison.B, Smith.C., and Davis.B. Introductory Economics, Second Edition, Pr Macmillan; 2013.*

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CSE324	INFORMATION SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- This course is to expose the students to the managerial issues relating to information systems and alsounderstand the role of Business Process Reengineering technique in an organization.
- The course also focus on the management of information technology to provide efficiency and effectiveness or strategy decision making.

Course Outcomes

CO1: Understand the fundamental concepts of Information Systems in business.

CO2: Understand and analyse the strategic role played by Information Systems in e-commerce.

CO3: Analyse management challenges in Global Businesses predominantly dependent on IS functions.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	2
CO2	2	2			2								3	2
CO3	1	3			2	2					2	1	3	2

SyllabusUnit 1

Introduction to IS -Fundamental concepts-IS in Business- Role of IS –Information system and technologies – Components of IS –resources and acivities –Types of IS- E business Applications –Role of BI and Analytics in IS-Functional Business Systems - Marketing Systems, Manufacturing systems, Human Resource Systems, Accounting Systems and Financial Management Systems.-Cross-Functional Enterprise Systems Cross-Functional Enterprise Applications, Enterprise Application Integration, Transaction Processing Systems and Enterprise Collaboration Systems. Enterprice Business Systems CRM, ERP, SCM , Case Studies

Unit 2

Electronic Commerce Systems : Scope of e-Commerce, Essential e-Commerce Processes and Electronic Payment Processes - E-commerce Applications & Issues -Decision Support Systems- Business and Decision Support, Decision Support Trends, Management Information Systems, Online Analytical Processing, Decision Support Systems, Executive

Information Systems, Enterprise Portals and Decision Support - Knowledge Management Systems. Artificial Intelligence Technologies and its application in Business- Strategic role of IT- Competing with IT, valuechain ,reengineering, virtual organization ,knowledge creation-Organizational Planning, The Scenario Approach, Planning for Competitive Advantage, SWOT Business Models and Planning, Business IT Planning, -Business/ ITStrategies and Business Application Planning- Developing and Implementing Business Systems - ImplementationChallenges- barriers - change management-: Case Studies

Unit 3

Management challenges-Security, Ethical and Societal Challenges- Ethical Responsibility of Business Professionals, Computer Crime, Privacy Issues, Health Issues, and Societal Solutions- Security Management of IT- Tools of security Management, Internetworked Security Defenses, other security measures –system controls and audits- Enterprise and Global Management of IT- Managing the IS Function and Failures in IT Management - Global IT Management, Cultural, Political and Geo-economic Challenges, Global Business/IT Strategies, Global Business/IT Applications,Global IT Platforms, Global Data Access Issues and Global Systems Development –Case studies

TEXT BOOK(S)

1. *O'Brien JA, Marakas GM. Management information systems. McGraw-Hill Irwin; 2006.*
2. *Brien,Marakas G M and Behi R , MIS,9th edition, Tata McGraw Hill Special Indian Edition;2010.*

REFERENCE(S)

Laudon K, Laudon JP. Management Information Systems;2010

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMSCOMMON TO ALL PROGRAMS

23CUL230	ACHIEVING EXCELLENCE IN LIFE -AN INDIAN PERSPECTIVE	L-T-P-C: 2-0-0-2

Course Objectives:

The course offers to explore the seminal thoughts that influenced the Indian Mind on the study of human possibilitiesfor manifesting excellence in life. This course presents to the students, an opportunity to study the Indian perspectiveof Personality Enrichment through pragmatic approach of self analysis and application.

SyllabusUnit 1

Goals of Life – Purusharthas

What are Purusharthas (Dharma, Artha, Kama, Moksha); Their relevance to Personal life; Family life; Social life & Professional life; Followed by a Goal setting workshop;

Yogic way of Achieving Life Goals – (Stress Free & Focused Life)

Introduction to Yoga and main schools of Yoga; Yogic style of Life & Time Management (Work Shop);Experiencing life through its Various Stages

Ashrama Dharma; Attitude towards life through its various stages (Teachings of Amma);

Unit 2

Personality Development

What is Personality – Five Dimensions – Pancha Kosas (Physical / Energy / Mental

/ Intellectual / Bliss); Stress Management & Personality; Self Control & personality; Fundamental Indian Values & Personality;

Learning Skills (Teachings of Amma)

Art of Relaxed Learning; Art of Listening; Developing 'Shraddha' – a basic qualification for obtaining Knowledge; Communication Skills - An Indian Perspective;

Unit 3

Developing Positive Attitude & Friendliness - (Vedic Perspective);

Achieving Work Excellence (Karma Yoga by Swami Vivekananda & teachings based on Amma);
Leadership Qualities – (A few Indian Role models & Indian Philosophy of Leadership);

REFERENCE BOOKS:

1. *Awaken Children (Dialogues with Sri Mata Amritanandamayi) Volumes 1 to 9*
2. *Complete works of Swami Vivekananda (Volumes 1 to 9)*
3. *Mahabharata by M. N Dutt published by Parimal publications – New Delhi (Volumes 1 to 9)*
4. *Universal message of Bhagavad-Gita (An exposition of Gita in the light of modern thought and Modern needs) by Swami Ranganathananda. (Vols.1 to 3)*
5. *Message of Upanishads, by Swami Ranaganathananda published by Bharatiya Vidya Bhavan, Bombay.*
6. *Personality Development – Swami Vivekananda published by Advaitha Ashram, Kolkatta.*
7. *Art of Man Making - Swami Chinmayananda published by Chinmaya Mission, Bombay*
8. *Will Power and its Development- Swami Budhananda published by Advaitha Ashram, Kolkatta*
9. *Ultimate Success - Swami Ramakrishnananada Puri published by Mata Amritanandamayi Math, Kollam*
10. *Yoga In Daily Life - Swami Sivananda – published by Divine Life Society*
11. *Hindu Dharma - H. H. Sri Chandrasekharandra Saraswati published by Bharatiya Vidya Bhavan, Bombay*
12. *All about Hinduism – Swami Sivananda - Published by Divine Life Society*
13. *The Mind and its Control by Swami Budhananda published by Advaitha Ashram, Kolkatta*
14. *Krida Yoga - Vivekananda Kendra, Publication.*
15. *Valmiki Ramayana – Four volumes- published by Parimal Publications, Delhi*

16. *New perspectives in Stress Management - Dr H R Nagendra & Dr R Nagaratna published by Swami Vivekananda Yoga Prakashana, Bangalore.*
17. *Mind Sound Resonance Technique (MSRT) Published by Swami Vivekananda Yoga Prakashana, Bangalore.*
18. *Yoga & Memory - Dr H R Nagendra & Dr. Shirley Telles, published by Swami Vivekananda Yoga Prakashana, Bangalore.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CUL231	EXCELLENCE IN DAILY LIFE	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

1. The anatomy of 'Excellence'. What is 'excellence'? Is it judged by external factors like wealth?
2. The Great Flaw. The subject-object relationship between individual and world. Promote subject enhanceexcellence.
3. To work towards excellence, one must know where he is. Our present state... An introspective analysis.Our faculties within.

Unit 2

4. The play of the mind. Emotions – convert weakness into strength.
5. The indispensible role of the intellect. How to achieve and apply clear thinking?
6. The quagmire of thought.The doctrine of Karma – Law of Deservance.
7. Increase Productivity, reduce stress.. work patterning.

Unit 3

8. The art of right contact with the world. assessment, expectations.
9. Myths and Realities on key issues like richness, wisdom, spirituality.
10. Collect yourself, there is no time to waste. The blue-print of perfect action.

REFERENCES:

The Bhaja Govindam and the Bhagavad Gita.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CUL232	EXPLORING SCIENCE AND TECHNOLOGY IN ANCIENT INDIA	L-T-P-C: 2-0-0-2

OBJECTIVES:

This course offers a journey of exploration through the early developments in India of astronomy, mathematics, technologies and perspectives of the physical world. With the help of many case studies, the students will be equipped to understand concepts as well as well as actual techniques.

SyllabusUnit 1

1. General introduction: principles followed and sources;
2. Astronomy & mathematics from the Neolithic to the Indus civilization;
3. Astronomy & mathematics in Vedic literature;
4. Vedanga Jyotisha and the first Indian calendars;
5. Shulba Sutras and the foundations of Indian geometry;

Unit 2

1. Astronomy & mathematics in Jain and Buddhist literature;
2. The transition to the Siddhantic period; Aryabhata and his time;
3. The Aryabhatiya: concepts, content, commentaries;
4. Brahmagupta and his advances;
5. Other great Siddhantic savants;
6. Bhaskara II and his advances;

Unit 3

1. The Kerala school of mathematics;
2. The Kerala school of astronomy;
3. Did Indian science die out?;
4. Overview of recent Indian scientists, from S. Ramanujan onward;
5. Conclusion: assessment and discussion;

TEXTBOOK:

Indian Mathematics and Astronomy: Some Landmarks, by S. Balachandra Rao

REFERENCE:

IFIH's interactive multimedia DVD on Science & Technology in Ancient India.

Evaluation Pattern

Assessment	Internal	End Semester

Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CUL233	YOGA PSYCHOLOGY	L-T-P-C: 2-0-0-2

OBJECTIVES:

This course offers the foundation necessary to understand Eastern approaches to psychology and spirituality. The course includes experiential components centering on meditation and spiritual practice.

SyllabusUnit 1

Introduction

Introduction to Modern Psychology

A short history of Modern Psychology - Major Schools of Modern Psychology - The three major forces in Western Psychology - Freudian Psychoanalysis; Behaviourism; Humanistic Psychology.

Introduction to Indian Psychology

What is Yoga? - Rise of Yoga Psychology tradition - Various schools of Yoga Psychology - Universal Goal of allYoga-schools.

Patanjali Yoga Sutra – 1

Introduction to Rishi Patanjali - Bird view of Yoga-Sutra - Definition of Yoga – Vrittis.

Patanjali Yoga Sutra – 2

Five Kinds of Vrittis - Pramanam - sources of right knowledge - Viparyayah – unfolded belief - Vikalpah – Unfoldedbelief - Smriti – Memory.

Unit 2

Patanjali Yoga Sutra – 3

Two formulae - Necessity of Abhyasah and Vairagyah - Foundation of Abhyasah - Foundation of Vairagyah.

Patanjali Yoga Sutra – 4

Introduction to Samadhi - Samprajnata-Samadhi - Reasoning in Samprajnata-Samadhi - Reflection in Samprajnata-Samadhi - Bliss in Samprajnata-Samadhi - Sense of Individuality in Samprajnata-Samadhi.

Patanjali Yoga Sutra – 5

Main obstacles in the path of Yoga - other obstructions - removal of obstacles by one – pointedness; by controlling Prana - by observing sense experience - by inner illumination - by detachment from matter - by knowledge of dream and sleep - by meditation as desired.

Patanjali Yoga Sutra – 6

How to make mind peaceful? - Cultivating opposite virtues: happiness – friendliness - misery – compassion - virtue

– gladness - vice – indifference.

Patanjali Yoga Sutra – 7

Five causes of Pain - avidya – ignorance (Root Cause) - asmita – 'I-Feeling' – raga – attraction - dwesha – repulsion

- abhinivesha – clinging to life.

