AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

(AMRITAPURI, BENGALURU, COIMBATORE, CHENNAI)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B. Tech. in ELECTRICAL AND COMPUTER ENGINEERING

(BTC-ELC)

CURRICULUM AND SYLLABI

(2023)

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
Cr	-	Credits
ENGG	-	Engineering Sciences (including General, Core and Electives)
HUM	-	Humanities (including Languages and others)
SCI	-	Basic Sciences (including Mathematics)
PRJ	-	Project Work (including Seminars)
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 and Computer Engineering
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
ELC	-	Electrical and Computer Engineering
HUM	-	Humanities
MAT	-	Mathematics
MEE	-	Mechanical Engineering
PHY	-	Physics

Program Educational Objectives (PEOs)

PEO1: Graduate can demonstrate electrical and computer engineering problem solving skill along with proficiency in communication and professional excellence in project management and execution.

PEO2: Graduate can be employable in engineering services including ICT enabled sectors and also motivated for entrepreneurship.

PEO3: Graduate will be competent for higher studies in world class universities and research in industrial organizations.

PEO4: Graduate will manifest social commitment, environmental awareness and moral and ethical values in professional and other discourses.

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 behaviour 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 behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

Program Outcomes (POs) for B.Tech in Electrical and Computer 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.

Program Specific Outcomes (PSOs)

PSO1: Design and develop autonomous systems by integrating knowledge of electrical and computer engineering domains.

PSO2: Apply computational and networking skills for secured smart electrical systems.

PSO3: Innovate sustainable solutions for interdisciplinary domains using emerging technologies and data-driven approaches.

CURRICULUM

SEMESTER I

Cat.	Code	Title	L T P	Credit
HUM	23ENG101	Technical Communication	2 0 3	3
SCI	23MAT122	Calculus, Matrix Algebra and Ordinary Differential Equations	3 1 0	4
ENGG	23ELC101	Problem Solving and Algorithmic Thinking	1 0 2	2
ENGG	23MEE102	Engineering Graphics and 3D Modelling	2 0 3	3
SCI	23PHY105/23CHY109	Engineering Physics - A/Engineering Chemistry – B	2 1 0	3
SCI	23PHY185/23CHY188	Engineering Physics Lab - A/Engineering Chemistry Lab – B	0 0 3	1
ENGG	23MEE182	Manufacturing Practice-B	0 0 3	1
HUM	22ADM101	Foundations of Indian Heritage	2 0 1	2
HUM	22AVP103	Mastery Over Mind	1 0 2	2
		Total	28	21

SEMESTER II

Cat.	Code	Title	L T P	Credit
SCI	23MAT125	Complex Analysis and Transforms	3 1 0	4
SCI	23PHY105/23CHY109	Engineering Physics – A/Engineering Chemistry - B	2 1 0	3
ENGG	23ELC111	Electrical Circuit Analysis	3 0 0	3
ENGG	23ELC112	Electronic Devices & Circuits	3 0 0	3
ENGG	23ELC113	Digital Electronics	3 0 0	3
ENGG	23ELC114	Computer Programming	2 0 2	3
ENGG	23EEE183	Electrical Engineering Practice	0 0 2	1
ENGG	23ELC181	Electrical, Electronics & Digital lab	0 0 2	1
SCI	23PHY185/23CHY188	Engineering Physics Lab –A/ Engineering Chemistry Lab - B	0 0 3	1
HUM	22ADM111	Glimpses of Glorious India	2 0 1	2
		Total	28	24

SEMESTER III

Cat.	Code	Title	L T P	Credit
SCI	23MAT224	Statistics and Foundations of Data Science	3 1 0	4
ENGG	23ELC201	Electric Machines	3 0 0	3
ENGG	23ELC202	Sensor Circuits & Actuators	3 0 0	3
ENGG	23ELC203	Artificial Intelligence	3 0 0	3
ENGG	23ELC204	Computer Architecture	2 0 0	2
ENGG	23EEE201	Signals & Systems	3 1 0	4
ENGG	23ELC205	Object Oriented Programming using Python	2 0 2	3
ENGG	23ELC281	Electric Machines Lab	0 0 3	1
ENGG	23ELC282	Sensor Circuits & Actuators Lab	0 0 3	1
HUM		Amrita Value Program 1	1 0 0	1
HUM	23LSE201	Life Skills for Engineers I	1 0 2	P/F
		TOTAL	33	25

SEMESTER IV

Cat.	Code	Title	L T P	Credit
ENGG	23ELC211	Operating Systems	2 0 2	3
ENGG	23ELC212	Machine Learning ##	3 1 0	4
ENGG	23EEE215	Control Systems	3 0 2	4
ENGG	23EEE214	Microcontrollers and Applications	3 0 2	4
ENGG	23ELC213	Data Structures and Algorithms	3 0 2	4
HUM	23LSE211	Life Skills for Engineers II	1 0 2	2
HUM		Amrita Value Program 2	1 0 0	1
		TOTAL	27	22

SEMESTER V

Cat.	Code	Title	L T P	Credit
ENGG	23ELC301	Energy Systems	3 0 0	3
ENGG	23EEE301	Digital Signal Processing ##	3 1 0	4
ENGG	23ELC302	Embedded System Design using ARM	3 0 2	4
ENGG	23ELC303	Data Base Systems and Programming	3 0 2	4
ENGG		Professional Elective I*	3 0 0	3
ENGG		Professional Elective II*	3 0 0	3
ENGG	23ELC381	Energy Systems Lab	0 0 2	1
HUM	23LSE301	Life Skills for Engineers III	1 0 2	2
ENGG	23LIV390***	Live In Lab I ***		[3]
		TOTAL	28	24+[3]

SEMESTER VI

Cat.	Code	Title	L T P	Credit
ENGG	23ELC311	Power Electronics and Drives	3 0 0	3
ENGG	23ELC312	Computer Networks and IoT	3 0 0	3
ENGG	23ELC313	Theory of Computation and Compiler Design	3 1 0	4
ENGG		Professional Elective III*	3 0 0	3
ENGG		Professional Elective IV*	3 0 0	3
ENGG	23ELC382	Power Electronics and Drives Lab	0 0 3	1
ENGG	23ELC383	Computer Networks and IoT Lab	0 0 2	1
ENGG	23ELC384	Open Lab	0 0 3	1
HUM	23LSE311	Life Skills for Engineers IV	1 0 2	2
ENGG	23LIV490***	Live in Lab II***		[3]
ENGG	23ELC397	Industry Internship		P/F
		TOTAL	27	21+ [3]

SEMESTER VII

Cat.	Code	Title	L T P	Credit
HUM		Free Elective**	2 0 0	2
ENGG		Professional Elective V*	3 0 0	3
PRJ	23ELC498	Project Phase I	0 0 18	6
ENGG	23ENV300	Environmental Science		P/F
HUM	23LAW300	Indian Constitution		P/F
		TOTAL	23	11

SEMESTER VIII

Cat.	Code	Title	L T P	Credit
ENGG		Professional Elective VI*	3 0 0	3
ENGG		Professional Elective VII*	3 0 0	3
PRJ	23ELC499	Project Phase II	0 0 18	6
		TOTAL	24	12

Total Credits		160

***Professional Elective** - Electives categorised under Engineering, Science, Mathematics, Live-in-Labs, and NPTEL Courses. Student can opt for such electives across departments/campuses. Students with CGPA of 7.0 and above can opt for a maximum of 3 NPTEL courses with the credits not exceeding 9.

** **Free Electives** - This will include courses offered by Faculty of Humanities and Social Sciences/ Faculty Arts, Commerce and Media/ Faculty of Management/ Amrita Darshanam - (International Centre for Spiritual Studies).

Simulation based Tutorials – These courses have simulation-based tutorials synchronized with theory. Software packages like MATLAB, LABVIEW, Python, ANSYS, etc. will be used for the tutorial. 1 theory and 1 tutorial slot in a week is to be combined as 2 continuous slots to offer the simulation-based tutorial.

*** **Live-in-Labs** - Students undertaking and registering for a Live-in-Labs project, can be exempted from registering for an Elective course in the higher semester.

PROFESSIONAL ELECTIVES

Power & Energy systems				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	23EEE342	Smart Grid	3 0 0	3
ENGG	23EEE331	Deregulated Power System	3 0 0	3
ENGG	23EEE332	Energy Storage Systems	3 0 0	3
ENGG	23EEE333	Instrumentation for Renewable Energy Systems	3 0 0	3
ENGG	23EEE334	Power System Operation Control and Stability	3 0 0	3
ENGG	23EEE335	Renewable Energy Technologies	3 0 0	3
ENGG	23EEE336	Digital Power System Protection	3 0 0	3
ENGG	23EEE337	High Voltage Engineering	3 0 0	3
ENGG	23EEE338	Computer Aided Electrical Machine Design	3 0 0	3
ENGG	23EEE339	High Voltage Transmission Systems	3 0 0	3
ENGG	23EEE340	Switched Mode Power Converters	3 0 0	3
ENGG	23EEE341	Energy Audit and Conservation	3 0 0	3

Embedded Systems, Control and Automation				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	23ELC341	Robotics and Automation	3 0 0	3
ENGG	23EEE352	Advanced Microcontrollers	3 0 0	3
ENGG	23EEE353	Digital Signal Processors	3 0 0	3
ENGG	23ELC342	Unmanned Aerial Vehicle	3 0 0	3
ENGG	23ELC343	FPGA based System Design	3 0 0	3
ENGG	23EEE354	Industrial Automation	3 0 0	3
ENGG	23ELC344	Wireless Sensor Networks	3 0 0	3
ENGG	23EEE355	Biomedical Instrumentation	3 0 0	3
ENGG	23EEE356	Advanced Control Systems	3 0 0	3
ENGG	23EEE357	Digital Control Systems	3 0 0	3
ENGG	23EEE358	Process Control and Instrumentation	3 0 0	3

Automotive Systems & EV				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	23EEE361	Systems Engineering for Electric Vehicle	3 0 0	3
ENGG	23EEE369	Electric Vehicle Technology	3 0 0	3
ENGG	23EEE362	Automotive Control Systems	3 0 0	3
ENGG	23EEE363	Vehicular Dynamics and Control	3 0 0	3
ENGG	23EEE364	Automotive Electronics	3 0 0	3
ENGG	23EEE365	Electric Machines for Electric Vehicle	3 0 0	3
ENGG	23EEE366	Autonomous Vehicles	3 0 0	3
ENGG	23EEE367	Battery Management System	3 0 0	3
ENGG	23EEE368	Condition Monitoring and Predictive Maintenance	3 0 0	3

Computing Technologies				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	23ELC361	Digital Image Processing	3 0 0	3
ENGG	23ELC362	Big Data Analytics	3 0 0	3
ENGG	23ELC363	Cloud Computing	3 0 0	3
ENGG	23ELC364	Deep Learning	3 0 0	3
ENGG	23ELC365	Block chain Technology	3 0 0	3
ENGG	23ELC366	Cyber Security	3 0 0	3
ENGG	23ELC367	Natural Language Processing	3 0 0	3
ENGG	23ELC368	Green Computing	3 0 0	3
ENGG	23ELC369	Evolutionary Optimization Techniques	3 0 0	3

Value Added Courses
e-Mobility Business and Policies
Renewable Energy Policies
Ethical Hacking
Introduction to LabVIEW
Energy Literacy
Soft Computing
Electro Magnetic Interference and Electro Magnetic Compatibility
AUTOSAR
Advanced Driver Assistance System
Web Application Development
Mobile Application Development
Robot Operating Systems
Wireless Communications

Evaluation Pattern

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

Continuous Assessment Weightage Split-up for Theory and Lab Integrated Courses

Before Midterm (Quiz/Assignment) *		After Midterm (Quiz/Assignment) *	
CA1	CA2	CA3	CA4
7.5	7.5	7.5	7.5

*Faculty have the flexibility to adopt Quiz/Assignment / mix of quiz and assignment, totalling up to four (4).

Continuous Assessment Weightage Split-up for Lab Courses

Before Midterm	After Midterm
6 Weeks Task or Experiments	6 Weeks Task or Experiments
20	20

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**	**itle**	**L T P**	**edit**
SCI	**23CHY240**	**omputational Chemistry and Molecular Modelling**	**3 0 0**	
SCI	**23CHY241**	**lectrochemical Energy Systems and Processes**	**3 0 0**	
SCI	**23CHY242**	**uels and Combustion**	**3 0 0**	
SCI	**23CHY243**	**reen Chemistry and Technology**	**3 0 0**	
SCI	**23CHY244**	**nstrumental Methods of Analysis**	**3 0 0**	
SCI	**23CHY245**	**atteries and Fuel Cells**	**3 0 0**	
SCI	**23CHY246**	**orrosion Science**	**3 0 0**	
PHYSICS				
SCI	**23PHY240**	**dvanced Classical Dynamics**	**3 0 0**	
SCI	**23PHY241**	**lectrical Engineering Materials**	**3 0 0**	
SCI	**23PHY242**	**hysics of Lasers and Applications**	**3 0 0**	
SCI	**23PHY243**	**oncepts of Nanophysics and Nanotechnology**	**3 0 0**	
SCI	**23PHY244**	**hysics of Semiconductor Devices**	**3 0 0**	
SCI	**23PHY245**	**strophysics**	**3 0 0**	
Mathematics				
SCI	**23MAT240**	**tatistical Inference**	**3 0 0**	
SCI	**23MAT241**	**ntroduction to Game Theory**	**3 0 0**	
SCI	**23MAT242**	**umerical Methods and Optimization**	**3 0 0**	

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

SYLLABUS

SEMESTER I

23ENG101	TECHNICAL COMMUNICATION	L-T-P-C: 2-0-3-3

Course 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

CO1: Understand and use the basic elements of formal correspondence and methods of documentation.
CO2: 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.