Unit 3

Patanjali Yoga Sutra – 8

Necessity of Yoga practice - eight parts of Yoga practice - five Yamas: ahimsa – satya – asteya – brahmacharyam

– aparigraha.

Patanjali Yoga Sutra – 9

Five Niyamas: Soucha – Santhosha – Tapas – Swadyah – Ishwara - Pranidhanam.

Patanjali Yoga Sutra – 10

Asanam – Pranayamah - various kinds of Pranayamah - Pratyaharah - Mastery over the senses.Report review Conclusion

REFERENCES:

1. *The course book will be "The four chapters of Freedom" written by Swami Satyananda Saraswati of Bihar School of Yoga, Munger, India.*
2. *"The message of Upanishads" written by Swami Ranganathananda. Published by Bharathiya Vidya Bhavan.*
3. *Eight Upanishads with the commentary of Sankaracharya, Translated by Swami Gambhirananda, Published by Advaita Ashram, Uttaranjal.*
4. *'Hatha Yoga Pradipika' Swami Muktibodhananda, Yoga Publications Trust, Munger, Bihar, India*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG230	BUSINESS COMMUNICATION	L-T-P-C: 1-0-3-2

OBJECTIVES:

To introduce business vocabulary; to introduce business style in writing and speaking; to expose students to thecross-cultural aspects in a globalised world; to introduce the students to the art of persuasion and negotiation inbusiness contexts.

Course Outcomes

CO1: Familiarize and use appropriate business vocabulary and etiquettes in verbal communication in theprofessional context

CO2: Understand organizational structures, pay structures and performance assessments

CO3: Apply language skills in drafting various business documents and other necessary communications in thebusiness context

CO4: Understand and address cross cultural differences in the corporate environmentCO5: Participate in planned and extempore enactments of various business situations

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										3		2
CO2									1		1	
CO3										3		
CO4						2						
CO5									2			

SyllabusUnit 1

Business Vocabulary - Writing: Drafting Notices, Agenda, and Minutes - Reading: Business news, Business articles.

Unit 2

Writing: Style and vocabulary - Business Memorandum, letters, Press Releases, reports – proposals – Speaking:Conversational practice, telephonic conversations, addressing a gathering, conducting meetings.

Unit 3

Active Listening: Pronunciation – information gathering and reporting - Speaking: Cross-Cultural Issues, Group Dynamics, negotiation& persuasion techniques.

Activities

Case studies & role-plays.

BOOKS RECOMMENDED:

1. *Jones, Leo & Richard Alexander. New International Business English. CUP. 2003.*
2. *Horner, David & Peter Strutt. Words at Work. CUP. 1996.*
3. *Levi, Daniel. Group Dynamics for Teams. 3 ed. Sage Publications India Pvt. Ltd. New Delhi, 2011.*
4. *Owen, Roger. BBC Business English. BBC. 1996.*

5. *Henderson, Greta Lafollette & Price R Voiles. Business English Essentials. 7th Edition. Glencoe / McGraw Hill.*
6. *Sweeney, Simon. Communicating in Business. CUP. 2000.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG231	INDIAN THOUGHT THROUGH ENGLISH	L-T-P-C: 2-0-0-2

OBJECTIVES:

To expose the students to the greatness of Indian Thought in English; to develop a sense of appreciation for the lofty Indian Thought; to develop an understanding of the eclectic Indian psyche; to develop an understanding about thesocietal changes in the recent past.

SyllabusUnit 1

Poems

Rabindranath Tagore's Gitanjali (1-10); Nizzim Ezekiel's Enterprise; A.K. Ramanujam's Small-Scale Reflections on a Great House.

Unit 2Prose

Khushwant Singh's The Portrait of a Lady; Jhumpa Lahiri's Short Story - Interpreter of Maladies.

Unit 3

Drama and Speech

Vijay Tendulkar's Silence, the Court is in Session; Motivational speeches by Jawaharlal Nehru/ S. Radhakrishnan / A. P. J. Abdul Kalam's My Vision for India etc. (any speech).

REFERENCES:

1. *Lahiri, Jhumpa. Interpreter of Maladies, Harper Collins Publications, 2000.*
2. *Ramanujan A. K. ed. K. M. George, Modern Indian Literature: An Anthology, Vol. I, Sahitya Akademi, 1992.*
3. *Singh, Khushwant. The Portrait of a Lady: Collected Stories, Penguin, 2009.*
4. *Tagore, Rabindranath. Gitanjali, Penguin Books India Pvt. Ltd, 2011.*
5. *Tendulkar, Vijay. Five Plays, Oxford University Press, 1996.*

Evaluation Pattern

Assessment	Internal	End Semester

Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG232	INSIGHTS INTO LIFE THROUGH ENGLISH LITERATURE	L-T-P-C: 2-0-0-2

OBJECTIVES:

To expose the students to different genres of Literature; to hone reading skills; to provide deeper critical and literary insights; to enhance creative thinking; to promote aesthetic sense.

SyllabusUnit 1

Poems

1. W. H. Auden: Refugee Blues; 2. A. K. Ramanujan: Obituary; 3. William Blake: The LittleBlack Boy; 4. Gieve

Patel: Grandparents at a Family Get–together.

Unit 2

Short Stories

1. Chinua Achebe: Marriage is a Private Affair; 2. Ruskin Bond: The Thief; 3. Isai Tobolsky: Not Just Oranges; 4.K A Abbas: The Refugee

Unit 3Prose

1. A G Gardiner: On The Philosophy of Hats; 2. Robert Lynd: Mispronunciation

Practicals:

Role plays: The Proposal, Chekov / Remember Ceaser, Gordon Daviot / Final Solutions, Mahesh Dattani, Bookreviews, Movie reviews.

SUGGESTED READING:

The Old Man and the Sea, Hemingway / Any one of the novels of R.K. Narayan, etc.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	

Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG233	TECHNICAL COMMUNICATION	L-T-P-C: 2-0-0-2

OBJECTIVES:

To introduce the students to the elements of technical style; to introduce the basic elements of formal correspondence; to introduce technical paper writing skills and methods of documentation; to improve oral presentation skills in formal contexts.

Course Outcomes:

After the completion of the course the student will be able to:

CO1: Understand and use the basic elements of formal correspondence and methods of documentationCO2: Learn to edit technical content for grammatical accuracy and appropriate tone and style

CO3: Use the library and internet recourses for research purposes

CO4: Demonstrate the ability to communicate effectively through group mock-technical presentations and other activities

Mapping of course outcomes with program outcomes:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										3				
CO2										3				
CO3				1										
CO4									3	3				

Syllabus:

Unit 1

Mechanics of writing: Grammar rules – punctuation - spelling rules - tone and style - graphical Representation.

Unit 2

Different kinds of written documents: Definitions – descriptions – instructions – recommendations - manuals -reports – proposals; Formal Correspondence: Letter Writing including job applications with Resume.

Unit 3

Technical paper writing: Library research skills - documentation style - document editing – proof reading – formatting.

Practice in oral communication and Technical presentations

REFERENCES:

1. *Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002*
2. *Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003*
3. *Strunk, William Jr. and White. E B. "The Elements of Style" New York. Alliyan & Bacon, 1999.*
4. *Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG234	INDIAN SHORT STORIES IN ENGLISH	L-T-P-C: 2-0-0-2

OBJECTIVES:

To help the students learn the fine art of story writing; to help them learn the techniques of story telling; to helpthem study fiction relating it to the socio- cultural aspects of the age; to familiarize them with different strategies of reading short stories; to make them familiar with the morals and values held in high esteem by the ideals of Indianness.

SyllabusUnit 1

Introduction: Differences between novel and short stories – origin and development of short stories - Rabindranath

Tagore: Kabuliwallah; Mulk Raj Anand: The Gold Watch.

Unit 2

R. K. Narayan: Sweets for Angels; K. A. Abbas: The Refugee; Khushwant Singh: The Mark of Vishnu.

Unit 3

Masti Venkatesha Iyengar: The Curds-Seller; Manohar Malgonkar: Upper Division Love; Romila Thapar: The Spell; Premchand: The Voice of God.

TEXT:

M. G. Narasimha Murthy (ed), Famous Indian Stories. Hyderabad: Orient Black Swan, 2014

REFERENCE:

Mohan Ramanan (Ed), English and the Indian Short Story: Essays in Criticism, Hyderabad, Orient Black Swan,2000.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	

*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23FRE230	PROFICIENCY IN FRENCH LANGUAGE (LOWER)	L-T-P-C: 2-0-0-2

SyllabusUnit 1

Population - Identity

How to introduce yourself (name, age, address, profession, nationality); Numbers; How to ask questions; Grammar – Pronouns - subjects; Regular verbs of 1st group (er) in the present; Être (to be) and avoir (to have) inthe present; Interrogative sentence; Gender of adjectives.

Unit 2

The suburbs - At the train station

Introduce someone; Buy a train ticket or a cinema ticket; Ask for information; Official time; Ask for a price; Thecity (church, town hall, post office…)

Grammar – Pronouns - subjects (continuation); Gender of adjectives (continuation); Plural of nouns and adjectives; Definite and indefinite articles; Interrogative adjectives; I would like (Je voudrais).

Unit 3

Paris and the districts - Looking for a room

Locate a room and indicate the way; Make an appointment; Give a price; Ordinal numbers; Usual time; Ask for thetime.

Grammar - Imperative mode; Contracted articles (au, du, des); negation.

TEXTBOOK:

Metro St Michel - Publisher: CLE international

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	

*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23FRE231	PROFICIENCY IN FRENCH LANGUAGE (HIGHER)	L-T-P-C: 2-0-0-2

SyllabusUnit 1

The first room of a student

A party to celebrate the 1st room; Description of a room; furniture; Locate objects: prepositions (devant, derrière, dans…), Read advertisement; Appreciation (I like, I prefer,).

Grammar - Perfect past tense with avoir; Possessive adjectives (mon, ton, son…); Demonstrative adjectives (ce, cet, cette); Yes (oui, si).

Unit 2 Small jobs

Conversation on the phone; Give Time indications; Answer a job offer; Describe a job; Suggest a meeting time. Grammar - Perfect past tense with être and avoir (continuation); Possessive adjectives (notre, votre, leur); Prepositions (à, pour, avec …); Pronoun as direct object (le, la, l’, les).

Unit 3

University Restaurant

Inquiry; Express an opinion; Ask questions (continuation); Food, meals, taste, preferences; Nutrition, diet, choosea menu or diet, Expression of quantities (beaucoup, peu).

Grammar - Partitif (expressing quantity) (du, de la, pas de….); Comparison (plus...que, moins….que, autant …que); Interrogation (continuation), inversion, Est-ce que, qu’est-ce que?.

TEXTBOOK:

Metro St Michel - Publisher: CLE International

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	

Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER230	GERMAN FOR BEGINNERS I	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Greetings; Introducing one-self (formal and informal context), saying their name, origin, living place, occupation. Numbers 1-100; Saying the telephone number. Countries and Languages.

Grammar: Structure – W - Questions and Yes/No questions and statements, personal pronouns, verb conjugations. Articles.

Vocabulary: Professions.

Unit 2

Giving the personal details. Name, age, marital status, year of birth, place of birth, etc.Numbers till 1000. Saying a year. Alphabets – spelling a word.

Filling up an application form; In the restaurant – making an order.

Grammar: Definite, indefinite and negative article in nominative. Accusative: indefinite and negative Article Vocabulary: Food items

Unit 3

Numbers above 1000. Orientation in Shopping plazas: asking the price, where do I find what, saying the opinion.Grammar: Accusative – definite article. Adjectives and plural forms. Vocabulary: Furniture and currencies.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER231	GERMAN FOR BEGINNERS II	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Shopping and orientation in supermarket; Conversation between the customer and salesman; Where one finds what in supermarket; Asking for requests and suggestions.

Grammar: Dative of personal pronouns. Imperative form. Vocabulary: Consumables and measurements;

Unit 2

Appointments; Work and leisure time activities; Time, weekdays, months and seasons; saying the date; fixing upan appointment.

Grammar: Model verbs; Prepositions with time and place; Ordinal numbers. Vocabulary: Leisure activities, weekdays, months and seasons.

Unit 3

Family and household; Family and relations; household and daily routine. Grammar: Possessive articles; Divisibleand indivisible verbs.

Vocabulary: Family circle; Household articles.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER232	PROFICIENCY IN GERMANLANGUAGE (LOWER)	L-T-P-C: 2-0-0-2

Syllabus

To have an elementary exposure to German language; specifically

1. to have some ability to understand simple spoken German, and to be able to speak it so as to be able tocarry on life in Germany without much difficulty (to be able to do shopping, etc.);
2. to be able to understand simple texts, and simple forms of written communication;
3. to have a basic knowledge of German grammar;
4. to acquire a basic vocabulary of 500 words;
5. to be able to translate simple letters with the use of a dictionary; and
6. to have some familiarity with the German life and culture.

(This will not be covered as part of the regular classroom teaching; this is to be acquired by self-study.)Some

useful websites will be given.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER233	PROFICIENCY IN GERMAN LANGUAGE (HIGHER)	L-T-P-C: 2-0-0-2

Syllabus

The basic vocabulary and grammar learned in the earlier course is mostly still passive knowledge. The endeavourof this course is to activate this knowledge and develop the skill of communication.

Topics are: Airport, railway station, travelling; shopping; invitations, meals, meeting people; around the house; the human body; colours; professions.

Past and future tenses will be introduced. Applying genitive, dative and accusative. Some German culture. Films.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HIN230	HINDI I	L-T-P-C: 2-0-0-2

OBJECTIVES:

To teach Hindi for effective communication in different spheres of life - Social context, Education, governance,Media, Business, Profession and Mass communication.

Course Outcomes:

After the completion of the course the student will be able to:

CO1: Gain knowledge about the nature and culture of Hindi languageCO2: Understand the structural aspects of Hindi language

CO3: Apply the knowledge of the grammatical structures to communicate in HindiCO4: Analyse the social significance of modern literature.

CO5: Develop the ability to translate a given text to Hindi

CO-PO Mapping:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									2	3				
CO2									2	3				
CO3									2	3				
CO4										3				
CO5									2					

SyllabusUnit 1

Introduction to Hindi Language, National Language, Official Language, link Language etc. Introduction to Hindilanguage, Devanagari script and Hindi alphabet.

Shabda Bhed, Roopanthar ki Drishti se- Bhasha – Paribhasha aur Bhed – Sangya - Paribhasha Aur Bhed - Sangyake Roopanthar - kriya.

Unit 2

Common errors and error corrections in Parts of Speech with emphasis on use of pronouns, Adjective and verb in different tenses – Special usage of adverbs, changing voice and conjunctions in sentences, gender& number - General vocabulary for conversations in given context –understanding proper pronunciation - Conversations, Interviews, Short speeches.

Unit 3

Poems – Kabir 1st 8 Dohas, Surdas 1st 1 Pada; Tulsidas 1st 1 Pada; Meera 1st 1 Pada

Unit 4

Letter writing – personal and Formal – Translation from English to Hindi.

Unit 5

Kahani – Premchand: Kafan, Abhilasha, Vidroh, Poos ki rath, Juloos.

BOOKS:

1. *Prem Chand Ki Srvashrestha Kahaniyam: Prem Chand; Diamond Pub Ltd. New Delhi*
2. *Vyavaharik Hindi Vyakaran ,Anuvad thaha Rachana : Dr. H. Parameswaran, Radhakrishna publishing House, New Delhi*
3. *Kamtha Prasad Guru : Hindi Vyakaran, Best Book pub House, New Delhi*
4. *Poetry : Kavya Ras - Ed: T.V. Basker - Pachouri Press; Mathura*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HIN231	HINDI II	L-T-P-C: 2-0-0-2

OBJECTIVES:

Appreciation and assimilation of Hindi Literature both drisya & shravya using the best specimens provided as anthology.

Course Outcomes:

After the completion of the course the student will be able to:

CO1: Understand the grammatical structures of Hindi CO2: Understand the post modern trends of literature CO3: Enhance critical thinking and writing skills

CO4: Identify and analyse different literary and audio-visual material

CO5: Apply fundamental knowledge of Hindi in formal and informal writing

CO-PO Mapping:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									**1**	**2**				
CO2									**1**	**2**				
CO3									**1**	**2**				
CO4										**3**				
CO5									**1**	**2**				

Syllabus:

Unit 1

Kavya Tarang; Dhumil ke Anthim Kavitha [Poet-Dhumil]; Dhabba [Poet-Kedarnath Singh]; Proxy [Poet-Venugopal]; Vakth [Poet-Arun Kamal]; Maachis [Poet-Suneeta Jain].

Unit 2

Communicative Hindi - Moukhik Abhivyakthi

Unit 3

Audio-Visual Media in Hindi – Movies like Tare Zameen par, Paa, Black etc., appreciation and evaluation. Newsreading and presentations in Radio and TV channels in Hindi.

Unit 4

Gadya Manjusha – Budhapa, Kheesa, Sadachar ka Thavis

Unit 5

Translation: Theory and Practice - Letter writing: Formal and Personal – Introduction to Hindi Software.

BOOKS:

1. *Kavay Tarang: Dr. Niranjan, Jawahar Pusthakalay, Mathura.*

2. *Gadya Manjusha: Editor: Govind, Jawahar Pusthakalay, Mathura*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM230	EMOTIONAL INTELLIGENCE	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Emotional Intelligence: Concept of Emotional Intelligence, Understanding the history and origin of Emotional Intelligence, Contributors to Emotional Intelligence, Science of Emotional Intelligence, EQ and IQ, Scope of Emotional Intelligence.

Unit 2

Components of Emotional Intelligence: Self-awareness, Self-regulation, Motivation, Empathy, Social skills. Emotional Intelligence Competencies, Elements of Emotional Intelligence, Models of Emotional Intelligence: The Ability-based Model, The Trait Model of Emotional Intelligence, Mixed Models of Emotional Intelligence.

Unit 3

Emotional Intelligence at Work place: Importance of Emotional Intelligence at Work place? Cost–savings of Emotional Intelligence, Emotionally Intelligent Leaders, Case Studies Measuring Emotional Intelligence: Emotionally Intelligence Tests, Research on Emotional Intelligence, Developing Emotional Intelligence.

REFERENCES:

1. *Daniel Goleman (1996). Emotional Intelligence- Why it can Matter More than IQ. Bantam Doubleday Dell Publishing Group*
2. *Daniel Goleman (2000). Working with Emotional Intelligence. Bantam Doubleday Dell Publishing Group*
3. *Liz Wilson, Stephen Neale & Lisa Spencer-Arnell (2012). Emotional Intelligence Coaching. Kogan Page India Private Limited*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM231	GLIMPSES INTO THE INDAN MIND -THE GROWTH OF MODERN INDIA	L-T-P-C: 2-0-0-2

Syllabus Unit 1
Introduction

General Introduction; 'His + Story' or 'History' ?; The concepts of 'nation', 'national identity' and 'nationalism';Texts and Textualities: Comparative Perspectives.

Unit 2

Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:

Raja Ram Mohan Roy; Dayananda Saraswati; Bal Gangadhar Tilak; Rabindranath Tagore;

Unit 3

Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:

Swami Vivekananda; Sri Aurobindo; Ananda K. Coomaraswamy; Sister Nivedita; Mahatma Gandhi; JawaharlalNehru; B.R. Ambedkar; Sri Chandrasekharendra Saraswati, the Paramacharya of Kanchi; Dharampal; Raja Rao;

V.S. Naipaul.

Conclusion.

REFERENCES:

1. *Tilak, Bal Gangadhar. The Orion / Arctic Home in the Vedas.*
2. *Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.*
3. *Vivekananda, Swami. "Address at the Parliament of Religions"/"The Future of India"/"In Defence of Hinduism" from Selections from the Complete Works of Swami Vivekananda.*
4. *Aurobindo, Sri. The Renaissance in India / On Nationalism.*
5. *Coomaraswamy, Ananda K. Essays in Indian Idealism (any one essay) / Dance of Shiva.*
6. *Nivedita, Sister. "Noblesse Oblige: A Study of Indian Caste" / "The Eastern Mother" from The Web of Indian Life.*
7. *Gandhi, Mahatma. Hind Swaraj.*
8. *Nehru, Jawaharlal. "The Quest" from Discovery of India.*
9. *Ambedkar, B. R. "Buddha and His Dhamma" from Collected Works.*
10. *Saraswati, Chandrasekharendra. "The Sastras and Modern Life" from The Hindu Dharma.*
11. *Dharampal. Bharatiya Chitta, Manas and Kala / Understanding Gandhi.*

12. *Naipaul, V. S. India: A Wounded Civilization / India: A Million Mutinies Now.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM232	GLIMPSES OF ETERNAL INDIA	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Introduction

A peep into India's glorious past

Ancient India – the vedas, the vedic society and the Sanatana Dharma – rajamandala and the Cakravartins – Ramarajya – Yudhisthira's ramarajya; Sarasvati - Sindhu Civilization and the myth of the Aryan Invasion; Classical India – Dharma as the bedrock of Indian society – Vaidika Brahmanya Dharma and the rise of Jainism and Buddhism

– the sixteen Mahajanapadas and the beginning of Magadhan paramountcy - Kautilya and his Arthasastra – Chandragupta Maurya and the rise of the Mauryan empire – Gupta dynasty Indian art and architecture – classical sanskrit literature – Harsavardhana; Trade and commerce in classical and medieval India and the story of Indian supremacy in the Indian ocean region; The coming of Islam – dismantling of the traditional Indian polity – the Mughal empire – Vijayanagara samrajya and days of Maratha supremacy.

Unit 2

India's contribution to the world: spirituality, philosophy and sciences

Indian Philosophy – the orthodox (Vaidika) and the heterodox (atheistic) schools; Ramayana and Mahabharata; Bhagavad Gita; Saints and sages of India; Ancient Indian medicine: towards an unbiased perspective; Ancient Indian mathematics; Ancient Indian astronomy; Ancient Indian science and technology.