CO-PO Mapping

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

Syllabus

Unit 1

Mechanics of Writing: Grammar rules – articles, tenses, auxiliary verbs (primary & modal) prepositions, subject – verb agreement, pronoun – antecedent agreement, discourse markers and sentence linkers. General Reading and Listening comprehension – rearrangement & organization of sentences.

Unit 2

Different kinds of written documents: Definitions – descriptions - instructions – recommendations – user manuals - reports – proposals. Formal Correspondence: Writing formal Letters. Mechanics of Writing: impersonal passive & punctuation. Scientific Reading & Listening Comprehension.

Unit 3

Technical paper writing: documentation style - document editing – proof reading - Organising and formatting. Mechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation. Reading and listening comprehension of technical documents. Mini Technical project (10 -12 pages). Technical presentations.

References

1. *Hirsh, Herbert L., "Essential Communication Strategies for Scientists, Engineers and Technology Professionals", 2nd Edition, New York, IEEE press, 2002.*
2. *Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach", 5th 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" 8th Edition (Indian Adaptation), New Delhi: Biztantra, 2004.*
5. *Michael Swan, "Practical English Usage", Oxford University Press, 2000.*

23MAT122 CALCULUS, MATRIX ALGEBRA AND ORDINARY DIFFERENTIAL EQUATIONS L-T-P-C: 3-1-0-4

Course Objectives

- Introduce the concepts of shifting and scaling of functions, their continuity, one- and two-sided limits, differentiability.
- Introduce tangents, normals, binormals, curvatures, minima and maxima of functions of single variables.
- Understand basic concepts of eigen values and eigen vectors.
- Apply eigen values and eigen vectors for diagonalization and quadratic form.
- To familiar various methods for solving first and second order differential equations.
- Apply numerical techniques to solve the differential equations.

Course Outcomes

CO1: To understand the concepts of shifting, scaling of functions, limits, continuity, .and differentiability. To learn definite integral, partial, and total derivatives.

CO2: To solve the system of equations. Also, understand the notion of eigenvalues and eigenvectors.

CO3: To analyze the possibility of diagonalization and hence compute a diagonal matrix, if possible.

CO4: To model the engineering problems as first order linear ordinary differential equations and to learn to solve them.

CO5: Solve the second order linear ordinary differential equations using variation of parameters, undetermined coefficients.

CO-PO Mapping

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

Syllabus

Unit 1

Functions and their Graphs. Shifting and Scaling of Graphs. Limit of Functions. Continuous Functions, Discontinuities, Monotonic Functions. Extreme Values of Functions, Concavity and Curve Sketching. Functions of severable variables: Partial differentiations, total derivatives, differentiation of implicit functions and transformation of coordinates by Jacobian.

Unit 2

System of linear Equations, linear independence. Eigen values and Eigen vectors: Definitions and properties. Positive definite, negative definite and indefinite.

Diagonalization and Orthogonal Diagonalization. Properties of Matrices. Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal matrices.

Unit 3

Ordinary Differential Equations: Linear Differential Equations and Bernoulli Equation.

Second Order Differential Equations: Euler – Cauchy Equations, Solution by Undetermined Coefficients, Solution by Variation of Parameters. System of ODEs, Basic Concepts and Theory, Homogeneous Systems and Non-homogeneous with Constant Coefficients.

Textbooks

1. *G.B. Thomas, Calculus, Pearson Education, 11th Edition, 2009.*
2. *E Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 10th Edition, 2018.*

References

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", 2nd edition, CBS Publishers, 2012.*
3. *Bruce A. Finlayson, "Introduction to Chemical Engineering Computing", John Wiley & Sons, 2006.*

23ELC101	PROBLEM SOLVING AND ALGORITHMIC THINKING	L-T-P-C: 1-0-2-2

Course Objective

- To provide computational perspectives of problem solving and focus on design principles and methods of algorithms.

Course Outcomes

CO1: Develop logical reasoning for problem solving.
CO2: Apply constituents of algorithms to define and solve problems.
CO3: Analyse problems and algorithm by tracing its computational states.
CO4: Design and implement algorithm(s) for a given scenario.

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	-	-	-	-	-	-	-	-	-	2	2	1
CO2	3	3	3	-	2	-	-	2	2	2	-	-	2	2	1
CO3	3	3	3	-	3	-	-	2	2	2	-	-	2	2	1
CO4	3	2	3	-	3	-	-	2	2	2	-	-	2	2	1

Syllabus

Unit 1

Problem Solving and Algorithmic Thinking – Overview – problem definition, logical reasoning; Algorithm – definition, practical examples, properties, representation, algorithms Vs programs.

Unit 2

Algorithmic thinking – Constituents of algorithms – Sequence, Selection and Repetition, input-output; Computation – expressions, logic.

Unit 3

Algorithms vs programs, Problem Understanding and Analysis – problem definition, input output, variables, name binding, data organization: lists and arrays, Algorithms to programs.

Textbook

1. *Riley D. D., Hunt K. A., "Computational Thinking for the Modern Problem Solver", CRC press, 2014.*

References

1. *Ferragina P and 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.*
3. *Curzon P. and McOwan P. W., "The Power of Computational Thinking: Games, Magic and Puzzles to help you become a computational thinker", World Scientific Publishing Company, 2017.*

23MEE102	ENGINEERING GRAPHICS AND 3D MODELLING	L-T-P-C: 2-0-3-

Course Objectives

- To understand the BIS and its importance in Technical Drawings.
- To acquire proficiency in orthographic and isometric projection techniques for 2D representation of 3D objects.
- To appreciate the significance of 3D modeling in engineering design and drafting.
- To familiarize with 3D modeling software.
- Develop lateral surface development principles for creating 2D representations of 3D objects.

Course Outcomes

CO1: Demonstrate proficiency in using BIS for drafting.
CO2: Construct engineering drawings using principles of orthographic and isometric projection.
CO3: Develop models using principles of lateral surface development.
CO4: Create proficiency in developing 3D solid models using the software.

CO-PO Mapping

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

Syllabus

Introduction to Engineering Graphics and 3D Modeling: Introduction to BIS of Engineering Drawing – Line type, dimensioning, Significance of 3D modelling, Introduction to 3D Modeling Software.
Orthographic and Isometric Projections in 3D: Understanding orthographic projections of points, lines, planes, and solids in 3D, Developing 2D projections of 3D models, Developing sectional views of 3D models of solids, Developing isometric projections from 3D models of solids, Real-world applications of orthographic projections.
Development of Lateral Surfaces: Developing lateral surfaces of right regular prisms, cylinders, pyramids, and cones Understanding the development of surfaces in 3D models, Real-world applications of surface development.
Advanced 3D Modeling Techniques: Advanced modeling techniques in 3D Modeling Software (Autodesk® Fusion 360®), Creating complex 3D models using multiple tools and techniques, Applications of advanced 3D modeling techniques in various industries, Exporting 3D models for prototyping and manufacturing.

Textbook

1. *Basant Agarwal and C M Agarwal, "Engineering Drawing," 2nd Edition, McGraw Hill Education, 2015*
2. *John Willis, Sandeep Dogra, and Cadartifex, "Autodesk Fusion 360: A Power Guide for Beginners and Intermediate Users", 4th Edition, CADArtifex.*

References

1. *Jain, Maheshwari and Gautam, "Engineering Graphics & Design", Khanna Book Publishing, 2021.*
2. *"Autodesk Fusion 360 For Beginners: Part Modeling, Assemblies, and Drawings" – Tutorial Book.*
3. *Bhatt N. D., Panchal V.M. and Ingle P.R., "Engineering Drawing", Charotar Publishing, 2014.*
4. *John K. C., "Engineering Graphics for Degree", 1e, Prentice Hall India, 2009.*
5. *Shah M. B. and Rana B. C., "Engineering Drawing and Computer Graphics", Pearson, 2018.*

23PHY105	ENGINEERING PHYSICS - A	L-T-P-C: 2-1-0-3

Course Objective

- This course covers basics of Electrostatics' and Magneto statics starting with a review of Vectors. Essentials of Quantum mechanics required in understanding physics of semiconducting and Dielectric materials also is covered.

Course Outcomes

CO1: Understand electric field, electric potential concepts to solve problems in electrostatics.
CO2: Understand various atom models.
CO3: Apply the principles of Quantum Mechanics to simple applications in atoms, molecules and solids.
CO4: Understand the Physics behind Semiconducting materials and dielectric materials and its applications.

CO-PO Mapping

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

Syllabus

Unit 1

Review of vectors, Dot products, Cross products, and Triple products. Differential calculus: Gradient, Divergence, Curl. Coulomb's law. Superposition principle. Electric field – discrete and continuous distribution, Gauss's law, Applications of Gauss's law. The curl of electric field, Electric potential, meaning of electric potential, Equipotential surfaces, Potential of localized charge distribution, Work and energy in electrostatics, Energy of a point charge distribution, Energy of continuous charge distribution.

Magnetic fields, Magnetic forces, Currents, Biot-Savart law, Divergence and Curl of magnetic field, Ampere's law and its applications.

Unit 2

Atomic structure: Historical Development of atomic structures: Thomson's Model, Rutherford's Model: Scattering formula and its predictions, Atomic spectra - Bohr's Model, Sommerfield's Model, Elementary Quantum Physics, Conductors Wave particle duality, uncertainty principle, potential well, tunnelling, potential box. Simulated emission and lasers.

Unit 3

Semiconductors, Dielectrics Classification of semiconductors, doping, temperature dependence, minority carriers and recombination, diffusion and conduction equations, continuity equation.

Optical Properties Light propagation in a homogeneous medium, absorption, scattering, luminescence, phosphors, LEDs, polarization, LCDs, electro optic effects.

Textbooks

1. *David J Griffiths "Introduction to Electrodynamics", 4th Edition, Pearson, 2015.*
2. *Arthur Beiser, ShobhitMahajan and S. RaiChoudhury, "Concepts of Modern Physics", McGraw Hill Education India Private Limited, 2017.*
3. *S. O. Kasap, "Principles of Electronic Materials and Devices", 4th Edition, McGraw Hill Education, 2018.*

References

1. *Halliday, Resnick and Jearl Walker, "Principles of Physics", 10th Edition, Wiley, 2015.*
2. *Charles Kittel, "Introduction to Solid State Physics" 8th Edition, Wiley, 2012.*

3. *David J Griffiths, "Introduction to Quantum Mechanics", 2nd Edition, Pearson Education, 2020.*

23PHY185	ENGINEERING PHYSICS LAB - A	L-T-P-C: 0 -0 -3 -1

Course Objectives

- To introduce experiments for the understanding of physics concepts in the areas of electronics, optics, semiconductors, quantum mechanics and electricity and magnetism.
- To acquire experimental skills in studying electrical properties of metals and semiconductors, optical and quantum phenomena and measurement of magnetic field.

Course Outcomes

CO1: Be able to design and perform experiment to study the electrical property of metals and semiconductors.
CO2: Be able to design, perform experiments on dispersion, interference and diffraction.
CO3: Be able to design, perform experiments to measure magnetic field.
CO4: Perform experiment to study atomic spectrum of H_2 atom and quantum nature of light.

CO-PO Mapping

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

List of Experiments

1. Carey Foster's bridge – finding resistance per unit length of the wire and to find the resistivity of the material of a given wire.
2. Spectrometer-Dispersive power of prism.
3. Radius of curvature of given convex lens by Newton's rings method.
4. Laser – wavelength and particle size determination.
5. Band gap of a semiconductor.
6. Solar cell – efficiency and fill factor of the cell.
7. Verifying the quantum nature of hydrogen atom by measuring the wavelengths of spectral lines in Balmer series.
8. Photoelectric Effect – Planck's constant and work function of the given metal.
9. Measurement of the magnetic field of paired coils in a Helmholtz arrangement.

23MEE182	MANUFACTURING PRACTICE-B	L-T-P-C: 0-0-3-1

Course Objectives

- Impart the knowledge of general safety procedures that should be observed on the shop floor.
- Use modelling software to design and print simple geometry for additive manufacturing processes.
- Hands-on experience - arc welding and soldering operations.
- Use of different tools and accessories used for basic manufacturing processes.
- Familiarize with the essential pneumatic and electro-pneumatic components for automation and design pneumatic / electropneumatic circuits for the given simple application
- Understanding the functioning of various sub-systems of automobiles, such as the power train, steering system, suspension system, and braking system and realize the importance of recent developments in automotive technologies.

Course Outcomes

CO1: Practice safety procedures in a shop floor environment.
CO2: Select appropriate tools and methods for basic manufacturing processes.
CO3: Build simple geometries using additive manufacturing process.
CO4: Perform basic metals joining using welding and soldering.
CO5: Design, simulate and test simple pneumatic and electro pneumatic circuit for automation application.
CO6: Understand the functioning of automotive systems and realize the importance of recent developments in automotive technologies.