The arrival of Europeans, British paramountcy and colonization

What attracted the rest of the world to India?; India on the eve of the arrival of European merchants; The story of colonization and the havoc it wrecked on Indian culture and civilization; Macaulay and the start of the distortion ofIndian education and history; Indian economy – before and after colonization: a brief survey; The emergence ofmodern India.

Unit 3

Women in Indian society

The role and position of women in Hindu civilization; Gleanings from the Vedas, Brihadarnyaka Upanishad, Saptasati Devi Mahatmyam, Ramayana, Mahabharata, Manusmriti, Kautilya's Arthasastra and Mrichchhakatikamof Sudraka; The role and position of Indian women vis-a-vis Islam and European cultures; The great women of India.

Modern India

The national movement for freedom and social emancipation; Swami Vivekananda, Sri Aurobindo, RabindranathTagore;

Understanding Mahatma Gandhi; A new nation is born as a republic – the pangs of birth and growth; India since Independence – the saga of socio-political movements; Problems facing the nation today; Globalization and Indian Economy; Bharatavarsha today and the way ahead: Regeneration of Indian National Resources.

Conclusion

The Wonder that was India; The 'politics' and 'purpose' of studying India.

REFERENCES:

1. *Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.*
2. *Somayaji, D. A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.*
3. *Sen, S. N. & K. V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.*
4. *Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.*
5. *Bose, D. M. et. al. A Concise History of Science in India. New Delhi: 1971.*
6. *Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
7. *Bajaj, Jitendra & M. D. Srinivas.Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
8. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*
9. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*

10. *Vivekananda, Swami. Selections from the Complete Works of Swami Vivekananda. Kolkata: Advaita Ashrama.*
11. *Mahadevan, T. M. P. Invitations to Indian Philosophy. Madras: University of Madras.*
12. *Hiriyanna, M. Outlines of Indian Philosophy. Motilal Banarsidass.*
13. *Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.*
14. *Majumdar, R. C. et. al. An Advanced History of India. Macmillan.*
15. *Mahajan, V. D. India Since 1526. New Delhi: S. Chand & Company.*
16. *Durant, Will. The Case for India. Bangalore: Strand Book Stall, 2008.*
17. *Aurobindo, Sri. The Indian Renaissance / India's Rebirth / On Nationalism.*
18. *Nivedita, Sister. The Web of Indian Life. Kolkata: Advaita Ashrama.*
19. *Durant, Will. The Story of Civilization. Volume 1 – Our Oriental Heritage. New York: Simon & Schuster.*
20. *Ranganathananda, Swami. Eternal Values for A Changing Society. Bombay: Bharatiya Vidya Bhavan.*
21. *Ranganathananda, Swami. Universal Message of the Bhagavad Gita. Kolkata: Advaita Ashrama.*
22. *Seturaman, V. S. Indian Aesthetics. Macmillan.*
23. *Coomaraswamy, Ananda K. The Dance of Shiva. New Delhi: Sagar Publications.*
24. *Coomaraswamy, Ananda K. Essays on Indian Idealism. New Delhi: Munshiram Manoharlal.*
25. *Danino, Michel. The Invasion That Never Was.*
26. *Kautilya. Arthasastra.*
27. *Altekar, A. S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
28. *Altekar, A. S. The Position of Women in Hindu Civilization. New Delhi: Motilal Banarsidass.*
29. *Sircar, D. C. Studies in the Religious Life of Ancient and Medieval India. New Delhi: Motilal Banarsidass.*
30. *Sircar, D. C. Studies in the Political and Administrative Systems in Ancient and Medieval Times.New Delhi: Motilal Banarsidass.*
31. *Madhavananda, Swami & R. C. Majumdar eds. The Great Women of India. Kolkata: Advaita Ashrama.*
32. *Dutt, R. C. The Economic History of India. London, 1902.*
33. *Dharampal. Collected Works.*
34. *Dharampal. Archival Compilations (unpublished)*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM233	**GLIMPSES OF INDIAN ECONOMY AND POLITY**	**L-T-P-C: 2-0-0-2**

Syllabus

Unit 1

Introduction

General Introduction; Primitive man and his modes of exchange – barter system; Prehistoric and proto-historicpolity and social organization.

Ancient India – up to 600 B.C.

Early India – the vedic society – the varnashramadharma – socio-political structure of the various institutions based on the four purusarthas; The structure of ancient Indian polity – Rajamandala and Cakravartins – Prajamandala;Socio-economic elements from the two great Epics – Ramayana and Mahabharata – the concept of the ideal King(Sri Rama) and the ideal state (Ramarajya) – Yudhisthira's ramarajya; Sarasvati - Sindhu civilization and India'strade links with other ancient civilizations; Towards chiefdoms and kingdoms – transformation of the polity: kingship – from gopati to bhupati; The mahajanapadas and the emergence of the srenis – states and cities of theIndo-Gangetic plain.

Unit 2

Classical India: 600B.C. – 1200 A.D.

The rise of Magadha, emergence of new religions – Buddhism and Jainism – and the resultant socio-economic impact; The emergence of the empire – the Mauryan Economy and Kautilya's Arthasastra; of Politics and trade –the rise of the Mercantile Community; Elements from the age of the Kushanas and the Great Guptas; India's maritime trade; Dharma at the bedrock of Indian polity – the concept of Digvijaya: dharma-vijaya, lobha-vijaya and asura-vijaya; Glimpses into the south Indian economies: political economies of the peninsula – Chalukyas, Rashtrakutas and Cholas

Medieval India: 1200 A.D. – 1720 A.D.

Advent of Islam – changes in the social institutions; Medieval India – agrarian economy, non-agricultural productionand urban economy, currency system; Vijayanagara samrajya and maritime trade – the story of Indian supremacyin the Indian Ocean region; Aspects of Mughal administration and economy; The Maratha and other provincial economies.

Unit 3

Modern India: 1720 - 1947

the Indian market and economy before the arrival of the European traders; Colonisation and British supremacy (dismantling of everything that was 'traditional' or 'Indian') – British attitude towards Indian trade, commerce and economy and the resultant ruining of Indian economy and business – man-made famines – the signs of renaissance:banking and other business undertakings by the natives (the members of the early Tagore family, the merchants ofSurat and Porbander, businessmen of Bombay, etc. may be referred to here) – the evolution of the modern bankingsystem; Glimpses into British administration of India and administrative models; The National movement and nationalist undertakings in business and industry: the Tatas and the Birlas; Modern India: the growth of large- scale industry – irrigation and railways –

money and credit – foreign trade; Towards partition – birth of two new nations

– division of property; The writing of the Indian Constitution – India becomes a democratic republic – a new polity is in place.

Independent India – from 1947

India since Independence – the saga of socio-political movements; Indian economy since Independence – the fiscal system – the five year plans – liberalisation – the GATT and after; Globalisation and Indian economy; Impact ofscience and (new/ emerging) technology on Indian economy; Histories of select Indian business houses and business entrepreneurship.

Conclusion

REFERENCES:

1. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*
   Kautilya. Arthasastra.

2. *Altekar, A. S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
3. *Sircar, D. C. Studies in the Political and Administrative Systems in Ancient and Medieval Times. New Delhi: Motilal Banarsidass.*
4. *Dutt, R. C. The Economic History of India. London, 1902.*
5. *Dharampal. Collected Works (Volumes IV & V).*
6. *Dharampal. Archival Compilations (unpublished).*
7. *Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
8. *Bajaj, Jitendra & M. D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
9. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*
10. *Tripathi, Dwijendra. The Oxford History of Indian Business. New Delhi: Oxford University Press, 2004.*
11. *McGuire, John, et al, eds. Evolution of World Economy, Precious Metals and India. New Delhi: Oxford University Press, 2001.*
12. *Tripathi, Dwijendra and Jyoti Jumani. The Concise Oxford History of Indian Business. New Delhi: Oxford University Press, 2007.*
13. *Kudaisya, Medha M. The Life and Times of G. D. Birla. New Delhi: Oxford University Press, 2003.*
14. *Raychaudhuri, Tapan and Irfan Haib, eds. The Cambridge Economic History of India. Volume*
15. *New Delhi: Orient Longman, 2004.*
16. *Kumar, Dharma, ed. The Cambridge Economic History of India. Volume 2. New Delhi: Orient Longman, 2005.*
17. *Sabavala, S. A. and R. M. Lala, eds. J. R. D. Tata: Keynote. New Delhi: Rupa & Co., 2004.*
18. *Mambro, Arvind ed. J. R. D. Tata: Letters. New Delhi: Rupa & Co., 2004.*
19. *Lala, R. M., For the Love of India: The Life and Times of Jamsetji Tata. New Delhi: Penguin, 2006.*
20. *Thapar, Romila. The Penguin History of Early India: From the Origins to AD 1300. New Delhi Penguin, 2002.*
21. *Majumdar, R. C., et. al. An Advanced History of India. Macmillan.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM234	HEALTH AND LIFESTYLE	L-T-P-C: 2-0-0-2

SyllabusUnit 1

Introduction to Health

Health is wealth; Role of lifestyle habits on health; Importance of adolescence; Stages, Characteristics and changes during adolescence; Nutritional needs during adolescence why healthy lifestyle is important for adolescence. Eating Habits - eating disorders, skipping breakfast, junk food consumption.

Practicals - Therapeutic Diets

Unit 2

Food and Nutritional Requirements during Adolescence

Fluid intake; nutrition related problems; lifestyle related problems, Role of physical activity; resting pattern and postures, Personal habits – alcoholism, and other tobacco products, electronic addiction etc

Practicals - Ethnic Foods

Unit 3

Need for a Positive Life Style Change

Peer pressure & procrastination, Stress, depression, suicidal tendency, Mini project review and viva, Whole portions revision.

Practical - Cooking without Fire or Wire-healthy Snacks

TEXTBOOKS:

1. *B. Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.*
2. *"Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.*

REFERENCE BOOKS:

1. *K Park “Textbook of preventive and social medicine”, 2010.*
2. *WHO Report on Adolescent Health: 2010*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM235	INDIAN CLASSICS FOR THE TWENTY-FIRST CENTURY	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Introductory study of the Bhagavad Gita and the Upanishads.

Unit 2

The relevance of these classics in a modern age.

Unit 3

Goals of human life - existential problems and their solutions in the light of these classics etc.

REFERENCE:

The Bhagavad Gita, Commentary by Swami Chinmayananda

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM236	INTRODUCTION TO INDIA STUDIES	L-T-P-C: 2-0-0-2

PREAMBLE:

This paper will introduce the students to the multiple dimensions of the contribution of India to the fields of philosophy, art, literature, physical and social sciences. The paper intends to give an insight to the students aboutthe far-reaching contributions of India to world culture and thought during the course of its long journey from thehoary antiquity to the present times. Every nation takes pride in its achievements and it is this sense of pride andreverence towards the achievements that lays the foundation for its all-round progress.

SyllabusUnit 1

A brief outline of Indian history from prehistoric times to the present times.

Contributions of India to world culture and civilization: Indian Philosophy and Religion; Art and Literature; Physical and Social Sciences.

Unit 2

Modern India: Challenges and Possibilities.

Scientific and technological progress in post-independence era; Socio-cultural and political movements after independence; Challenges before the nation today - unemployment – corruption – degradation of cultural and moral values - creation of a new system of education; Creation of a modern and vibrant society rooted in traditional values.

Unit 3

Modern Indian Writing in English: Trends in Contemporary Indian Literature in English.

TEXTBOOK:

Material given by the Faculty

BACKGROUND LITERATURE:

1. *Selections from The Cultural Heritage of India, 6 volumes, Ramakrishna Mission Institute of Culture (Kolkata) publication.*
2. *Selections from the Complete Works of Swami Vivekananda, Advaita Ashrama publication.*

3. *Invitations to Indian Philosophy, T. M. P. Mahadevan, University of Madras, Chennai.*
4. *Outlines of Indian Philosophy, M. Hiriyanna, MLBD.*
5. *An Advanced History of India, R. C. Majumdar et al, Macmillan.*
6. *India Since 1526, V. D. Mahajan, S. Chand & Company*
7. *The Indian Renaissance, Sri Aurobindo.*
8. *India's Rebirth, Sri Aurobindo.*
9. *On Nationalism, Sri Aurobindo.*
10. *The Story of Civilization, Volume I: Our Oriental Heritage, Will Durant, Simonand Schuster, New York.*
11. *Eternal Values for a Changing Society, Swami Ranganathananda, Bharatiya Vidya Bhavan.*
12. *Universal Message of the Bhagavad Gita, Swami Ranganathananda, Advaita Ashrama.*
13. *Awaken Children: Conversations with Mata Amritanandamayi*
14. *Indian Aesthetics, V. S. Seturaman, Macmillan.*
15. *Indian Philosophy of Beauty, T. P. Ramachandran, University of Madras, Chennai.*
16. *Web of Indian Thought, Sister Nivedita*
17. *Essays on Indian Nationalism, Anand Kumaraswamy*
18. *Comparative Aesthetics, Volume 2, Kanti Chandra Pandey, Chowkhamba, Varanasi*
19. *The Invasion That Never Was, Michel Danino*
20. *Samskara, U. R. Ananthamurthy, OUP.*
21. *Hayavadana, Girish Karnard, OUP.*

22. *Naga-Mandala, Girish Karnard, OUP.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM237	INTRODUCTION TO SANSKRIT LANGUAGE AND LITERATURE	L-T-P-C: 2-0-0-2

OBJECTIVES:

To familiarize students with Sanskrit language; to introduce students to various knowledge traditions in Sanskrit;to help students appreciate and imbibe India's ancient culture and values.

SyllabusUnit 1

Sanskrit Language – Vakya Vyavahara (प्रथमादीक्षा) - Introduction to Sanskrit language - Devanagari script and Sanskrit alphabet - Vowels and Consonants – Pronunciation - Classification of Consonants – Samyukthakshara Words – Nouns and Verbs - Cases – Introduction to Numbers and Time – Verbs: Singular, Dual and Plural – SarvaNamas: First Person, Second Person, Third Person – Tenses: Past, Present and Future -Words for Communication – Selected Slokas – MoralStories – Subhashithas – Riddles.

Unit 2

Language Studies - Role of Sanskrit in Indian & World Languages.

Unit 3

Introduction to Sanskrit Classical Literature – KavyaTradition – Drama Tradition - Stotra Tradition – Panchatantra Stories.

Unit 4

Introduction to Sanskrit Technical Literature – Astronomy – Physics – Chemistry – Botany – Engineering – Aeronautics – Ayurveda – Mathematics – Medicine – Architecture - Tradition of Indian Art – Administration –Agriculture.

Unit 5

Indology Studies – Perspectives and Innovations.

TEXTBOOKS AND REFERENCE BOOKS:

1. *Vakya Vyavahara- Prof. Vempaty Kutumba Sastri, Rashtriya Sanskrit Sansthan, New Delhi*
2. *The Wonder that is Sanskrit - Dr.Sampadananda Mishra, New Delhi*
3. *Science in Sanskrit – Samskritha Bharathi, NewDelhi*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM238	NATIONAL SERVICE SCHEME	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Introduction to Basic Concepts of NSS: History, philosophy, aims and objectives of NSS, Emblem, flag, motto,song, badge etc., Organisational structure, roles and responsibilities of various NSS functionaries.

NSS Programmes and Activities: Concept of regular activities, special campaigning, Day Camps, Basis of adoption of village / slums, methodology of conducting survey, financial pattern of the scheme, other youth programme/schemes of GOI, Coordination with different agencies, Maintenance of the Diary.

Unit 2

Volunteerism and Shramdan: Indian Tradition of volunteerism, Needs and importance of volunteerism, Motivation and Constraints of volunteerism, Shramdan as part of volunteerism, Amalabharatam Campaign, Swatch Bharath.

Unit 3

Understanding youth: Definition, profile and categories of youth, Issues, challenges and opportunities for youth, Youth as an agent of social change.

Youth and Yoga: History, philosophy and concept of Yoga, Myths and misconceptions about Yoga, Different Yoga traditions and their impacts, Yoga as a preventive and curative method, Yoga as a tool for healthy life style

Unit 4

Youth Development Programmes in India: National Youth Policy, Youth development programmes at the national level, state level and voluntary sector, youth-focused and youth-led organizations.

Youth and Crime: Sociological and psychological factors influencing youth crime, Peer mentoring in preventing crimes, Awareness about Anti-Ragging, Cyber Crime and its prevention, Juvenile Justice.

Unit 5

Environmental Issues: Environment conservation, enrichment and sustainability, climate change, waste management, rain water harvesting, energy conservation, waste land development.

Project Work / Practical

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM239	PSYCHOLOGY FOR EFFECTIVE LIVING	L-T-P-C: 2-0-0-2

Course Objectives

1. To help students acquire the basic knowledge of behavior and effective living
2. To create an awareness of the hazards of health compromising behaviours
3. To develop and strengthen the tools required to handle the adversities of life

Course Outcome

CO 1: Understand the basic concepts of Behavioral PsychologyCO 2:
Demonstrate self reflective skills through activities

CO 3: Apply the knowledge of psychology to relieve stress

CO 4: Analyse the adverse effects of health compromising behaviours.

CO 5: Evaluate and use guided techniques to overcome and cope with stress related problems.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						1						1
CO2						2	3		3	3		
CO3						3	3	2	1		3	2
CO4						2	2	3				1
CO5						1	2				1	1

SyllabusUnit 1

Self-Awareness & Self-Motivation

Self analysis through SWOT, Johari Window, Maslow's hierarchy of motivation, importance of self esteem and enhancement of self esteem.

Unit 2

The Nature and Coping of Stress

Conflict, Relationship issues, PTSD. Stress – stressors – eustress - distress, coping with stress, stress management techniques.

Unit 3

Application of Health Psychology

Health compromising behaviours, substance abuse and addiction.

TEXTBOOKS:

1. *V. D. Swaminathan & K. V. Kaliappan "Psychology for effective living - An introduction to Health*
2. *Psychology. 2nd edition Robert J. Gatchel, Andrew Baum & David S. Krantz, McGraw Hill.*

REFERENCE BOOKS:

1. *S. Sunder, 'Textbook of Rehabilitation', 2nd edition, Jaypee Brothers, New Delhi. 2002.*
2. *Weiben & Lloyd, 'Psychology applied to Modern Life', Thompson Learning, Asia Ltd.2004.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM240	PSYCHOLOGY FOR ENGINEERS	L-T-P-C: 2-0-0-2

Course Objectives:

1. To strengthen the fundamental knowledge of human behavior
2. To strengthen the ability to understand the basic nature and behavior of humans in organizations as awhole
3. To connect the concepts of psychology to personal and professional life

Course Outcome

CO 1: Understand the fundamental processes underlying human behavior such as learning, motivation,individual differences, intelligence and personality.

CO 2: Apply the principles of psychology in day- to- day life for a better understanding of oneself and others.CO 3: Apply the knowledge of Psychology to improve study skills and learning methods

CO 4: Apply the concepts of defense mechanisms to safeguard against abusive relationships and to nurturehealthy relationships.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3	3		3	2		1
CO2						3	3	2	3	3	1	2
CO3										2	1	
CO4							3		2	2		2

SyllabusUnit 1

Psychology of Adolescents: Adolescence and its characteristics.

Unit 2

Learning, Memory & Study Skills: Definitions, types, principles of reinforcement, techniques for improving study skills, Mnemonics.

Unit 3

Attention & Perception: Definition, types of attention, perception.

TEXTBOOKS:

1. *S. K. Mangal, "General Psychology", Sterling Publishers Pvt. Ltd.2007*
2. *Baron A. Robert, "Psychology", Prentice Hall of India. New Delhi 2001*

REFERENCE BOOKS:

1. *Elizabeth B. Hurlock, Developmental Psychology - A life span approach, 6th edition.*
2. *Feldman, Understanding Psychology, McGraw Hill, 2000.*
3. *Clifford Morgan, Richard King, John Scholper, "Introduction to Psychology", Tata Mcgraw Hill, PvtLtd 2004.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM241	SCIENCE AND SOCIETY - AN INDIAN PERSPECTIVE	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Introduction

Western and Indian views of science and technology

Introduction; Francis Bacon: the first philosopher of modern science; The Indian tradition in science andtechnology: an overview.

Unit 2

Indian sciences

Introduction; Ancient Indian medicine: towards an unbiased perspective; Indian approach to logic; The methodology of Indian mathematics; Revision of the traditional Indian planetary model by Nilakantha Somasutvan in circa 1500 AD

Science and technology under the British rule

Introduction; Indian agriculture before modernization; The story of modern forestry in India; The building ofNew Delhi

Unit 3

Science and technology in Independent India

Introduction; An assessment of traditional and modern energy resources; Green revolution: a historical perspective; Impact of modernisation on milk and oilseeds economy; Planning without the spirit and thedetermination.

Building upon the Indian tradition

Introduction; Regeneration of Indian national resources; Annamahatmyam and Annam Bahu Kurvita: recollecting the classical Indian discipline of growing and sharing food in plenty and regeneration of Indian agriculture to ensure food for all in plenty.