CO-PO MAPPING

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	-	-	1	-	-	-	1	-	2
CO2	2	3	-	-	-	2	-	-	-	2	-	3
CO3	2	2	1	-	3	1	1	-	-	2	1	3
CO4	2	3	2	-	-	-	-	-	-	2	1	3
CO5	3	2	2	-	3	-	-	-	-	2	1	3
CO6	3	2	2	-	3	-	-	-	-	3	1	3

Syllabus

Additive Manufacturing Laboratory: Introduction to digital manufacturing. Introduction to Additive Manufacturing - types – additive manufacturing applications - Materials for 3D printing, CAD Modelling for Additive manufacturing, Slicing and STL file generation- G code generation - 3D printing of simple geometries.
Mechanical Engineering Laboratory: Study of tools and equipment used for basic manufacturing processes. Manual arc welding practice for making Butt and Lap joints - Soldering Practice. Introduction to Machine Tools and Machining Processes.
Automation lab: Design, simulate and test pneumatic and electro-pneumatic circuits. Introduction to PLC –PLC programming for automation applications.

Automobile Engineering lab: Overview of automobiles – components –functioning of various sub-systems; Power train, steering system, suspension system and braking system. Introduction to electric vehicles, hybrid vehicles, alternate fuels. Introduction to E Mobility.

22ADM101	FOUNDATIONS OF INDIAN HERITAGE	L-T-P-C: 2-0-1-2

Course Objectives

- To introduce students to the depths and richness of the Indian heritage and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields. To equip students with a knowledge of their country and its eternal values.

Course Outcomes

CO1: Increase student understanding of true essence of India's cultural and spiritual heritage. Emancipating Indian histories and practices from manipulation, misunderstandings, and other ideological baggage thus, shows its contemporary relevance.

CO2: Understand the ethical and political strategic concepts to induce critical approach to various theories about India.

CO3: Familiarize students 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. Gives an understanding of bringing Indian teaching into practical life.

CO-PO Mapping

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

Syllabus

Unit 1

Educational Heritage of Ancient India
Life and Happiness
Impact of Colonialism and Decolonization
A timeline of Early Indian Subcontinent

Unit 2

Pinnacle of Selflessness and ultimate freedom
Indian approach towards life
Circle of Life
Ocean of love; Indian Mahatmas.

Unit 3

Man's association with Nature
Celebrating life 24/7.
Metaphors and Tropes
Become A Strategic Thinker (Games / Indic activity)

Unit 4

India: In the Views of Other Scholars and Travellers
Personality Development Through Yoga.
Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness
Conversations on Compassion with Amma

Text Book

1. *Foundations of Indian Heritage- In house publication*

References

1. *The beautiful tree by Dharampal.*
2. *Peasants and Monks in British India by William Pinch.*
3. *India, that is Bharat: Coloniality, Civilisation, Constitution by J Sai Deepak.*
4. *Awaken Children Dialogues with Mata Amritanandamayi.*
5. *Man, and Nature by Mata Amritanandamayi Devi.*
6. *What Becomes of the Soul After Death, Divine Life Society.*

22AVP103	MASTERY OVER MIND	L-T-P-C: 1-0-2-2

Course Objectives

- Mastery Over Mind (MaOM) is an Amrita initiative to implement schemes and organize university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3).
- It gives an introduction to immediate and long-term benefits of MA OM meditation and equips every attendee to manage stressful emotions and anxiety, in turn facilitating inner peace and harmony.
- This course will enhance the understanding of experiential learning based on the University's mission: "Education for Life along with Education for Living" and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

Course Outcomes

CO1: Describe what meditation is and to understand its healthbenefits.
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.
CO6: Understand the power of meditation in compassion-drivenaction.

CO-PO Mapping

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

Unit 1

Describe Meditation and Understand its Benefits.

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). Mata Amritanandamayi Mission Trust.

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

B: Understand how meditation works. Understand how meditation helps in improving physical 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 .

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). Mata Amritanandamayi Mission Trust.

Unit 3

The Science of Meditation.

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). Mata Amritanandamayi Mission Trust.

Unit 4

Practicing MA OM Meditation in Daily Life.

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). Mata Amritanandamayi Mission Trust.

Unit 5

Improving Communication and Relationships.

How meditation and mindfulness influence interpersonal communication. The role ofmeditation 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.

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.

Textbooks

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.*

SEMESTER II

23MAT125 COMPLEX ANALYSIS AND TRANSFORMS L-T-P-C: 3-1-0-4

Course Objectives

- To perform calculus for complex variables.
- To understand the residues and pole and evaluate the complete integrations.
- To understand and apply Laplace transform to solve differential equations.
- To understand the concepts of Fourier series and Fourier transforms.

Course Outcomes

CO1: To carry out differentiation for complex functions.
CO2: To perform integral calculus in complex variables.
CO3: To apply the Laplace transform for solving the ordinary differential equations.
CO4: To understand and apply the Fourier series for solving heat and wave equations.
CO5: To understand the Fourier transform and its properties.

CO-PO Mapping

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

Syllabus

Unit 1

Complex Analysis: Analytic Functions, Cauchy - Riemann Equations, Laplace Equation, Conformal mapping. Complex Line Integral, Cauchy Integral Theorem, Cauchy Integral Formula. Power Series, Taylor Series and Maclaurin Series. Laurent Series, Zeros and Singularities, Residues, Cauchy Residue Theorem.

Unit 2

Laplace Transforms, Inverse Transforms, Linearity, Shifting, Transforms of Derivatives and Integrals, Differential Equations, Unit Step Function, Second Shifting Theorem, Dirac's Delta Function. Differentiation and Integration of Transforms. Convolution, Integral Equations, Differential Equations, Systems of Differential Equations. Applications in Engineering problems.

Unit 3

Fourier Series, Periodic functions, Full range and Half range Fourier series. Fourier integral. Fourier transform, properties of Fourier transform. Fourier series solution of one dimensional wave and heat equations.

Textbook

1. *E Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley and Sons, 2018.*

References

1. *Dennis G. Zill and Michael R. Cullen, "Advanced Engineering Mathematics", 2nd Edition, CBS Publishers, 2012.*
2. *Bruce A. Finlayson, "Introduction to Chemical Engineering Computing", John Wiley & Sons, 2006.*

23CHY109	ENGINEERING CHEMISTRY - B	L-T-P-C: 2-1-0-3

Course Objectives

- Apply numerical techniques to solve the differential equations.
- The objective of the course is 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

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
CO1	3	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1

Crystalline and amorphous solids, isotropy and anisotropy, Miller indices, space lattice and unit cell, Bravais lattices, the seven crystal systems and their Bravais lattices, X– ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique), types of crystals – molecular, covalent, metallic and ionic crystals – close packing of spheres – hexagonal, cubic and body centred cubic packing, 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 2

Faradays laws, origin of potential, electrochemical series, reference electrodes, Nernst equation, introduction to batteries – classification – primary, secondary and reserve (thermal) batteries. Characteristics – cell potential, current, capacity and storage density, energy efficiency. Construction, working and application of Leclanche cell – Duracell, Li-MnO_2 cell, lead acid batteries. Ni-Cd battery, Lithium ion batteries. Fuel cell – construction and working of PEMFC.

Unit 3

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.

References

1. *Jain and Jain, "Engineering Chemistry", Dhanpat Rai Publishing company, 2015.*
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.*

23ELC111	ELECTRICAL CIRCUIT ANALYSIS	L-T-P-C: 3-0-0-3

Course Objective

- To impart knowledge on the operation and analysis of electrical circuits under steady state and transient conditions.

Course Outcomes

CO1: Understand the fundamental laws and formulate the equations for DC and AC electric networks.
CO2: Compute the steady state electrical quantities using network theorems and graph theory.
CO3: Analyze the behavior of electric circuits under transient conditions.
CO4: Evaluate three phase circuits and two port networks.

CO-PO Mapping

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

Syllabus

Unit 1

Review of circuit elements, fundamental laws, AC fundamentals, Phasor representations, Power and power factor. Steady state analysis of DC and AC circuits: Practice of Mesh Current and Node Voltage analysis of circuits with independent and dependent sources. Source transformation, Star-Delta Transformation, Network Theorems - Thevenin and Norton's theorems, Superposition theorem, Maximum Power Transfer Theorem, Tellegen's and Reciprocity Theorem.

Unit 2

Graph Theory: Incidence matrix, Fundamental Tie-Set Matrix, Fundamental Cutset Matrix, Formulation of network equations using KCL and KVL. Transient Analysis: Time domain analysis of first and second order circuits – with DC excitation, Analysis of AC circuits using Laplace transforms. Frequency response of series and parallel circuits: RLC Resonance, Q-factor and Bandwidth.

Unit 3

Three phase systems – Three phase 3-wire and 4-wire circuits, balanced and unbalanced, Star and Delta connected source and loads, Phasor Diagrams, Complex power. Coupled circuits – Dot convention, Analysis using Laplace Transforms. Two-Port Networks: Z, Y, ABCD, hybrid and inverse hybrid parameters, interconnections and relationships among different network parameters.

Textbook

1. *Alexander C. K. and Sadiku M. N. O., Fundamentals of electric circuits, 7th Edition, McGraw-Hill, New York, 2022.*

References

1. *Nahvi M and Edminister J, Schaum's Outline of Electric Circuits, 5th Edition, McGraw-Hill, New York, 2017.*
2. *Hayt W., Kemmerly J., and Durbin S., Engineering circuit analysis, 8th Edition, McGrawHill Higher Education, 2013.*
3. *Van Valkenburg M. E., Network Analysis, 3rd Edition, Prentice Hall-India, New Delhi, 2011.*

23ELC112	ELECTRONIC DEVICES & CIRCUITS	L-T-P-C: 3-0-0-3

Course Objective

- To impart knowledge on the fundamental concepts, design and development of analog electronic and integrated circuits for various applications.

Course Outcomes

CO1: Understand the working principle of Diodes, transistors, MOSFET and Operational Amplifier.
CO2: Analyse the characteristics of Diodes, transistors, MOSFET and Operational Amplifier.
CO3: Design electronic circuits using BJT, MOSFET and OPAMPs for various applications.

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	3	3	3	-	-	-	-	1	-	-	-	-	2	-	-

Syllabus

Unit 1

Overview of Semiconductor devices. PN- Junction Diode – characteristics, rectifiers – Clippers and clampers. Zener Diode – Regulated power supplies. Transistor – characteristics, modes of operation, BJT as a switch, Transistor Biasing, Load line analysis, BJT as an amplifier.

Unit 2

MOSFET - Introduction, device structures and physical operations, Biasing, small signal operation and models, MOS CS Amplifiers, frequency and switching characteristics, Differential Amplifiers.

Unit 3

Operational amplifiers: Equivalent circuit, Characteristics, Applications of Op Amp: amplifiers – Summing amplifiers – Integrator, Differentiator – Voltage comparators – Schmitt trigger with voltage limiter – Precision rectifier circuits - Sample and Hold circuit.

Textbooks

1. *Adel.S.Sedra, Kenneth.C. Smith, "Microelectronic Circuits", 7th Edition, Oxford University Press, 2005.*
2. *Boylestad and Nashlesky – Electronic Devices and Circuit Theory, 10th Edition, PHI,.*

References

1. *Edward Hughes – Electrical and Electronics Technology, Pearson, 11th Edition.*
2. *Thomas L. Floyd and David L. Buchla – Electronics Fundamentals, Circuits, Devices and application, 8th Edition.*
3. *Thomas L Floyd, Electronic Devices, 7th Edition, PHI.*

23ELC113	DIGITAL ELECTRONICS	L-T-P-C: 3-0-0-3

Course Objective

- To acquire the basic knowledge of digital logic to analyze, design and implement combinational and sequential logic circuits.

Course Outcomes

CO1: Understand the basics concepts of digital systems.
CO2: Develop logic functions using various minimization methods.

CO3: Implement logic functions using combinational logic circuits.
CO4: Analyse the synchronous and asynchronous 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	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	1	-	1	-	-	1	-	-
CO3	3	3	3	-	-	-	-	1	-	1	-	-	1	-	-
CO4	3	3	3	-	-	-	-	1	-	1	-	-	1	-	-

Syllabus

Unit 1
Introduction to Digital system Design - Digital Logic, Boolean Algebra, Boolean function minimization, K-Map, Combinational Circuit design, Design of Adder, Subtractor circuits, Design of common digital elements.

Unit 2
Design of complex combinational circuits, Combinational logic problem design, Combinational Logic design, Logic Design with PLA, Synchronous Sequential Circuit Design, Design of Sequential modules.

Unit 3
Programmable Logic Devices, Design of Arithmetic Circuits, Design of Memory Circuits, Algorithmic State Machines Chart, Design of Computer Instruction Set and the CPU.

Textbook

1. *Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.*

References

1. *Morris Mano, "Digital Design", 3rd Edition, Pearson Education, 2006.*
2. *Donald D. Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Company Limited, 2003.*
3. *Allen Dewey, "Analysis and Design of Digital Systems with VHDL", PWS Publishing Company, 1999.*
4. *John F. Wakerly, "Digital Design Principles and Practices", 3rd Edition, Pearson Education, 2001.*

23ELC114	COMPUTER PROGRAMMING	L-T-P-C: 2-0-2-3

Pre-requisite: Problem Solving and Algorithmic Thinking.

Course Objective

- To learn fundamentals of programming through C.

Course Outcomes

CO1: Understand standard and user defined data types – arrays, strings, pointers, structures and union
CO2: Familiarize typical programming constructs.
CO3: Apply control structures for algorithms.
CO4: Analyze programs through debugging for coding errors.