Conclusion

REFERENCES:

1. *Joseph, George Gheverghese. The Crest of the Peacock: Non-European Roots of Mathematics. London: Penguin (UK), 2003.*
2. *Iyengar, C. N. Srinivasa. History of Hindu Mathematics. Lahore: 1935, 1938 (2 Parts).*
3. *Amma, T. A. Saraswati. Geometry in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.*
4. *Bag, A. K. Mathematics in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.*
5. *Sarma K. V. & B. V. Subbarayappa. Indian Astronomy: A Source-Book. Bombay: Nehru Centre, 1985.*
6. *Sriram, M. S. et. al. eds. 500 Years of Tantrasangraha: A Landmark in the History of Astronomy. Shimla: Indian Institute of Advanced Study, 2002.*
7. *Bajaj, Jitendra & M. D. Srinivas. Restoring the Abundance: Regeneration of Indian Agriculture to Ensure Food for All in Plenty.Shimla: Indian Institute of Advanced Study, 2001.*
8. *Bajaj, Jitendra ed. Report of the Seminar on Food for All: The Classical Indian Discipline of Growingand Sharing Food in Plenty. Chennai: Centre for Policy Studies, 2001.*
9. *Bajaj, Jitendra & M. D. Srinivas. Annam Bahu Kurvita: Recollecting the Indian Discipline of Growingand Sharing Food in Plenty. Madras: Centre for Policy Studies, 1996.*
10. *Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.*
11. *Somayaji, D. A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.*
12. *Sen, S. N. & K. V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.*
13. *Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.*
14. *Bose, D. M. et. al. A Concise History of Science in India. New Delhi: 1971.*
15. *Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*

16. *Bajaj, Jitendra & M. D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
17. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*
18. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*

** The syllabus and the study material in use herein has been developed out of a 'summer programme' offered by the Centre for Policy Studies (CPS), Chennai at the Indian Institute of Advanced Study (IIAS), Rashtrapati Nivas, Shimla, sometime ago. The same has been very kindly made available to us by Professors Dr M.D. Srinivas (Chairman) and Dr J.K. Bajaj (Director) of the CPS.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM242	THE MESSAGE OF BHAGWAD GITA	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Introduction: Relevance of Bhagavad Gita today – Background of Mahabharatha. ArjunaVishada

Yoga: Arjuna's Anguish and Confusion – Symbolism of Arjuna's Chariot.

Sankhya Yoga: Importance of Self-knowledge – Deathlessness: Indestructibility of Consciousness – Being Established in Wisdom – Qualities of a Sthita-prajna.

Unit 2

Karma Yoga: Yoga of Action – Living in the Present – Dedicated Action without Anxiety over Results - Conceptof Swadharma.

Dhyana Yoga: Tuning the Mind – Quantity, Quality and Direction of Thoughts – Reaching Inner Silence.

Unit 3

Bhakti Yoga: Yoga of Devotion – Form and Formless Aspects of the Divine – Inner Qualities of a True Devotee.

GunatrayaVibhaga Yoga: Dynamics of the Three Gunas: Tamas, Rajas, Sattva – Going Beyond the Three Gunas – Description of a Gunatheetha.

TEXTBOOKS / REFERENCES:

1. *Swami Chinmayananda, "The Holy Geeta", Central Chinmaya Mission Trust, 2002.*
2. *Swami Chinmayananda, "A Manual of Self Unfoldment", Central Chinmaya Mission Trust, 2001.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	

Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM243	THE MESSAGE OF THE UPANISHADS	L-T-P-C: 2-0-0-2

OBJECTIVES:

To give students an introduction to the basic ideas contained in the Upanishads; and explores how their messagecan be applied in daily life for achieving excellence.

SyllabusUnit 1

An Introduction to the Principal Upanishads and the Bhagavad Gita - Inquiry into the mystery of nature - Sruti

versus Smrti - Sanatana Dharma: its uniqueness - The Upanishads and Indian Culture - Upanishads and ModernScience.

Unit 2

The challenge of human experience & problems discussed in the Upanishads – the True nature of Man – theMoving power of the Spirit – The Message of Fearlessness – Universal Man - The central problems of theUpanishads – Ultimate reality – the nature of Atman - the different manifestations of consciousness.

Unit 3

Upanishad Personalities - episodes from their lives and essential teachings: Yajnavalkya, Aruni, Uddalaka, Pippalada,Satyakama Jabala, Svetaketu, Nachiketas, Upakosala, Chakrayana Ushasti, Raikva, Kapila and Janaka. Important verses from Upanishads - Discussion of Sage Pippalada's answers to the six questions in Prasnopanishad.

REFERENCES:

1. *The Message of the Upanishads by Swami Ranganathananda, Bharatiya Vidya Bhavan*
2. *Eight Upanishads with the commentary of Sankaracharya, Advaita Ashrama*
3. *Indian Philosophy by Dr. S. Radhakrishnan, Oxford University Press*
4. *Essentials of Upanishads by R L Kashyap, SAKSI, Bangalore*
5. *Upanishads in Daily Life, Sri Ramakrishna Math, Mylapore.*
6. *Eternal stories of the Upanishads by Thomas Egenes and Kumuda Reddy*
7. *Upanishad Ganga series – Chinmaya Creations*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	

End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM244	UNDERSTANDING SCIENCE OF FOOD AND NUTRITION	L-T-P-C: 2-0-0-2

Course Objectives:

- To introduce the significance of food, nutrients, locally available food resources, synergic food combinations, good cooking methods and importance of diversity in foods
- To understand nutritional imbalances and chronic diseases associated with the quality of food.
- To gain awareness about the quality of food - Organic food, genetically modified food, adulterated food,allergic food, , food poisoning and food safety.
- To understand food preservation processing, packaging and the use of additives.

Course Outcome:

CO1: Acquire knowledge about the various food and food groups

CO2: Understand nutritional imbalances and chronic diseases prevailing among different age groups.CO3: Understand the significance of safe food and apply the food safety standards

CO4: Demonstrate skills of food processing, preservation and packaging methods with or without additives CO5: Evaluate the quality of food based on the theoretical knowledge of Food and Nutrition

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1		1	1			1	2	1	1	1	1	3
CO 2		1	1			1	1	1	1	1	1	3
CO 3		1	1			1	1	1	1	1	1	3
CO 4		1	1			1	1	1	1	1	1	3
CO 5		1	1			1	2	1	2	1	1	3

SyllabusUnit 1

Food and Food Groups

Introduction to foods, food groups, locally available foods, Nutrients, Cooking methods, Synergy between foods, Science behind foods, Food allergies, food poisoning, food safety standards.

Cookery Practicals - Balanced Diet

Unit 2

Nutrients and Nutrition

Nutrition through life cycle, RDA, Nutrition in disease, Adulteration of foods & Food additives, Packaging and labeling of foods.

Practicals - Traditional Foods

Unit 3

Introduction to Food Biotechnology

Future foods - Organic foods and genetically modified foods, Fortification of foodsvalue addition of foods, functional foods, Nutraceuticals, supplementary foods, Processing and preservation of foods, applications of food technology in daily life, and your prospects associated with food industry – Nanoparticles, biosensors, advancedresearch.

Practicals - Value added foods

TEXTBOOKS:

1. *N. Shakuntalamanay, M. Shadaksharaswamy, "Food Facts and principles", New age international (P) ltd, publishers, 2005.*
2. *B. Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.*

REFERENCE BOOKS:

1. *B. Srilakshmi, "Food Science", New age international (P) ltd, publishers, 2008.*
2. *"Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23JAP230	PROFICIENCY IN JAPANESE LANGUAGE (LOWER)	L-T-P-C: 2-0-0-2

Syllabus

This paper will introduce the basics of Japanese language. Students will be taught the language through various activities like writing, reading, singing songs, showing Japanese movies etc. Moreover this paper intends to givea thorough knowledge on Japanese scripts that is Hiragana and Katakana. Classes will be conducted throughoutin Japanese class only. Students will be able to make conversations with each other in Japanese. Students can make self-introduction and will be able to write letters in Japanese. All the students will be given a text on Japanese verbs and tenses.

Students can know about the Japanese culture and the lifestyle. Calligraphy is also a part of this paper. Informal sessions will be conducted occasionally, in which students can sing Japanese songs, watch Japanese movies, do Origami – pattern making using paper.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23JAP231	PROFICIENCY IN JAPANESE LANGUAGE (HIGHER)	L-T-P-C: 2-0-0-2

Syllabus

Students will be taught the third and the most commonly used Japanese script, Kanji. Students will be taught towrite as well as speak.

Students will be given detailed lectures on Calligraphy.

This version of the course includes a new project where the students should make a short movie in Japaneselanguage selecting their own topics.

By the end of the semester they the students will master the subject in all means. They will be able to speak Japanese as fluently as they speak English. Students will be encouraged to write stories and songs in Japaneselanguage themselves.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23KAN230	KANNADA I	L-T-P-C: 2-0-0-2

OBJECTIVES:

To enable the students to acquire basic skills in functional language; to develop independent reading skills andreading for appreciating literary works; to analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech.

SyllabusUnit 1

Adalitha Kannada: bhashe, swaroopa, belavanigeya kiru parichaya Paaribhaashika padagalu

Vocabulary Building

Unit 2

Prabhandha – Vyaaghra Geethe - A. N. Murthy Rao

Prabhandha – Barededi…baredidi, Baduku mugiyuvudilla allige…- Nemi Chandra Paragraph writing –Development: comparison, definition, cause & effect Essay – Descriptive & Narrative

Unit 3

Mochi – Bharateepriya

Mosarina Mangamma – Maasti Venkatesh Iyengar Kamalaapurada Hotelnalli – Panje Mangesh Rao Kaanike – B.

M. Shree

Geleyanobbanige bareda Kaagada – Dr. G. S. Shivarudrappa Moodala Mane – Da. Ra. Bendre
Swathantryada Hanate – K. S. Nissaar Ahmed

Unit 4

Letter W riting - Personal: Congratulation, thanks giving, invitation, condolence

Unit 5

Reading Comprehension; nudigattu, gaadegalu Speaking Skills: Prepared speech, pick and speak

REFERENCES:

1. *H. S. Krishna Swami Iyangar – Adalitha Kannada – Chetana Publication, Mysuru*
2. *N. Murthy Rao – Aleyuva Mana – Kuvempu Kannada Adyayana Samste*
3. *Nemi Chandra – Badhuku Badalisabahudu – Navakarnataka Publication*
4. *Sanna Kathegalu - Prasaranga, Mysuru University , Mysuru*
5. *B. M. Shree – Kannadada Bavuta – Kannada Sahitya Parishattu*
6. *K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna Book House (P) Ltd.*
7. *Dr. G. S. Shivarudrappa – Samagra Kavya – Kamadhenu Pustaka Bhavana*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23KAN231	KANNADA II	L-T-P-C: 2-0-0-2

OBJECTIVES:

To enable the students to acquire basic skills in functional language; to develop independent reading skills andreading for appreciating literary works; to develop functional and creative skills in language; to enable the students to plan, draft, edit & present a piece of writing.

SyllabusUnit 1

Official Correspondence: Adhikrutha patra, prakatane, manavi patra, vanijya patra

Unit 2

Nanna Hanate - Dr. G. S. Shivarudrappa

Mankuthimmana Kaggada Ayda bhagagalu – D. V. Gundappa (Padya Sankhye 5, 20, 22, 23, 25, 44, 344, 345,

346, 601)

Ella Marethiruvaga - K. S. Nissaar Ahmed Saviraru Nadigalu – S Siddalingayya

Unit 3

Sayo Aata – Da. Ra. Bendre

Unit 4

Sarva Sollegala turtu Maha Samelana - Beechi Swarthakkaagi Tyaga - Beechi

Unit 5

Essay writing: Argumentative & Analytical Précis writing

REFERENCES:

1. *H. S. Krishnaswami Iyangar – Adalitha Kannada – Chetan Publication, Mysuru*
2. *Dr. G. S. Shivarudrappa – Samagra Kavya. - Kamadhenu Pustaka Bhavana*
3. *Shrikanth - Mankuthimmana Kagga – Taatparya – Sri Ranga Printers & Binders*

4. *K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna book house*
5. *Dr. Da. Ra. Bendre – Saayo Aata – Shri Maata Publication*
6. *Beechi – Sahukara Subbamma – Sahitya Prakashana*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23MAL230	MALAYALAM I	L-T-P-C: 2-0-0-2

Course Objectives:

To appreciate the aesthetics & cultural implications; to enhance creative thinking in mother0-tongue; to learn ourculture & values; to equip students read & write correct Malayalam; to correct the mistakes in pronunciation; to create awareness that good language is the sign of complete personality

Course Outcome:

After the completion of the course the student will be able to:

CO1: Understand and inculcate philosophical thoughts and practices CO2: Understand and appreciate the post modern trends of literature.

CO3: Analyse the literary texts and comprehend the cultural diversity of KeralaCO4: Distinguish the different genres in Malayalam literature

CO5: Demonstrate the ability to effectively communicate in Malayalam

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	**2**	**3**	-	-
CO2	-	-	-	-	-	-	-	-	**2**	**3**	-	-
CO3	-	-	-	-	-	-	-	-	**2**	**3**	-	-
CO4	-	-	-	-	-	-	-	-	**-**	**3**	-	-
CO5	-	-	-	-	-	-	-	-	**1**	**1**	-	-

SyllabusUnit 1

Ancient poet trio: Adhyatmaramayanam,

Lakshmana Swanthanam (valsa soumitre… mungikidakayal), Ezhuthachan - Medieval period classics –Jnanappana (kalaminnu… vilasangalingane), Poonthanam

Unit 2

Modern Poet trio: Ente Gurunathan, Vallathol Narayana Menon - Critical analysis of the poem.

Unit 3

Short stories from period 1/2/3, Poovanpazham - Vaikaom Muhammed Basheer - Literary & Cultural figures ofKerala and about their literary contributions.

Unit 4

Literary Criticism: Ithihasa studies - Bharatha Paryadanam - Vyasante Chiri - Kuttikrishna Mararu - Outline of literary Criticism in Malayalam Literature - Introduction to Kutti Krishna Mararu & his outlook towards literature & life.

Unit 5

Error-free Malayalam: 1. Language; 2. Clarity of expression; 3. Punctuation – Thettillatha Malayalam

Writing - a. Expansion of ideas; b .Precis Writing; c. Essay Writing; d. Letter writing; e. Radio Speech; f. Script /Feature / Script Writing; g. News Editing; h. Advertising; i. Editing; j. Editorial Writing; k. Critical appreciation of literary works (Any one or two as an assignment).

REFERENCES:

1. *P. K. Balakrishnanan, Thunjan padhanangal, D. C. Books, 2007.*
2. *G. Balakrishnan Nair, Jnanappanayum Harinama Keerthanavum, N. B. S, 2005.*
3. *M. N. Karasseri, Basheerinte Poonkavanam, D. C. Books, 2008.*
4. *4 M. N. Vijayan, Marubhoomikal Pookkumbol, D. C. Books, 2010.*
5. *M. Thomas Mathew, Lavanyanubhavathinte Yukthisasthram, National Book Stall, 2009.*
6. *M. Leelavathy, Kavitha Sahityacharitram, National Book Stall, 1998.*
7. *Thayattu Sankaran, Vallathol Kavithapadhanam, D. C. Books, 2004.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23MAL231	MALAYALAM II	L-T-P-C: 2-0-0-2

OBJECTIVES:

To appreciate the aesthetics & cultural implications; to enhance creative thinking in mother-tongue; to learn our culture & values; to equip students read & write correct Malayalam; to correct the mistakes in pronunciation; tocreate awareness that good language is the sign of complete personality.

Course Outcome:

After the completion of the course the student will be able to:

CO1: Understand the different cultural influences in linguistic translationCO2: Identify and appreciate the Romantic elements of modern literatureCO3: Analyze the genre of autobiographical writing

CO4: Critically evaluate the significance of historical, political and socio cultural aspects in literatureCO5: Demonstrate good writing skills in Malayalam

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	**2**	**3**	-	-
CO2	-	-	-	-	-	-	-	-	**2**	**3**	-	-
CO3	-	-	-	-	-	-	-	-	**2**	**3**	-	-
CO4	-	-	-	-	-	-	-	-	**-**	**3**	-	-
CO5	-	-	-	-	-	-	-	-	**1**	**1**	-	-

SyllabusUnit 1

Ancient poet trio: Kalayanasougandhikam, (kallum marangalun… namukkennarika vrikodara) Kunjan Nambiar - Critical analysis of his poetry - Ancient Drama: Kerala Sakunthalam (Act 1), Kalidasan (Translated by Attor Krishna Pisharody).

Unit 2

Modern / romantic / contemporary poetry: Manaswini, Changampuzha Krishna Pillai – Romanticism – modernism.

Unit 3

Anthology of short stories from period 3/4/5: Ninte Ormmayku, M. T. Vasudevan Nair - literary contributions of his time

Unit 4

Part of an autobiography / travelogue: Kannerum Kinavum, V. T. Bhattathirippadu - Socio-cultural literature - historical importance.

Unit 5

Error-free Malayalam - 1. Language; 2. Clarity of expression; 3. Punctuation - Thettillatha Malayalam

W riting - a. Expansion of ideas; b. Précis Writing ; c. Essay Writing; d. Letter writing; e. Radio Speech; f. Script /Feature / Script Writing; g. News Editing; h. Advertising; i. Editing; j. Editorial Writing; k. Critical appreciationof literary works (Any one or two as an assignment).

REFERENCES:

1. *Narayana Pillai. P. K, Sahitya Panchanan. Vimarsanathrayam, Kerala Sahitya Academy, 2000*
2. *Sankunni Nair. M. P, Chathravum Chamaravum, D. C. Books, 2010.*
3. *Gupthan Nair. S, Asthiyude Pookkal, D. C Books. 2005*
4. *Panmana Ramachandran Nair, Thettillatha Malayalam, Sariyum thettum etc., D. C. Book, 2006.*
5. *M. Achuthan, Cherukatha-Innale, innu, National Book Stall, 1998.*
6. *N. Krishna Pillai, Kairaliyude Katha, National Book Stall, 2001.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23SAN230	SANSKRIT I	L-T-P-C: 2-0-0-2

OBJECTIVES:

To familiarize students with Sanskrit language and literature; to enable them to read and understand Sanskritverses and sentences; to help them acquire expertise for self- study of Sanskrit texts and communication in Sanskrit; to help the students imbibe values of life and Indian culture as propounded in scriptures.

SyllabusUnit 1

Introduction to Sanskrit language, Devanagari script - Vowels and consonants, pronunciation, classification of

consonants, conjunct consonants, words – nouns and verbs, cases – introduction, numbers, Pronouns,communicating time in Sanskrit. Practical classes in spoken Sanskrit

Unit 2

Verbs- Singular, Dual and plural – First person, Second person, Third person. Tenses – Past, Present and Future – Atmanepadi and Parasmaipadi-karthariprayoga

Unit 3

Words for communication, slokas, moral stories, subhashithas, riddles (from the books prescribed)

Unit 4

Selected slokas from Valmiki Ramayana, Kalidasa's works and Bhagavad Gita. Ramayana – chapter VIII - verse5, Mahabharata - chapter 174, verse -16, Bhagavad Gita – chapter - IV verse 8, Kalidasa's Sakuntalam Act IV – verse 4

Unit 5

Translation of simple sentences from Sanskrit to English and vice versa.

ESSENTIAL READING:

1. *Praveshaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore - 560 085*
2. *Sanskrit Reader I, II and III, R. S. Vadhyar and Sons, Kalpathi, Palakkad*
3. *Prakriya Bhashyam written and published by Fr. John Kunnappally*
4. *Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston*
5. *Sabdamanjari, R. S. Vadyar and Sons, Kalpathi, Palakkad*

6. *Namalinganusasanam by Amarasimha published by Travancore Sanskrit series*
7. *Subhashita Ratna Bhandakara by Kashinath Sharma, published by Nirnayasagar press*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23SAN231	SANSKRIT II	L-T-P-C: 2-0-0-2

OBJECTIVES:

To familiarize students with Sanskrit language and literature; to enable them to read and understand Sanskritverses and sentences; to help them acquire expertise for self- study of Sanskrit texts and communication in Sanskrit; to help the students imbibe values of life and Indian culture as propounded in scriptures.

SyllabusUnit 1

Seven cases, indeclinables, sentence making with indeclinables, Saptha karakas.

Unit 2

Ktavatu Pratyaya, Upasargas, Ktvanta, Tumunnanta, Lyabanta. Three Lakaras – brief introduction, Lot lakara.

Unit 3

W ords and sentences for advanced communication. Slokas, moral stories (Pancatantra) Subhashitas, riddles.

Unit 4

Introduction to classical literature, classification of Kavyas, classification of Dramas - The five Mahakavyas, selected slokas from devotional kavyas- Bhagavad Gita – chapter - II verse 47, chapter - IV verse 7, chapter -VI verse 5, chapter - VIII verse 6, chapter - XVI verse 21, Kalidasa's Sakuntala act IV – verse 4, Isavasyopanishat 1st Mantra, Mahabharata chapter 149 verses 14 - 120, Neetisara chapter - III

Unit 5

Translation of paragraphs from Sanskrit to English and vice versa.

ESSENTIAL READING:

1. *Praveshaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore -560 085*
2. *Sanskrit Reader I, II and III, R.S. Vadhyar and Sons, Kalpathi, Palakkad*
3. *Prakriya Bhashyam written and published by Fr. John Kunnappally*
4. *Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston*
5. *Sabdamanjari, R. S. Vadyar and Sons, Kalpathi, Palakkad*
6. *Namalinganusasanam by Amarasimha published by Travancore Sanskrit series*
7. *Subhashita Ratna Bhandakara by Kashinath Sharma, published by Nirnayasagar Press.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23SWK230	CORPORATE SOCIAL RESPONSIBILITY	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Understanding CSR - Evolution, importance, relevance and justification. CSR in the Indian context, corporate strategy. CSR and Indian corporate. Structure of CSR - In the Companies Act 2013 (Section 135); Rules underSection 13; CSR activities, CSR committees, CSR policy, CSR expenditure CSR reporting.

Unit 2

CSR Practices & Policies - CSR practices in domestic and international area; Role and contributions of voluntary organizations to CSR initiatives. Policies; Preparation of CSR policy and process of policy formulation; Government expectations, roles and responsibilities. Role of implementation agency in Section 135 of the Companies Act, 2013. Effective CSR implementation.

Unit 3

Project Management in CSR initiatives - Project and programme; Monitoring and evaluation of CSR Interventions. Reporting - CSR Documentation and report writing. Reporting framework, format and procedure.

REFERENCES:

1. *Corporate Governance, Ethics and Social Responsibility, V Bala Chandran and V Chandrasekaran, PHI learning Private Limited, New Delhi 2011.*
2. *White H. (2005) Challenges in evaluating development effectiveness: Working paper 242, Institute of Development Studies, Brighton.*
3. *UNDP (nd) Governance indicators: A users guide. Oslo: UNDP*
4. *Rao, Subbha (1996) Essentials of Human Resource Management and Industrial Relations, Mumbai, Himalaya*
5. *Rao, V. S. L. (2009) Human Resource Management, New Delhi, Excel Books,*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23SWK231	WORKPLACE MENTAL HEALTH	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Mental Health – concepts, definition, Bio-psycho-social model of mental health. Mental health and mental illness, characteristics of a mentally healthy individual, Signs and symptoms of mental health issues, presentation of a mentally ill person. Work place – definition, concept, prevalence of mental health issues in the work place, whyinvest in workplace mental health, relationship between mental health and productivity, organizational culture and mental health. Case Study, Activity.