CO-PO Mapping

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

CO2	3	3	3	-	2	-	-	2	2	2	-	-	2	2	1
CO3	3	3	3	-	2	-	-	2	2	2	-	-	2	2	1
CO4	3	3	3	-	2	-	-	2	2	2	-	-	2	2	1

Syllabus

Unit 1

Structure of C programs, data types, data input-output statements, control structures. Functions – inter function communication, standard functions, scope. Arrays – 1D & 2D arrays. Recursion – recursive functions.

Unit 2

Strings: fixed length and variable length strings, strings and characters, string input, output, array of strings, string manipulation functions, sorting of strings. Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic.

Unit 3

Structures: structure vs array comparison, complex structures, structures and functions, Union. Files and streams, file input output, command line arguments.

Textbook

1. *Forouzan B. A., Gilberg R. F., "Computer Science: A structured programming approach using C", 3rd Edition, Cengage Learning, 2006.*

References

1. *Byron Gottfried, "Programming With C", 4th Edition, McGrawHill, 2018.*
2. *Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", 2nd Edition, Prentice Hall, 1988.*
3. *Eric S. Roberts, "Art and Science of C", Addison Wesley, 1995.*
4. *Jeri Hanly and Elliot Koffman, "Problem Solving and Program Design in C", 5th Edition, Addison Wesley Pearson, 2007.*

23EEE183	**ELECTRICAL ENGINEERING PRACTICE**	**L-T-P-C: 0-0-2-1**

Course Objective

- To develop practical skill in handling Electrical and Electronic appliances and installations.

Course Outcomes

CO1: Familiarize the electrical tools, electronic components, and safety measures.
CO2: Understand the operation of electrical and electronic appliances.
CO3: Perform domestic wiring and soldering.

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	3	-	-	1	1	-	-
CO2	3	-	-	-	-	-	-	1	3	-	-	1	1	-	-
CO3	3	-	-	-	-	1	-	1	3	-	-	1	1	-	-

Syllabus

Electronics: Familiarization of electronic components (passive and active components), Resistor, Inductor and capacitor. Study of measuring instruments (Voltmeter, Ammeter and Multimeter). Verification of OHM's law. Measurement and theoretical Verification of series and parallel combination of resistors and capacitors. Familiarization of CRO and function generator, Rectifier circuits, Soldering and De-soldering practice.

Electrical: Study on power supply and protective devices, Study on basic electrical tools and electrical accessories, Study on various lighting technologies, Study on house hold appliances: Iron box, Fan, Refrigerator, Air conditioner, Food Mixer/grinder.

Domestic wiring practices: Glow an incandescent lamp using SPST switch, glow a fluorescent lamp using SPST switch, operate a fan and an incandescent lamp using two independent SPST switch, Operate a fluorescent lamp and a 3 pin socket using two independent SPST switch, Staircase wiring.

23ELC181	ELECTRICAL, ELECTRONICS & DIGITAL LAB	L-T-P-C: 0-0-2-1

Course Objective

- To provide an understanding of operation and analysis of electrical and electronic circuits, and familiarize with their applications.

Course Outcomes

CO1: Demonstrate network theorems, fabricate circuits, and validate performance through simulation and hardware.
CO2: Illustrate electronic circuit performance through hardware and simulation.
CO3: Design of basic combinational and 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	1	-	2	-	-	1	2	1	-	-	2	2	-
CO2	3	2	2	-	3	-	-	1	2	1	-	-	2	2	-
CO3	3	3	2	-	1	-	-	1	2	1	-	-	2	1	1

Syllabus

Hardware/Simulation experiments in Kirchhoff's laws, Network Theorems, Transients, Resonance etc. Hardware/Simulation experiments in Diode Applications, BJT Characteristics and Amplifier Design, MOSFET Switching characteristics, Regulators, Oscillators. Logic gates, adders, MUX, DeMUX, Encoder, Decoder, Flip flop, Shift registers.

Textbooks

1. *Alexander C K and Sadiku M. N. O., Fundamentals of electric circuits, 7th Edition, New York, McGraw-Hill, 2022.*
2. *Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits", 7th Edition, Oxford University Press, 2017.*

23CHY188	ENGINEERING CHEMISTRY LAB	L-T-P-C: 0-0-3-1

Course Objective

- To analyze the ions present in water using instrumental techniques.
- To understand the kinetics of chemical reactions and adsorption principles.
- To determine the rate of corrosion and its control.
- To synthesis nanoparticles and determine the surface charge of oxide particles.
- To estimate the amount of given substances using electrochemical methods.

Course Outcomes

CO1: Analyze the ions present in the given sample water.
CO2: Analyze the adsorption isotherm and determine the rate constant of a reaction.
CO3: Apply the solid state chemistry principles for preparing nanoparticles and determining the surface charge on oxides.
CO4: Apply the fundamental principles of electrochemistry for the analysis of given substance and understand the corrosion kinetics.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	-	-	1	-	1	-	1	-	-	-
CO 2	3	1	-	-	-	-	-	-	1	-	-	-
CO 3	3	1	-	-	-	-	-	-	1	-	-	-
CO 4	3	1	-	-	-	-	-	-	1	-	-	-

Syllabus

Chemical Kinetics and surface chemistry – understanding the principle of adsorption, determining the rate constant of a reaction. Electrochemistry – Evaluating the dissociation constant of acids, estimation of acid and ferrous ion present in water. Corrosion and control – anodization and Tafel plot.
Instrumentation techniques – Estimations of ions in water using flame photometer and UV-Visible spectrophotometer. Solid state - Determination of point of zero charge of metal oxide.

List of Experiments

1. Adsorption of acetic acid by charcoal.
2. Adsorption of dye on charcoal.
3. Determination of rate constant for acid catalyzed ester hydrolysis.
4. Estimation of ferrous ion by potentiometric titration.
5. Potentiometric titration of dibasic acid Vs strong base.
6. Conductometric titration of mixture of acid Vs NaOH.
7. Verification of Beer–Lambert law by UV-spectrophotometer.
8. Determination of point of zero charge of metal oxide.
9. Synthesis of polyaniline conducting polymer via electrochemical polymerization.
10. Synthesis of silver nanoparticle by chemical reduction method.
11. Determination of sodium and potassium ions in water using Flame photometry.
12. Kinetics of electrochemical reactions - Construction of Tafel linear polarization curves.
13. Determination of optimum current density for the anodization of aluminium.

22ADM111	GLIMPSES OF GLORIOUS INDIA	L-T-P-C: 2-0-1-2

Course Objectives

- The course aims at introducing Bhārath in nutshell to the student, which includes the sources of Indian thoughts, eminent personalities who shaped various disciplines, India's significant contribution to mankind, the current stature of India in geopolitics and the Indian approach to science and ecology.

Course Outcomes

CO1: Will be able to recognise the call of Upanishads and outstanding personalities for confronting the wicked in the real world while admiring the valour, pursuit and divinity in both classical and historical female characters of India.

CO2: Will get introduced to Acharya Chanakya, his works, and his views on polity and nation to find synchrony between public and personal life, alongside understanding India's cultural nuances and uniqueness concerning the comprehension of God across major global communities.

CO3: Will be able to appreciate Bhagavad Gita as the source of the Indian worldview through the various Yogic lessons enshrined in it, making it one of India's numerous soft powers, and also understand the faith-oriented mechanism of preserving nature.

CO4: Will be informed about the enormous contribution of Indian civilisation over two and a half millennia to humanity and develop awareness about India's approach toward science, devoid of dogmas and rooted in humanism.

CO-PO Mapping

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

Syllabus

Chapter 1 – Face the Brutes
Chapter 2 – Role of Women in India
Chapter 3 – Acharya Chanakya
Chapter 4 – God and Iswara
Chapter 5 – Bhagavad Gita: From Soldier to Samsarin to Sadhaka
Chapter 6 – Lessons of Yoga from Bhagavad Gita
Chapter 7 – Indian Soft powers
Chapter 8 – Preserving Nature through Faith
Chapter 9 - Ancient Indian Cultures (Class Activity)
Chapter 10 - Practical Vedanta
Chapter 11 - To the World from India
Chapter 12 - Indian Approach to Science

Text Book

1. *Glimpses of Glorious India- (In-house publication)*

References

1. *Fear Not: Be Strong (Swami Tathagatananda).*
2. *Essays on Gita (Sri Aurobindo)- Aurobindo Ashram.*
3. *Indian Contribution to Science (Vijana Bharati Publication).*
4. *The Culture and Civilisation Of Ancient India In Historical Outline (D. D. Kosambi).*
5. *The Kautilya Arthashastra by Chankaya – Translation with critical and explanatory note by R P Kangle – Motilal Banarasidass Publishers- 1972.*
6. *Chanakya Neeti – Strategies for success – Radhakrishnan pillai – Jaico Publishing house -2020.*

7. *Universal Message of the Bhagavad Gita: An exposition of the Gita in the Light of Modern Thought and Modern Needs. - Swami Ranganathananda, Advaita Ashrama Belur Math, 2000.*
8. *A Concise History Of Science In India – D M Bose, S N Sen, B V Subbarayappa,The Indian National Science Academy 1971.*
9. *Indian Culture and India's Future – Michel Danino - D.K. Printworld (P) Ltd -2011.*

SEMESTER III

23MAT224 STATISTICS AND FOUNDATIONS OF DATA SCIENCE L-T-P-C: 3-1-0-4

Course Objectives

- To perform data pre-processing methods for some data sets.
- To understand the data visualization methods and descriptive statistics and apply to some data sets.
- To understand discrete and continuous random variables and to compute important measures.
- To understand and apply correlations and regressions for given data set.

Course Outcomes

CO1: Understand the data pre-processing methods.
CO2: Understand various the data visualization methods and understand the basics of the descriptive statistics.
CO3: Understand the basics of probability, random variables and distributions.
CO4: Understand and apply the basic concepts of correlations and regressions to the given data.
CO5: Understand and apply the basic concepts of sampling techniques and simple hypothetical testing to the given data.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction, Causality and Experiments, Data pre-processing: Data cleaning, Data reduction, Data transformation, Data discretization. Overlaid Graphs, plots, and summary statistics of exploratory data analysis, Randomness.

Unit 2

Probability: Definition of probability, conditional probabilities and Bayes' Theorem. Random Variable and Distributions: Introduction to random variable – discrete and continuous distribution functions- mathematical expectations – moment generating functions and characteristic functions. Binomial, Poisson, Exponential, Normal distribution functions. Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions.

Unit 3

Statistical Inference; Hypothesis Testing, Assessing Models, Decisions and Uncertainty, Comparing Samples, A/B Testing, P-Values, Causality. Estimation, Prediction, Confidence Intervals. Graphical Models, Updating Predictions. Two dimensional random variables. Joint and marginal density functions. Correlations and Regressions.

Textbooks

1. *E Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley and Sons, 2016.*
2. *Adi Adhikari and John DeNero, "Computational and Inferential Thinking: The Foundations of Data Science", e-book.*

References

1. *Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl Jr., "Data Mining for Business Analytics: Concepts, Techniques and Applications in R", Wiley India, 2018.*
2. *Rachel Schutt & Cathy O'Neil, "Doing Data Science" O' Reilly, 1st Edition, 2013.*

3. *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons Inc., 2005.*
4. *J. Ravichandran, "Probability and Random Processes for Engineers", 1st Edition, IK International, 2015.*
5. *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.*

23ELC201	ELECTRIC MACHINES	L-T-P-C: 3-0-0-3

Course Objective

- Introduce the fundamental concepts, operation, and application of electrical machines.

Course Outcomes

CO1: Understand the basic principles, construction, and application of electrical machines.
CO2: Develop steady state equations and equivalent circuit of electrical machines.
CO3: Select suitable technique for starting, braking and speed control of electrical machines.
CO4: Test and analyse the performance characteristics 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	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	2	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	2	2	-

Syllabus

Unit 1

Review of electric and magnetic circuits – Principles of electromechanical energy conversion, DC Machines: Construction, working, types and characteristics, Starting, Speed Control and Braking of DC Motors, Efficiency and Testing – Applications.

Unit 2

Transformer: Construction and working, Equivalent Circuit, Losses, Efficiency, Regulation, Testing - Autotransformers, Three-phase Transformers – connections - Applications.
Induction machines – Construction and working, types, Equivalent Circuit, Losses, Efficiency, testing, starting methods and speed control, torque slip characteristics, single phase induction motor – starting – Applications.

Unit 3

Synchronous machines – Construction and working, generators and motors, types-salient pole and non-salient pole, characteristics, performance evaluation- regulation, efficiency, testing, parallel operation – Applications.

Textbook

1. *Kothari D.P. and Nagrath I.J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.*

References

1. *Fitzgerald A.E., Charles Kingsley and Stephen D. Umans, "Electric Machinery", Tata McGraw-Hill Publishing Company Limited 2002.*
2. *Albert E. Clayton, "The performance and design of direct current machines", 3rd Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1992.*
3. *S.K. Bhattacharya, "Electrical Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi.*
4. *M.G.Say, "Performance and Design of Direct Current Machines", CBS publishers, New Delhi, 1993.*

23ELC202	SENSOR CIRCUITS & ACTUATORS	L-T-P-C: 3-0-0-3

Course Objective

- To understand the operating principles and selection of different sensors and actuators for various applications.

Course Outcomes

CO1: Understand the characteristics and operating principles of different types of sensors.
CO2: Select different actuators for various applications.
CO3: Apply different analog and digital signal conditioning techniques for sensor circuits.
CO4: Design and analyse sensor-based applications.