Unit 2

Mental Health Issues in the Workplace: Emotions, Common emotions at the workplace, Mental Health issues - Anger, Anxiety, Stress & Burnout, Depression, Addictions – Substance and Behavioural, Psychotic Disorders - Schizophrenia, Bipolar Disorder, Personality disorders. Crisis Situations - Suicidal behavior, panic attacks, reactions to traumatic events. Stigma and exclusion of affected employees. Other issues –work-life balance, Presenteeism, Harassment, Bullying, Mobbing. Mental Health First Aid - Meaning. Case Study, Activity.

Unit 3

Strategies of Help and Care: Positive impact of work on health, Characteristics of mentally healthy workplace, Employee and employer obligations, Promoting mental health and well being- corporate social responsibility (CSR), an inclusive work environment, Training and awareness raising, managing performance, inclusive recruitment, Supporting individuals-talking about mental health, making reasonable adjustments, Resources and support for employees - Employee Assistance Programme / Provider (EAP), in house counsellor, medical practitioners, online resources and telephone support, 24 hour crisis support, assistance for colleagues and care givers, Legislations. Case Study, Activity.

REFERENCES:

1. *American Psychiatric Association. "Diagnostic and statistical manual of mental disorders: DSM-IV 4th ed." www.terapiacognitiva.eu/dwl/dsm5/DSM-IV.pdf*
2. *American Psychiatric Association. (2000) www.ccsa.ca/Eng/KnowledgeCentre/OurDatabases/Glossary/Pages/index.aspx.*

3. *Canadian Mental Health Association, Ontario "Workplace mental health promotion, A how to guide"wmhp.cmhaontario.ca/*
4. *Alberta Health Services Mental Health Promotion. (2012). Minding the Workplace: Tips for employees and managers together. Calgary: Alberta Health Services.http:// www.mentalhealthpromotion.net/resources/minding-the-workplace-tips-for-employees-and- managers-together.pdf*
5. *Government of Western Australia, Mental Health Commission. (2014) "Supporting good mental health in the work place." http://www.mentalhealth.wa.gov.au/Libraries/pdf_docs/ supporting_good_mental_health_in_the_workplace_1.sflb.ashx*
6. *Mental Health Act 1987 (India) www.tnhealth.org/mha.htm*
7. *Persons with disabilities Act 1995 (India) socialjustice.nic.in*
8. *The Factories Act 1948 (India) www.caaa.in/Image/19ulabourlawshb.pdf*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23TAM230	TAMIL I	L-T-P-C: 2-0-0-2

Course Objectives:

- To introduce the students to different literature- Sangam literature, Epics, Bhakthi literatureandmodern literature.
- To improve their ability tocommunicate with creative concepts, and also to introduce them to theusefulness of basicgrammaticalcomponents in Tamil.

Course Outcomes

CO 1: To understand the Sangam literatureCO 2:
To understand the creative literature

CO 3: To understand the literary work on religious scripturesCO 4:
To improve the communication and memory skills

CO 5: To understand the basic grammar components of Tamil language and their usage and applications.CO 6:
Understand creative writing aspects and apply them.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			-	-	-	-	-	-	2	2	-	-
CO2			-	-	-	-	-	-	2	2	-	-
CO3			-	-	-	-	-	-	2	2	-	-
CO4			-	-	-	-	-	-	2	2	-	-
CO5			-	-	-	-	-	-	2	2	-	-
CO6			-	-	-	-	-	-	2	2	-	-

SyllabusUnit1

The history ofTamilliterature: Nāṭṭupuṟap pāṭalkaḷ, kataikkaḷ, paḻamoḻikaḷ - ciṟukataikaḷ tōṟṟamum vaḷarcciyum, ciṟṟilakkiyaṅkaḷ: Kaliṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.

Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai naṭaiyiyal āyvu maṟṟum aimperum – aiñciṟuṅ kāppiyaṅkaḷ toṭarpāṉa ceytikaḷ.

Unit 2

tiṇai ilakkiyamum nītiyilakkiyamum - patiṉeṇkīḻkkaṇakku nūlkaḷ toṭarpāṉa piṟa ceytikaḷ - tirukkuṟaḷ (aṉpu, paṇpu, kalvi, oḻukkam, naṭpu, vāymai, kēḷvi, ceynaṉṟi, periyāraittuṇakkōṭal, viḻippuṇarvu pēṉṟa atikārattil uḷḷa ceytikaḷ.

Aṟanūlkaḷ: Ulakanīti (1-5) – ēlāti (1,3,6). - Cittarkaḷ: Kaṭuveḷi cittar pāṭalkaḷ (āṉantak kaḷippu –1, 4, 6, 7,

8) , maṟṟum akappēy cittar pāṭalkaḷ (1-5).

Unit 3

tamiḻ ilakkaṇam: Vākkiya vakaikaḷ – taṉviṉai piṟaviṉai – nērkkūṟṟu ayaṟkūṟṟu

Unit 4

tamiḻaka aṟiñarkaḷiṉ tamiḻ toṇṭum camutāya toṇṭum: Pāratiyār, pāratitācaṉ, paṭṭukkōṭṭai kalyāṇacuntaram, curatā, cujātā, ciṟpi, mēttā, aptul rakumāṉ, na.Piccaimūrtti, akilaṉ, kalki, jī.Yū.Pōp, vīramāmuṉivar, aṇṇā, paritimāṟ kalaiñar, maṟaimalaiyaṭikaḷ.

Unit 5

tamiḻ moḻi āyvil kaṇiṉi payaṉpāṭu. - Karuttu parimāṟṟam - viḷampara moḻiyamaippu – pēccu - nāṭakam paṭaippu -ciṟukatai, katai, putiṉam paṭaippu.

Textbooks:

1. http:/Www.tamilvu.trg/libirary/libindex.htm.
2. http:/Www.tunathamizh.tom/2013/07/blog0post_24.html
3. Mu.Varatarācaṉ “tamiḻ ilakkiya varalāṟu” cāhitya akaṭemi papḷikēṣaṉs, 2012
4. nā.Vāṉamāmalai “paḻaṅkataikaḷum, paḻamoḻikaḷum” niyū ceñcuri puttaka veḷiyīṭṭakam,
5. 1980,2008
6. nā.Vāṉamāmalai, “tamiḻar nāṭṭuppāṭalkaḷ” niyū ceñcuri puttaka veḷiyīṭṭakam 1964,2006
7. poṉ maṇimāṟaṉ “aṭōṉ tamiḻ ilakkaṇam “aṭōṉ papḷiṣiṅ kurūp, vañciyūr,
8. tiruvaṉantapuram, 2007.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23TAM231	TAMIL II	L-T-P-C: 2-0-0-2

Course Objectives

- To learn the history of Tamil literature.
- To analyze different styles of Tamil Language.
- To strengthen the creativity in communication, Tamil basic grammar and use of computer on TamilLanguage.

Course Outcomes

CO 1: Understand the history of Tamil literature.

CO 2: Apply practical and comparative analyses on literature.

CO 3: Understand thinai literature, literature on justice, Pathinenkeelkanaku literature.CO 4: Understand the tamil scholars' service to Tamil language and society.

CO 5: Understand components of Tamil grammar and its usageCO 6: Understand creative writing aspects and apply them

CO-PO Mapping

PO/PSO												
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			-	-	-	-	-	-	2	2	-	-
CO2			-	-	-	-	-	-	2	2	-	-
CO3			-	-	-	-	-	-	2	2	-	-
CO4			-	-	-	-	-	-	2	2	-	-
CO5			-	-	-	-	-	-	2	2	-	-
CO6			-	-	-	-	-	-	2	2	-	-

SyllabusUnit 1

The history ofTamilliterature: Nāṭṭupuṟap pāṭalkaḷ, kataikkaḷ, paḻamoḻikaḷ - ciṟukataikaḷ tōṟṟamum vaḷarcciyum, ciṟṟilakkiyaṅkaḷ: Kaliṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.

Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai naṭaiyiyal āyvu maṟṟum aimperum – aiñciṟuṅ kāppiyaṅkaḷ toṭarpāṉa ceytikaḷ.

Unit 2

tiṇai ilakkiyamum nītiyilakkiyamum - patiṉeṇkīḻkkaṇakku nūlkaḷ toṭarpāṉa piṟa ceytikaḷ - tirukkuṟaḷ (aṉpu, paṇpu, kalvi, oḻukkam, naṭpu, vāymai, kēḷvi, ceynaṉṟi, periyāraittuṇakkōṭal, viḻippuṇarvu pēṉṟa atikārattil uḷḷa ceytikaḷ.

Aṟanūlkaḷ: Ulakanīti (1-5) – ēlāti (1,3,6). - Cittarkaḷ: Kaṭuveḷi cittar pāṭalkaḷ (āṉantak kaḷippu –1, 4, 6, 7, 8), maṟṟum akappēy cittar pāṭalkaḷ (1-5).

Unit 3

tamiḻ ilakkaṇam: Vākkiya vakaikaḷ – taṉviṉai piṟaviṉai – nērkkūṟṟu ayaṟkūṟṟu

Unit 4

tamiḻaka aṟiñarkaḷiṉ tamiḻ toṇṭum camutāya toṇṭum: Pāratiyār, pāratitācaṉ, paṭṭukkōṭṭai kalyāṇacuntaram, curatā, cujātā, ciṟpi, mēttā, aptul rakumāṉ, na.Piccaimūrtti, akilaṉ, kalki, jī.Yū.Pōp, vīramāmuṉivar, aṇṇā, paritimāṟ kalaiñar, maṟaimalaiyaṭikaḷ.

Unit 5

tamiḻ moḻi āyvil kaṇiṉi payaṉpāṭu. - Karuttu parimāṟṟam - viḷampara moḻiyamaippu – pēccu - nāṭakam paṭaippu -ciṟukatai, katai, putiṉam paṭaippu.

Text Books / References

http:/Www.tamilvu.trg/libirary/libindex.htm. http:/Www.tunathamizh.tom/2013/07/blog0post_24.html
Mu.Varatarācaṉ “tamiḻ ilakkiya varalāṟu” cāhitya akaṭemi papḷikēṣaṉs, 2012

nā.Vāṉamāmalai “paḻaṅkataikaḷum, paḻamoḻikaḷum” niyū ceñcuri puttaka veḷiyīṭṭakam, 1980,2008
nā.Vāṉamāmalai, “tamiḻar nāṭṭuppāṭalkaḷ” niyū ceñcuri puttaka veḷiyīṭṭakam 1964,2006 poṉ maṇimāṟaṉ “aṭōṉ tamiḻ ilakkaṇam “aṭōṉ papḷiṣiṅ kurūp, vañciyū

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.