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	1	1	-	-	-	-	1	-	-	-	-	-	-	2
CO3	3	3	1	2	-	-	-	1	-	-	-	-	1	2	-
CO4	3	2	3	2	1	-	-	1	-	-	-	-	1	2	2

Syllabus

Unit 1

Measurement system architecture, Overview of Signal Conditioning, measurement characteristics, Sensors and Transducers, Selection of Sensors, Basic Interfacing circuits. Electrical Sensors: Hall effect sensor, CT, PT, Inductance and Eddy Current Sensors. Thermal Sensors: RTD, Thermistors, Thermocouples, Thermal IC Sensors.
Mechanical Sensors: Displacement- LVDT, Velocity, accelerometer, gyro, Pressure, Flow, level, Proximity, humidity, Force, optical.
Error budgeting: Errors due to resistance drift, offset voltage drift, offset current drift and temperature drift.

Unit 2

Analog Signal Conditioning – Principles of analog signal conditioning, Instrumentation amplifier, Signal-Level and Bias Changes, Linearization, Conversions, Filtering, and Impedance Matching. Concept of Loading, Sensor-to-Frequency Conversion.
Data-Acquisition Systems: Hardware and Software components of Data Acquisition System (DAS). Characteristics of digital data: Digitized Value, Sampled Data Systems.

Unit 3

Actuation systems: Pneumatic and Hydraulic Systems – Directional Control Valves – Rotary Actuators.
Mechanical Actuation Systems – Mechanical Switches – Cams – Gear Trains – Ratchet and Pawl – Belt and Chain Drives – Bearings.
Electrical Actuation Systems – Solid State Switches – Solenoids. Smart sensors – communication.
Case Study: Applications of sensors and actuators

Textbooks

1. *Robert B. Northrop, "Introduction to Instrumentation and Measurement", 3rd Edition, CRC – Press – Taylor and Francis Group.*
2. *Patranabis, "Sensors and Transducers", 2nd Edition, Prentice Hall of India, 2013.*

References

1. *Paul Horowitz and Winfield Hill, "The Art of Electonics", 2nd Edition, Cambridge University Press, 1992.*
2. *Curtis D. Johnson, "Process Control Instrumentation Technology", 6th Edition, Prentice Hall International Edition.*
3. *Ida, Nathan., "Sensors, actuators, and their interfaces: a multidisciplinary introduction", No. 11040. SciTech Publishing Inc, 2013.*
4. *John G. Webster, "Measurement, Instrumentation, and Sensors Handbook", CRC – Press – Taylor and Francis*

Group, 1999.

5. *Pallas-Areny, Ramon, and John G. Webster. Sensors and signal conditioning. John Wiley & Sons, 2012.*
6. *J.P.Bentley, "Principles of Measurement systems", 4th Edition, Pearson education ltd, UK, 2005.*
7. *G.C.M. Meijer, "Smart Sensor Systems", Vol 10, John Wiley and Sons, UK, 2008.*

23ELC203	ARTIFICIAL INTELLIGENCE	L-T-P-C: 3-0-0-3

Pre-requisites: Probability and statistics, matrix algebra.

Course Objective

- To learn concepts of Artificial Intelligence and develop programs for self-learning agents.

Course Outcomes

CO1: Understand concepts of state space and Intelligent agents.
CO2: Apply search algorithms for real world applications.
CO3: Develop planning strategies for structured environment.
CO4: Familiarise propositional logic and inference for AI 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	2	1	-	-	-	-	-	-	-	3	2	2
CO2	3	3	3	3	1	-	-	-	-	-	-	-	3	2	2
CO3	3	3	3	3	1	-	-	-	-	-	-	-	3	2	2
CO4	3	3	2	2	1	-	-	-	-	-	-	-	3	2	2

Syllabus

Unit 1

Introduction: Overview and Historical Perspective, Turing test, State Space. Intelligent agents, Game Playing – Minimax Algorithm.

Unit 2

Search technique: Depth First Search, Breadth First Search, DFID. Heuristic Search - Best First Search, Hill Climbing, Beam Search. Randomized Search - Genetic Algorithms. Finding Optimal Paths: Branch and Bound, A*. Problem Decomposition: Goal Trees, AO*.

Unit 3

Planning and Constraint Satisfaction – Domains, Forward and Backward Search. Logic and Inferences – Propositional Logic, First Order Logic, predicate logic, applications.

Textbook

1. *John Haugeland, "Artificial Intelligence: The Very Idea", A Bradford Book, The MIT Press, 1985.*

References

1. *Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education, India, 2013.*
2. *Stefan Edelkamp and Stefan Schroedl, "Heuristic Search: Theory and Applications", Morgan Kaufmann, 2011.*
3. *Pamela McCorduck, "Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence", 2nd Edition, A K Peters/CRC Press, 2004.*

23ELC204	COMPUTER ARCHITECTURE	L-T-P-C: 2-0-0-2

Pre-requisite: Digital Systems.

Course Objective

- To introduce the concepts of computer architecture, organization, and methods to improve system performance.

Course Outcomes

CO1: Understand the design principles of a computing system.
CO2: Familiarize the basics of pipelining technique, design issues and hazards.
CO3: Comprehend the concepts of memory organization.

CO4: Validate the learned concepts through simulation.

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	1	1	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	2	-	-	1	-	2	-	-	1	1	-

Syllabus

Unit 1

Introduction and Performance of Computing system, Processor Architecture with example as MIPS & Instruction Set, Single Cycle Datapath Design, Control Hardware, Computer Arithmetic, Floating Point Arithmetic, Role of performance.

Unit 2

Introduction to multicycle at a path, Pipelining Technique – Design Issues, Hazards: Structural Hazards, Data Hazards and Control Hazards, Static Branch Prediction, Dynamic Branch Prediction.

Unit 3

Memory Organization – Introduction, Cache Memory Organization, Main Memory & Interleaving, I/O Organization, Modern Processors.

Textbook

1. *Patterson DA, Hennessy JL. Computer Organisation and Design, The Hardware/Software interface Fifth Edition, Morgan Kaufmann; 2014.*

References

1. *Hamacher et. al. Computer Organisation. 6th Edition, McGraw-Hill, 2017.*
2. *Hennessy JL, Patterson DA. Computer architecture: a quantitative approach. 5th Edition, Morgan Kauffmann, 2011.*
3. *Hayes JP. Computer Organisation and Architecture. 3rd Edition, McGraw Hill; 2017.*
4. *Stallings W. Computer Organisation and Architecture, 10th Edition, PHI, 2016.*

23EEE201	SIGNALS & SYSTEMS	L-T-P-C: 3-1-0-4

Pre-requisites: Vector calculus, Laplace, Fourier Transforms.

Course Objective

- To understand various types of signals and systems and analyze their properties using continuous and discrete transforms in time and frequency domain.

Course Outcomes

CO1: Understand the classification of signals and systems.
CO2: Evaluate LTI output using linear convolution technique.
CO3: Analyse signals and systems in time and frequency domains.
CO4: Validate time and frequency responses of various signals in LTI systems using simulations.

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	1	1

CO2	3	3	2	-	-	-	-	2	-	-	-	-	2	1	1
CO3	3	3	3	-	-	-	-	2	-	-	-	-	2	1	1
CO4	3	2	3	-	3	-	-	3	3	2	-	2	2	2	1

Syllabus

Unit 1

Introduction: Integrated approach for continuous and discrete – time cases.

Signals: Classification of signals, Continuous – Discrete time, Even/Odd signals, Periodic/ Nonperiodic signals, Deterministic/Random signals, Energy/Power signals, Basic operations on signals, Basic (Continuous/Discrete) signals. Systems (Continuous/Discrete): Representation, Classification – Linear/Nonlinear, Causal/Noncausal, Time invariant/Time variant, with/ without memory, BIBO stability, Feedback system, LTI system – Response of LTI system, Convolution, Properties (Continuous/Discrete).

Unit 2

Review of Fourier series and Fourier Transforms-Applications-Case Study, Discrete Time Fourier transform and its properties. Laplace Transform analysis of systems: ROC, Inverse LT, Unilateral LT, Solving differential equation with initial conditions.

Unit 3

Sampling: Sampling theorem, Reconstruction of signal, Aliasing, Sampling of discrete time signals. z-Transform: Definition, ROC, Inverse z-Transform, Properties, Transform analysis of LTI Systems. Interrelationship amongst different representation and Transforms.

Textbook

1. *Simon Haykin, Barry Van Veen, "Signals and Systems", Second Edition, John Wiley and Sons, 2005.*

References

1. *Alan V. Oppenheim, Alan S.Willsky ,S,HamidNawab, "Signals and Systems", Prentice Hall India Private Limited,2nd Edition, 1997.*
2. *Michael.J.Roberts, "Fundamentals of Signals and Systems", First Edition, Tata McGraw Hill Publishing Company Limited, 2007.*
3. *Rodger E.Ziemer, William.H.TranterD.Ronald Fannin, "Signals and Systems", Fourth Edition, Pearson Education, 2004.*
4. *Virtual labs, NPTEL Videos, Simulation demos etc.*

23ELC205	OBJECT ORIENTED PROGRAMMING USING PYTHON	L-T-P-C: 2-0-2-3

Course Objective

- To learn the fundamentals of programming using object-oriented approach through Python.

Course Outcomes

CO1: Familiarize python programming constructs.
CO2: Apply the concepts of classes, objects, and inheritance for modularity.
CO3: Analyse polymorphism and overloading for standard applications.
CO4: Understand exceptions for building robust programs.

CO-PO Mapping

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

Syllabus

Unit 1

Review of Data Types, Variables, Operators, Control Flow, Arrays, Lists, Tuples, Dictionaries, Functions in python. Object Oriented Programming concepts – Abstraction – objects and classes – Encapsulation – Inheritance – Polymorphism – Defining classes in Python – constructors, methods -access specifiers – static members.

Unit 2

Polymorphism - overloading, overriding, Inheritance – constructors, abstract classes, and methods- static, final methods.

Unit 3

Exceptions – exception handling. Input / Output Basics – Reading and Writing Console – Reading and Writing Files

Textbook

1. *Python 3 Object-oriented Programming – Second Edition by Dusty Phillips Publisher: Packt Publishing, 2015.*

References

1. *John Guttag, "Introduction to Computation and Programming Using Python: With Application to Understanding Data", 2nd Edition. MIT Press, 2016.*
2. *Tony Gaddis, "Starting Out with Python", 3rd Edition, Pearson, 2014.*
3. *Kenneth A. Lambert, "Fundamentals of Python: First Programs", Cengage Learning, 2nd Edition, 2018.*
4. *Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", O'Reilly Media, 2012.*

23ELC281	ELECTRIC MACHINES LAB	L-T-P-C: 0-0-3-1

Course Objective

- Test and analyse the performance of electrical machines.

Course Outcomes

CO1: Analyse the performance characteristics of electrical machines.
CO2: Construct the equivalent circuit and predetermine the characteristics of induction motors and transformer.
CO3: Implement the speed control of DC and asynchronous motors.
CO4: Demonstrate the operation of synchronous and asynchronous machines connected to infinite busbar.

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	1	-	-	2	1	-
CO2	3	3	-	-	-	-	-	2	2	1	-	-	2	1	-
CO3	3	3	-	-	-	-	-	2	2	1	-	-	2	-	-
CO4	3	3	-	-	-	-	-	2	2	1	-	-	2	-	-

Syllabus

DC Machines: Internal and External Characteristics, Speed control, Swinburn's test and load test. Transformers: Transformer OC & SC tests, load test. Induction Machines: Performance evaluation – Direct and indirect testing, speed control methods. Synchronous Machines: Regulation of synchronous generator and parallel operation.

23ELC282	SENSOR CIRCUITS & ACTUATORS LAB	L-T-P-C: 0-0-3-1

Course Objective

- Implement sensors and actuators-based applications using software and hardware.

Course Outcomes

CO1: Understand the characteristics of different types of sensors and actuators.
CO2: Calibrate sensors and communicate data for processing.
CO3: Develop hardware application using sensors and actuators.

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	-	2	-	-	2	2	2	-	-	-	-	1
CO2	3	2	1	2	2	-	-	2	2	2	-	1	2	2	2
CO3	3	2	3	-	2	-	-	2	2	2	-	1	2	2	2

Syllabus

Study the characteristics of measurement system, thermal, electrical, and magnetic sensors, mechanical sensors using software and develop hardware circuits for an application.

Study the characteristics of actuator systems – rotary actuators, motors, valves and solenoids using software and develop hardware circuits for an application.

22ADM211	LEADERSHIP FROM RAMAYANA	L-T-P-C: 1-0-0-1

Course Objectives

- Through a study of the Rāmāyaṇa, the student should gain a deeper understanding of the ethical grandeur of Indian culture, and be inspired to follow the ideals of the characters depicted therein.

Course Outcomes

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
CO1	-	-	-	-	-	2	2	3	3	3	-	3
CO2	-	-	-	-	-	3	3	3	3	2	-	3
CO3	-	-	-	-	-	3	2	3	3	3	-	3
CO4	-	-	-	-	-	2	2	3	3	3	-	3
CO5	-	-	-	-	-	3	3	3	3	2	-	3

Syllabus

Unit 1

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.

Unit 2

Ayodhya-Kāṇḍa: Harbinger of an Entire Tradition of Nobleness.
Araṇya-Kāṇḍa: Tale of the forest life.

Unit 3

Kishkindha-Kāṇḍa: The Empire of Holy Monkeys.
Sundara-Kāṇḍa: Heart of the Ramayana.

Unit 4

Yuddha-Kāṇḍa: The most popular part of the Ramayana.
Uttara-Kāṇḍa: An attempt to explain the untold stories.

Unit 5

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.*

23LSE201	Life Skills for Engineers I	L-T-P-C: 1-0-2- P/F

Pre-requisite: 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 manage emotions 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 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 word analysis 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 identify errors 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 world through various individual speaking activities.

References:

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
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

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.**

SEMESTER IV

23ELC211 OPERATING SYSTEMS L-T-P-C: 2-0-2-3

Course Objective

- To introduce the concepts of operating systems, its components and services.

Course Outcomes

CO1: Understand the architecture and functionalities of operating systems.
CO2: Analyse process scheduling algorithms.
CO3: Apply the concepts of process synchronization.
CO4: Familiarize storage and memory allocation techniques.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to Operating Systems: Overview – Types of systems-Computer system operations – Operating systems services – System calls –System structure. Process Management: Process concepts – Process scheduling-operation on process – Interprocess communication – Multi threading models-Threading issues –Thread types-CPU scheduling – scheduling algorithms.

Unit 2

Process Synchronization: Semaphores – Critical Regions-Monitors – Deadlocks – Methods of handling deadlocks – Deadlock Prevention– Avoidance – Detection and recovery. Storage Management: Memory Management–Swapping –Contiguous memory allocation.

Unit 3

Paging-Segmentation-Segmentation with Paging – Virtual Memory - Demand paging-page replacement – Thrashing. File Systems: Directory Structure-Disk scheduling.

Textbook

1. *Silberschatz A., Gagne G., Galvin P. B., "Operating system concepts", 10th Edition, John Wiley and Sons, 2018.*

References

1. *Deitel HM, Deitel PJ, Choffnes DR. Operating systems. 3rd Edition, Prentice Hall, 2004.*
2. *Tannenbaum A. S., "Modern Operating Systems", 4th Edition, Prentice Hall, 2016.*
3. *Stevens W. R., Rago S. A., "Advanced programming in the UNIX environment", 2ns Edition, Addison-Wesley, 2008.*
4. *Nutt G., "Operating systems", 3rd Edition, Addison Wesley, 2009.*

23ELC212	MACHINE LEARNING	L-T-P-C: 3-1-0-4

Course Objective

- To understand the idea of learning by machines, training, classification, and prediction techniques.

Course Outcomes

CO1: Understand the basic concepts of optimization for learning.
CO2: Design microcontroller frameworks for classification problems.
CO3: Develop prediction models using regression.
CO4: Analyse modern tools for real world scenarios.

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

Syllabus

Unit 1

Introduction to optimization, gradient decent, types of machine learning problems – classification, regression, and reinforcement. Supervised and Un-supervised learning. Concept of training, testing and validation. Exploratory data analysis and pre-processing, Principal Component Analysis for dimensionality reduction.

Unit 2

Regression models and implementation – Linear regression, Logistic Regression, SVR, Random Forest. Performance measurements of models: MSE, Mean absolution deviation (MAD), R-squared -coefficient of determination.

Unit 3

Classification models and implementation – Naïve Bayes, KNN, SVM, Decision trees, Neural Networks - Perceptron. Performance measurements of models: Accuracy, Confusion matrix, F1-score, ROC curve and AOC, Log loss. K-Means clustering.

References

1. *Christopher Bishop, "Pattern Recognition and Machine Learning", 1st Edition, Springer-Verlag New York, 2009.*
2. *Tom mitchell, "Machine Learning", McGraw-Hill, 1997*
3. *Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall.*
4. *Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition, Wiley publishers, 2000.*

23EEE215	CONTROL SYSTEMS	L-T-P-C: 3-0-2-4

Course Objective

- To impart knowledge on control system design in time and frequency domains.

Course Outcomes

CO1: Model dynamic systems in time domain and frequency domain.
CO2: Analyse the system behaviour in time and frequency domains.
CO3: Evaluate the stability of the control system.
CO4: Design the compensators and controllers for desired response.
CO5: Implement control systems concepts using hardware and simulation.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to control systems, Mathematical models of physical systems- transfer function, block diagram representation, Signal flow graph. Feedback control system characteristics, Control over system dynamics & disturbance, Performance of feedback control systems. Use of software tools to analyze and design of control system.

Unit 2

Standard test input signals, transient and steady state response of first, second and higher order systems, Time domain analysis: performance indices, concept of stability – Routh-Hurwitz Stability criterion, Root locus method. Frequency response analysis: Bode plots, Polar plots – Stability in the frequency domain - Nyquist criterion.

Unit 3

Design of feedback systems: Lead-Lag compensation, PID controllers. State space representation - Controllability and observability. Control system design case studies: Inverted Pendulum/ Motor speed control/Turbine governor/ Robotic hand/ship steering/Landing – Take off/ Qbot.
Lab Practice: Experiments in modelling, design and analysis of controllers using Simulation / Hardware.

Textbook

1. *Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson, 2011.*

References

1. *Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.*
2. *M. Gopal, "Modern Control System Theory", New Age International, 3rd Edition 2014.*
3. *Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013.*
4. *Nagrath I. J., Gopal M., "Control Systems Engineering", New Age Publishers 2017.*

23EEE214	MICROCONTROLLERS AND APPLICATIONS	L-T-P-C: 3-0-2-4

Pre-requisite: Digital Electronics.

Course Objective

- To design microcontroller-based solutions for real world applications.

Course Outcomes

CO1: Understand the concepts of microprocessors and microcontrollers.
CO2: Comprehend microcontroller architecture and instruction set.
CO3: Develop programs for PIC16FXXX microcontroller.
CO4: Demonstrate real world applications through simulation and hardware.

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	-	-	-	-	-	-	1	2	1	-	-	2	1	-
CO3	3	3	3	-	2	-	-	1	2	1	-	-	3	2	-
CO4	3	3	3	2	3	-	-	2	2	3	-	-	3	2	1

Syllabus

Unit 1

Introduction to micro controllers – Architecture and programming, Register files, Memory Organisation, Tristate – logic, Busses-Memory Address register-Memory addressing-Read and write operations, ROM – RAM – PROM – EPROM-E2PROM.

Unit 2

PIC16FXXX architecture, operation, data and program memory organization, special function registers, addressing modes, instruction set. Assembler, assembler directives, simple programs, conditional branching. Subroutines, nested subroutines, interrupts, ISR, priority.

Unit 3

Peripherals: Port configuration, Parallel Slave Port, LED and Keyboard interface, Timers/Counters, WatchDog Timer, ADC, USART, CCP module, real world application development. Introduction to 8051 microcontroller: Architecture, Instruction Set, Interrupts, Ports, Timers.

Textbook

1. *Myke Predko, "Programming and customizing the PIC microcontroller", 3rd Edition, Tata McGraw Hill Publishing Company Limited, 2008.*

References

1. *T. R. Padmanabhan, "Introduction to microcontrollers and applications", 1st Edition, Narosa publishing house private limited, 2007.*
2. *PIC Micro mid Range MCU Family Reference Manual - Micro Chip Technology Inc.*

23ELC213	DATA STRUCTURES AND ALGORITHMS	L-T-P-C: 3-0-2-4

Course Objective

- To understand linear and nonlinear data structures and perform complexity analysis.

Course Outcomes

CO1: Understand complexity analysis of algorithms.
CO2: Apply operations of linear data structures using ADT, array, linked list.
CO3: Comprehend the operations of non-linear data structures using linked list.
CO4: Familiarize searching and sorting algorithms using data structures.

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	-	-	-	-	2	2	2	-	-	2	1	2
CO2	3	2	2	-	2	-	-	2	2	2	-	-	2	1	2
CO3	3	2	2	-	2	-	-	2	2	2	-	-	2	1	2
CO4	3	2	1	-	2	-	-	2	2	2	-	-	2	1	2

Syllabus

Unit 1

Introduction: Overview of Data Structures. Abstract Data Types. Basic complexity analysis – Best, Worst, and Average Cases, Linked List: Using Arrays, Lists – Linked Lists – LL ADT – Singly Linked List – Doubly Linked List – Circular Linked List. Stacks and Queues: ADT – Array based, Linked list based, Double-ended queue, Circular queue.

Unit 2

Trees: Tree Definition and Properties – Tree ADT – Basic tree traversals - Binary tree – Data structure for representing trees. Priority queues: ADT – Implementing Priority Queue using List – Heaps.

Unit 3

Search trees – Binary search tree – Heap Sort – Divide and Conquer Strategy – Merge Sort - Quick Sort.

Textbooks

1. *Michael T Goodrich and Roberto Tamassia and Michael H Goldwsasser, "Data Structures and Algorithms in Java", 5th Edition, John Wiley publication, 2010.*
2. *Clifford A. Shaffer, "Data Structures and Algorithm Analysis", 3rd Edition, Dover Publications, 2012.*

References

1. *Michael T Goodrich and Roberto Tamassia and Michael H Goldwsasser, "Data Structures and Algorithms in Java", John Wiley publication, 2013.*
2. *Tremblay J P and Sorenson P G, "An Introduction to Data Structures with Applications", 2nd Edition, Tata McGraw-Hill, 2002.*

23LSE211	Life Skills for Engineers II	L-T-P-C: 1-0-2-2

Pre-requisite: An inquisitive mind, 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
- 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 manage emotions 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 and Circular 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 right words. Usage of more appropriate words in different contexts is emphasized.
Grammar (**Basic-intermediate**): Help students master usage of grammatical forms and enable students 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 them understand different tones in comprehension passages.
Speaking Skills: Make students be aware of the importance of impactful communication through individual speaking activities in class.
Writing Skills: Introduce formal written communication and keep the students informed about the etiquette of email writing.

References:

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
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

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

- Through a study of the Mahabharata, the student should gain a deeper understanding of the ethical grandeur of Indian culture, and be inspired to follow the ideals of the characters depicted therein.

Course Outcomes

CO1: Understand the impact of *itihasas* on Indian civilization with a special reference to the *Adiparva* of Mahabharata.

CO2: Enabling students to 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: Getting the deeper understanding of the Yuddha Dharma through the subsequent Parvas viz., Drona, Karna, Shalya, Sauptika Parvas.

CO5: Making the students appreciative of 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
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 1

Introduction and Summary of the Mahabharata.
A Preamble to the Great Itihasa.
Unbroken Legacy.

Unit 2

Dharmic Insights of a Butcher.
The Vows We Take.
Kingship and Polity Acumen.

Unit 3

Karna – The Maestro that Went Wide off the Mark.
Tactics of Krishna.
Yajnaseni.

Unit 4

Popular Regional Tales.
Maha Prasthanam – The Last Journey.

Unit 5

Mahabharata - An All-Encompassing Text.
Mahābhārata- Whats and WhatNots.
Nyayas in Mahabharata.

Textbooks/ References

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

SEMESTER V

23ELC301	ENERGY SYSTEMS	L-T-P-C: 3-0-0-3

Course Objective

- To familiarize with the structure, operation, and analysis of components in power system network.

Course Outcomes

CO1: Understand the operations of generation, transmission, and distribution systems.
CO2: Model power system components and networks.
CO3: Perform load flow, fault, and stability analysis of power system.
CO4: Monitor and control the power system network.

CO-PO Mapping

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

Syllabus

Unit 1

Structure of Electric Power Systems Network – Conventional, Deregulated, Micro-grid and Smart Grid. Conventional and Alternate Energy sources. Transmission line parameters, modelling and analysis. Real and reactive power flow and compensation.

Unit 2

Representation of power system: Single line diagram, per unit representation and matrix representation.
Analysis of Power Networks – Load flow analysis – Gauss seidel, Newton Raphson. Short circuit analysis – symmetrical and unsymmetrical faults.

Unit 3

Power System stability – swing equation – steady state and transient stability – equal area criterion – critical clearing time. Introduction to power system operation and control.

Virtual lab platforms / simulation demos can be used for effective classroom teaching.

Textbook

1. *John J. Grainger and Stevenson W. D, "Power System Analysis", McGraw Hill International, 2016.*

References

1. *Hadi Saadat,"Power system analysis", McGraw Hill publishing company, 2003.*
2. *B.R.Gupta, "Power system analysis and design", S. Chand & Company Ltd., 2004.*
3. *Wadhwa C. L., "Electric Power System", Wiley Eastern Limited, India 2007.*
4. *L.L.Grigsby, "Electrical power engineering Handbook", IEEE press, 2001.*
5. *Kothari D. P. and Nagrath I. J., "Modern Power System Analysis", Tata McGraw Hill Publishing Company, 2003.*
6. *Abhijith Chakrabarti, D. P.Kothari and A. K. Mukhopadhyay, "An Introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems", PHI learning private limited, India, 2010.*

23EEE301	DIGITAL SIGNAL PROCESSING	L-T-P-C: 3-1-0-4

Pre-requisite: Signals and Systems.

Course Objective

- To explore various digital signal processing techniques for real time applications.

Course Outcomes

CO1: Understand the frequency analysis of signals in discrete domain.
CO2: Apply FFT for frequency analysis of signals in discrete domain.
CO3: Design, analyze and build digital filters.
CO4: Implement DSP algorithms and digital filters.

CO-PO Mapping

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

Syllabus

Unit 1

Discrete Fourier Transforms: Frequency domain sampling and reconstruction of discrete time signals The DFT as a Linear Transformation – Relationship of the DFT to other Transforms, Properties of DFT – Linear Filtering methods based on DFT – Efficient computation of the DFT-FFT Algorithms. Efficient computation of DFT of Two real sequences – Use of FFT in Linear filtering and correlation.

Unit 2

Digital Filters: Introduction, Specifications of practical filters. a) FIR Filters: Symmetric and anti-symmetric FIR filters, Design of linear phase FIR filter using Windows/optimization techniques. Design of Linear phase FIR Filters FIR filters for harmonic elimination b) IIR Filters: Design from Analog filters, Impulse Invariance and Bilinear Transformation. IIR filters for extraction of fundamental frequency. c) Characteristics of commonly used Analog filters.

Unit 3

Digital Filter realization, structures for realisation of discrete time systems, Structures for FIR systems – direct form structures, cascade form structures, frequency sampling structures, lattice structures. Structures for IIR systems, Direct, cascade and parallel form structures. Analysis of Finite word length effect and limit cycle oscillations in recursive systems. Applications of DSP: Multirate Digital Signal Processing, Sampling rate conversion, Decimation and interpolation.

Simulation experiments on DFT, FFT, Filter design, Noise models and their impact on signal/noise ratio, Application in power systems.

Textbooks

1. *Sanjit K. Mitra, "Digital Signal Processing, A Practical approach", Tata McGraw Hill Publishing Company Limited, 2005.*
2. *John G Proakis, G. Manolakis, "Digital Signal Processing Principles, Algorithms, Applications", 4th Edition, Prentice Hall India Private Limited, 2007.*

References

1. *Allen V. Oppenheim, Ronald W. Schafer, "Discrete time Signal Processing", 5th Edition, Prentice Hall India Private Limited, 2000.*

23ELC302	EMBEDDED SYSTEM DESIGN USING ARM	L-T-P-C: 3-0-2-4

Pre-requisite: Microcontrollers and applications.

Course Objective

- To develop real world applications using advanced microcontrollers.

Course Outcomes

CO1: Understand the basics of embedded systems.
CO2: Comprehend embedded computing architecture.
CO3: Develop programs for ARM based microcontrollers.
CO4: Demonstrate ARM based real time applications through simulation and hardware.

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	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	2	-	2	-	-	1	3	1	-	-	3	2	-
CO4	3	3	3	2	2	-	-	2	3	2	-	-	3	3	2

Syllabus

Unit 1

Introduction to embedded systems – Definition, Characteristics, Classifications, Building Blocks, Applications. Hardware & Software Components. Embedded system design process. Evolution of Processors – Microprocessor, Microcontroller, Digital Signal Processor, Application Specific Processor, Multicore Processor, FPGA, ASIC, GPU.

Unit 2

Introduction to ARM processors – Evolution. Advanced ARM Architecture – Core Architecture, Processor, Programmers Model, Exception Model, Memory Model, Instruction Set, Addressing modes. Assembly Language Programming.

Unit 3

Introduction to ARM based Microcontrollers – Peripherals – Ports, Timers, PWM, ADC, UART, SPI, I2C – Application development – Bare - metal Programming, Rapid Prototyping with libraries. Case studies with real world automation applications.

Textbooks

1. *Marilyn Wolf, "Computers as Components – Principles of Embedded Computing System Design", 3rd Edition Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.*
2. *Trevor Martin, "The Designer's Guide to the Cortex-M Processor Family - A Tutorial Approach", 1st Edition, Elsevier Science, 2013.*

References

1. *Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide - Designing and Optimizing System Software", Elsevier Science, 2004.*
2. *Stephen B. Furber, "Arm System-On-Chip Architecture", Pearson Education, 2001.*

23ELC303	DATA BASE SYSTEMS AND PROGRAMMING	L-T-P-C: 3-0-2-4

Course Objective

- To learn fundamentals of database management systems and understand how to connect database to front-end programs.

Course Outcomes

CO1: Understand relational data modelling, and formulate relational algebraic queries.
CO2: Develop Entity-Relationship models for different database requirements.
CO3: Design and build normalized databases.
CO4: Apply SQL statements and PL/SQL programs for relational database operations.
CO5: Implement CURD operations for relational databases using Python SQLite.

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	-	2	-	-	2	2	2	-	-	2	1	2
CO2	3	3	3	2	3	-	-	2	2	2	-	-	2	1	2
CO3	3	3	3	2	3	-	-	2	2	2	-	-	2	1	2
CO4	3	2	3	2	3	-	-	2	2	2	-	-	2	1	2
CO5	3	3	3	2	3	-	-	2	2	2	-	-	2	1	2

Syllabus

Unit 1

Introduction: Overview of DBMS, File vs. DBMS, elements of DBMS. Database design: E–R model, Notations, constraints, cardinality and participation constraints, ER design issues, Weak and strong entity sets, Extended ER features. Relational Data Model: Introduction to relational model, Structure of relational mode, domain, keys, tuples to relational models.

Unit 2

Relational Database Design: Functional dependency, Reduction of ER model to Relational model, Normalization: 1NF, 1NF, 2NF, 3NF. Decomposition Using Functional Dependencies including establishing keys and relationships. SQL: Various DDLs, DMLs, DCLs.

Unit 3

Python and databases: Development tools, drivers, and modules, Design a database within RDBMS and SQLite. Database connectivity with python. CRUD statements using python programming language. Python wrappers within RDBMS.
An overview of NoSQL databases.

Text Book

1. *Silberschatz A., Korth H. F. and Sudharshan S., "Database System Concepts", 6th Edition, Tata McGraw-Hill Publishing Company Limited, 2010.*

References

1. *Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, "Database Systems: The Complete Book", 2nd Edition, 2011.*
2. *Elmasri R. and Navathe S. B., "Fundamentals of Database Systems", 5th Edition, Addison Wesley, 2006.*
3. *Ramakrishnan R and Gehrke J, "Database Management Systems", Third Edition, McGraw-Hill, 2003.*
4. *Andreas Meier, Michael Kaufmann, "SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management", Springer Verlag 2019*

Course Objective

- To plan, monitor, control and protect the power system.

Course Outcomes

CO1: Perform load flow, short circuit, and stability studies.
CO2: Apply passive and active compensation techniques for power flow control.
CO3: Analyse the operation of power system.
CO4: Develop protection scheme for power system components and 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	2	3	-	-	1	2	1	-	-	2	2	-
CO2	3	3	2	2	3	-	-	1	2	1	-	-	2	2	-
CO3	3	3	2	-	3	-	-	1	2	1	-	-	2	2	-
CO4	3	3	2	-	3	-	-	1	2	1	-	-	2	2	-

Syllabus

Experiments on analysing the performance of transmission line, perform load flow analysis, short circuit analysis, transient stability analysis, shunt and series compensation techniques, enhancement of steady state stability, monitoring, control and protection of a power system network.

23LSE301	Life Skills for Engineers III	L-T-P-C: 1-0-2-2

Pre-requisite: 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 become good 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 for arriving 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 questions on 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. Being enterprising. 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 in a group discussion. Personality traits evaluated in a group discussion. Initiation techniques and maintaining 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, Circular Arrangements, 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 Grammar and 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.

References:

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
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

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.**

23LIV390***	LIVE IN LAB I***	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.
- User Need Assessment through Quantitative and Qualitative Measurements
- Designing a solution by integrating Human Centered Design concepts
- Devising proposed intervention strategies for Sustainable Social Change Management

Course Outcomes

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

23ELC311 POWER ELECTRONICS AND DRIVES L-T-P-C: 3-0-0-3

Course Objective

- To impart knowledge on the characteristics of power semiconductor devices, operation of different power conversion circuits for various applications and development of electrical drives.

Course Outcomes

CO1: Understand the characteristics of power semiconductor devices, power converters and drives.
CO2: Analyze the behaviour of converters and their control techniques for electric drives.
CO3: Design various converter circuits under different operating modes.
CO4: Evaluate the performance of power converters for drive applications.

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	3	3	-	2	-	-	-	-	-	-	-	2	-	-
CO3	3	2	3	-	2	-	-	-	-	-	-	-	2	2	1
CO4	3	2	3	-	2	-	-	-	-	-	-	-	2	-	1

Syllabus

Unit 1

Power semiconductor Devices: Diode, SCR, MOSFET, IGBT, safe operating area, selection of devices for various applications. Heat sink, Harmonic Analysis. AC to DC converters: Single phase and three phase thyristor full bridge rectifiers. DC to DC converters: Buck, Boost, Buck-Boost converters.

Unit 2

DC to AC converters: Basic concepts of VSI, operation of single-phase full bridge inverter, PWM modulation strategies: Single phase Sinusoidal PWM (unipolar, bipolar), Three phase PWM inverters. Single phase PWM rectifiers, control scheme of PWM rectifiers, applications of PWM rectifiers.

Unit 3

Review of speed – torque characteristics of DC motors – speed control methods – Single phase and three phase converter configurations – Separately excited dc motors for two quadrant operations – chopper-controlled dc drives - Speed controlled drive system. Torque speed characteristics of induction machine – Methods of speed control - Variable frequency operation of three phase induction machine, voltage fed inverter control, Introduction to Vector control – Wound Rotor Induction Machine Control: Static rotor resistance control, slip power recovery schemes. Introduction to PMSM and BLDC Motor Drives.

Textbook

1. *Ned Mohan, Tore M. Underland and William P. Robbins, "Power Electronics: Converters, Applications and Design", 3rd Edition, John Wiley & Sons, 2007.*

References

1. *Muhammed H. Rashid, "Power Electronics- circuits, devices and applications", 4th Edition, Pearson Education, 2017.*
2. *R. Krishnan, "Electric Motor Drives, Modeling, Analysis and Control", Prentice Hall, NJ, 2015.*
3. *L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.*
4. *Erickson, Maksimovic, and Dragan, "Fundamentals of Power Electronics", Kluwer academic publishers, 2020.*
5. *Joseph Vithayathil, "Power Electronics" Tata McGraw Hill, 2010.*

23ELC312	COMPUTER NETWORKS AND IoT	L-T-P-C: 3-0-0-3

Pre-requisite: Microcontrollers and Applications.

Course Objective

- To introduce the basic concepts and operation of computer networks and IoT devices.

Course Outcomes

CO1: Understand layered approach of network design in computer networks.
CO2: Familiarize protocol layers and services in computer networks.
CO3: Comprehend IoT devices, components, and networks.
CO4: Design IoT solutions 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	-	-	-	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	2	-	2	-	-	1	-	1	-	-	2	3	2
CO3	3	-	-	-	2	-	-	-	-	-	-	-	3	3	3
CO4	3	2	2	1	-	-	-	1	-	1	-	-	3	3	3

Syllabus

Unit 1

Data communication Systems: Components, Types. Introduction to Networked Systems – Components, Types. Protocol – Need, Services, Layered Architecture. ISO/OSI Model & TCP/IP Model – Layers & Services, Comparison. Introduction to IOT: Architectural Overview, Components, Functional Elements, Applications, Challenges. IoT Devices: End device, Edge Device, Server/Cloud Devices.

Unit 2

Constrained nodes and network, Content Centric Networking, In-Network Processing. Physical Layer: Modulation, Multiplexing, Transmission media. Data Link Layer: Framing, Error detection and correction, Addressing, Medium access protocols. Network Layer: Routing & Addressing. Transport Layer: TCP, UDP, Socket, Congestion control algorithms, Application layer: security, symmetric encryption-AES, DES, stream cipher, asymmetric encryption. Application layer protocols: HTTP, MQTT, CoAP, XMPP, AMQP.

Unit 3

Familiarization of Communication technologies for IoT: IEEE 802.3/802.11/802.15.4, Bluetooth Low Energy, ZigBee, LoRa, 6LoWPAN. IoT Node Design. Programming IoT Devices. Case Studies on IoT Solutions for real world automation problems: Agriculture/Industrial/Healthcare/Robotics/Automotive/Smart City/Smart Grid/Smart Buildings.

Textbooks

1. *Andrew S. Tanenbaum and David J. Wetherall, "Computer Networks", 5th Edition, Pearson Education, 2011.*
2. *Vijay madisetti, Arshdeep Bahga, Internet of Things, "A Hands-on approach". University Press, 1st Edition, 2015.*

References

1. *Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley and Sons Ltd., 2005.*
2. *Rayes, Ammar, Salam, Samer "Internet of Things from Hype to Reality", 2nd Edition, Springer, 2018.*
3. *Boris Adryan, Dominik Obermaier, Paul Fremantle "The Technical Foundations of IoT", 2nd edition, Artech House, 2017.*

23ELC313	THEORY OF COMPUTATION AND COMPILER DESIGN	L-T-P-C: 3-1-0-4

Course Objective

- To introduce to the mathematical foundations of computations.

Course Outcomes

CO1: Apply Finite state machines for lexical analyser.
CO2: Demonstrate the push down automata model for a given language.
CO3: Develop algorithms for structural correctness of source programs.
CO4: Analyse intermediate representation and procedure calls in Turing 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	2	-	-	-	-	-	-	-	-	2	2	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO3	3	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO4	3	2	2	2	-	-	-	-	-	-	-	-	2	2	-

Syllabus

Unit 1

Automata and Languages: Chomsky hierarchy of languages – Introduction to finite state Automata – Regular Expressions – Nondeterministic Finite Automata – equivalence of NFAs and DFAs – Minimization of DFA. Lexical Analysis.

Unit 2

Non-Regular Languages -Context free languages – Context Free Grammar -Chomsky normal form – Push Down Automata – parse tree derivations- Ambiguous grammar, removing ambiguity. Top down and bottom up parser- LR(0), LR(1), LALR.

Unit 3

Turing Machines – Non-deterministic Turing Machines – intermediate representation – procedure calls.

Textbooks

1. *Linz P., "An introduction to formal languages and automata", 6th Edition, Jones and Bartlett Publishers, 2016.*
2. *Aho, Alfred V., Monica S. Lam, Ravi Sethi, and Jeffrey Ullman, "Compilers: Principles, Techniques and Tools", 2nd Edition, Prentice Hall, 2006.*

References

1. *Michael Sipzer, "Introduction to the Theory of Computation", 2nd Edition, Boston, MA: Course Technology, 2005 (pumping lemma to be followed from this book).*
2. *Martin and John, "Introduction to Languages and the Theory of Computation", New York, NY: McGraw Hill, 2002.*
3. *J E Hopcroft, R Motwani and J D. Ullman, "Introduction to Automata Theory, Languages, and Computation", 3rd Edition, Addison-Wesley, 2007.*
4. *Cooper, Keith, and Linda Torczon, "Engineering a Compiler", 2nd Edition, Morgan Kaufman, 2011.*

23ELC382	POWER ELECTRONICS AND DRIVES LAB	L-T-P-C: 0-0-3-1

Course Objective

- To understand the characteristics of power semiconductor devices, and power converters for drives.

Course Outcomes

CO1: Understand the characteristics of power semiconductor devices, power electronic converters and drives.
CO2: Build power converter circuits with suitable control techniques.
CO3: Analyze the performance of power converters for drive applications.

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	-	3	-	-	1	2	2	-	-	2	1	1
CO2	3	2	2	-	3	-	-	1	2	2	-	-	2	1	1
CO3	3	2	2	-	3	-	-	1	2	2	-	-	2	1	1

Syllabus

Characteristics of Power diode and Power MOSFET, harmonic analysis of single-phase full converter, DC – DC Chopper, PWM inverter, Modelling of DC motor, Converter fed DC motor, Chopper fed DC motor, Induction motor drive, BLDC drive, PMSM drive.

Textbooks

1. *Daniel W. Hart," Introduction to Power Electronics", McGrawHill Education,2017*
2. *Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2001.*

23ELC383	COMPUTER NETWORKS AND IoT LAB	L-T-P-C: 0-0-2-1

Pre-requisite: Microcontrollers and Applications.

Course Objective

- To develop real world applications using networking and IoT concepts.

Course Outcomes

CO1: Analyse protocol layers and services in computer networks using simulation software.
CO2: Develop programs for various network algorithms.
CO3: Develop IoT devices and networks.
CO4: Demonstrate IoT solutions 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	1	3	-	-	2	3	2	-	-	2	3	2
CO2	3	2	2	2	3	-	-	2	3	2	-	-	2	3	1
CO3	3	2	2	2	3	-	-	2	3	2	-	-	2	3	2
CO4	3	3	3	3	3	-	1	2	3	3	-	-	3	3	2

Syllabus

Simulation study of various communication networks using communication network simulators, Network analysis tools and packet data frame formats, Error correction, routing and cryptographic algorithms**,** End, edge and server devices, TCP/IP connection using microcontroller board & PC/Laptop, IoT network for real-world applications.

Textbooks

1. *Andrew S. Tanenbaum and David J. Wetherall, "Computer Networks", 5th Edition, Pearson Education, 2011.*
2. *Vijay madisetti, Arshdeep Bahga, Internet of Things, "A Hands-on approach", 1st Edition, University Press, 2015.*

References

1. *Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley and Sons Ltd., 2005.*
2. *Rayes, Ammar, Salam, Samer "Internet of Things from Hype to Reality", 2nd Edition, Springer, 2018.*
3. *Boris Adryan, Dominik Obermaier, Paul Fremantle "The Technical Foundations of IoT", 2nd Edition, Artech House, 2017.*

23ELC384	OPEN LAB	L-T-P-C: 0-0-3-1

Course Objective

- To empower with practical experience to reinforce theoretical concepts, teamwork, technical writing and publication skills.

Course Outcomes

CO1: Solve real time problems through the acquired theoretical knowledge in core courses.
CO2: Manage the time and cost of the product development.
CO3: Communicate the scientific findings through oral and writing modes with clarity and justification.
CO4: Work as a team and effectively utilize the advanced tools.

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	-	-	-	1	-	-	-	2	-	3	
CO2	-	-	-	-	-	-	-	1	-	-	3	2	-	-	
CO3	-	-	-	-	-	-	-	1	-	3	-	2	-	-	
CO4	-	-	-	-	3	-	-	1	2	-	-	2	3	3	

Syllabus

This is a hands – on section for the students. By the sixth semester, the students are adept in different core streams like Power Electronics, Power Systems, Electrical Machines, Energy Systems and Digital Signal Processing etc. The students will apply their acquired knowledge and develop an application related to one or more of the core areas and implement a pragmatic setup, justifying the application.

23LSE311	Life Skills for Engineers IV	L-T-P-C: 1-0-2-2

Pre-requisite: Self-confidence, presentation skills, listening skills, basic English language skills, 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 their knowledge, 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 questions on 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/deductive reasoning 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

Team Work: 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.

Aptitude

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 of Amrita 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.

Verbal

Vocabulary: Empower students to communicate effectively through one-word substitution.
Grammar: Enable students to improve sentences through a clear understanding of the rules of grammar.
Reasoning: Facilitate the student to tap his reasoning skills through Syllogisms, critical reasoning arguments and logical ordering of sentences.
Reading Comprehension (**Advanced**): Enlighten students on the different strategies involved in tackling reading comprehension questions.
Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently 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 Vishwa Vidyapeetham.
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

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***	3

Course Objectives

- Proposal writing to bring in a detailed project planning, enlist the materials required and propose budget requirement.
- Use the concept of Co-design to ensure User Participation in the Design Process in order to rightly capture user needs/requirements.
- Building and testing a prototype to ensure that the final design implementation is satisfies the user needs, feasible, affordable, sustainable, and efficient.
- Real time project implementation in the village followed by awareness generation and skill training of the users (villagers).

Course Outcomes

CO1: Learn co-design methodologies and engage participatorily to finalise a solution.
CO2: Understand sustainable social change models and identify change agents in a community.
CO3: Learn Project Management to effectively manage the resources.
CO4: Lab scale implementation and validation.
CO5: Prototype implementation of the solution.

CO-PO Mapping

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

Syllabus

The students shall visit villages or rural sites during the vacations (after 6th 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

23ELC397	INDUSTRY INTERNSHIP	P/F

Course Objectives

- To expose the students to industry setting and get acquainted with its various functions.
- To gain direct experience so as to relate and reinforce the concepts learned in the class room.
- To promote collaboration between industry/Research Laboratory and the institution.

Course Outcomes

CO1: Familiarize with the industry environment/Research Laboratory.
CO2: Understand the application of theoretical concepts in a practical setting.
CO3: Prepare technical documents/presentations related to the work completed.

CO-PO Mapping

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

Syllabus

Students have to undergo minimum of one week of practical training in Electrical, Electronics Engineering or allied industries/research laboratory of their choice with the approval of the department. At the end of the training student should submit a report and certificate of completion to the department in the prescribed format.

Evaluation Pattern

This course is mandatory and a student has to pass this course to be eligible for the award of degree. The student shall make a report. The committee constituted by the department which will assess the student based on the report submitted.

SEMESTER VII		
23ELC498	**PROJECT PHASE I**	**L-T-P-C: 0-0-18-6**

Course Objective

- To comprehend, design, develop, implement, and test the functionality of a project work and prepare a technical paper in an approved format and present it.

Course Outcomes

CO1: Ability to investigate an engineering problem and design/develop the proof of concept of its solution.
CO2: Ability to estimate and manage the cost and time of the project.
CO3: Ability to present the project with clarity and ethics in both oral and written mode.
CO4: Ability to develop a team and effectively participate in the team to execute the project.
CO5: Ability to support the environmental, social and engineering discipline through the project.

CO-PO Mapping

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

23ENV300	ENVIRONMENTAL SCIENCE	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

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

CO-PO Mapping

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

Syllabus

Unit 1

Overview of the global environment crisis – Biogeochemical cycles – Climate change and related international conventions and treaties and regulations – Ozone hole and related International conventions and treaties and regulations – Over population – energy crisis – Water crisis – ground water hydrogeology – surface water resource development.

Unit 2

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 and effluent treatment – air pollution and related international and local conventions – treaties and regulations – Other pollution (land – thermal - noise).

Unit 3

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

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

References

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.*

23LAW300	INDIAN CONSTITUTION	P/F

Course Objectives

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

Course Outcomes

CO1: Understand the functions of the Indian government.
CO2: Understand and abide the rules of the Indian constitution.
CO3: Understand and appreciate different cultures among the people.

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	-	-	-	-	-	-	-

Syllabus

Unit 1

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 2

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

Unit 3

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

Text Books

1. *Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.*
2. *R.C.Agarwal, "Indian Political System", S.Chand and Company, New Delhi, 1997.*

References

1. *Sharma, Brij Kishore, "Introduction to the Constitution of India", Prentice Hall of India, New Delhi.*

SEMESTER VIII

23ELC499	PROJECT PHASE II	L-T-P-C: 0-0-18-6

Course Objective

- The project shall be focused on the synthesis of the knowledge gained over the past seven semesters, by taking up a work of relevance to Electrical & Computer Engineering covering design/ development/ realization/ application/ performance analysis/ state-of-the-art technology.

Course Outcomes

CO1: Ability to investigate on an engineering problem and suggest the proof of concept of its solution.
CO2: Ability to estimate and manage the cost and time of the project.
CO3: Ability to present the project with clarity and ethics in both oral and written mode.
CO4: Ability to develop a team and effectively participate in the team to execute the project.
CO5: Ability to support the environmental, social and engineering discipline through the project.

CO-PO Mapping

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

23EEE342	SMART GRID[+]	L-T-P-C: 3-0-0-3

[+]Not applicable for EEE

Pre-requisite: Energy Systems.

Course Objective

To understand and evaluate Smart Grid technologies.

Course Outcomes

CO1: Understand the fundamental concepts and challenges in smart grid.
CO2: Familiarize with various smart grid technologies.
CO3: Comprehend standards and protocols for smart grid operation.
CO4: Apply computational intelligence in smart grid applications.

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	1	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1
CO3	3	-	-	-	2	3	-	-	-	-	-	-	3	2	1
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3

Syllabus

Unit 1

Smart Grid: Comparison with existing grid, Concept of smart grid – Definition, Features, Stakeholders, Applications, International policies, Opportunities & Barriers. Smart grid as a Cyber-Physical System. Smart grid Architecture. Concepts of smart homes, smart cities and cooperative grids. Energy market overview, Role of System Operators, DSO, and TSO under the smart grid, Transactive Energy.

Unit 2

Smart grid Technologies Overview: Smart Generation System – SCADA, Distributed Generation. Smart Transmission System – Wide Area Measurement Systems (WAMS), Wide Area Protection Systems (WAPS), Wide Area Control Systems (WACS), WAMPAC, Smart Substations – SCADA. Smart Distribution Systems – Demand Side Management – Demand Response and Demand Despatch, Advanced Metering Infrastructure (AMI). Smart Micro Grids. Integration of resources to grid – Distributed energy resources (DERs), Plug-in Electric Vehicles.

Unit 3

ICT in Smart Grid – End to end communication models, Communication Networks –HAN/BAN, LAN/FAN/NAN, WAN. Communication Technologies – Wired & Wireless, Protocols and Standards. Cyber Security in Smart Grid. IoT & Smart Grid. Need of artificial intelligence for smart grid applications. Data Analytics and cloud computing in the Smart Grid. Case study in smart grid.

Textbooks/ References

1. *Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", John Wiley & Sons, IEEE Press, 2011.*
2. *James Momoh, "Smart Grid - Fundamentals of Design and Analysis", John Wiley & Sons, IEEE Press, 2012.*
3. *Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyam, Nick Jenkins, "Smart Grid Technology and Applications" John Wiley & Sons, 2012.*
4. *Clark W. and Gellings P. E., "The Smart Grid: Enabling Energy Efficiency and Demand Response", The Fairmont Press, Taylor & Francis, 2009.*
5. *Mini S. Thomas, John Douglas McDonald,"Power System SCADA and Smart Grids", CRC Press, April 2015.*

23EEE331	DEREGULATED POWER SYSTEM	L-T-P-C: 3-0-0-3

Pre-requisite: Energy Systems / Energy Systems I.

Course Objective

- To expose the deregulated power market operation, pricing mechanisms and electricity regulation and policies followed in India.

Course Outcomes

CO1: Understand the operation of deregulated power system and electricity market.
CO2: Comprehend Indian power sector acts, regulations, and policies.
CO3: Apply different pricing mechanisms and market strategies.
CO4: Deploy technologies for transmission congestion management, market settlement, and tariff computation.

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	1	-	-	-	3	-	-	-	-	-	-	1	-	-
CO3	3	3	3	2	3	-	-	-	-	-	-	-	2	2	1
CO4	3	3	3	3	3	-	-	-	-	-	-	-	2	2	1

Syllabus

Unit 1

Power Sector in India – Classical operation of power systems, least-cost operation, marginal cost, incremental cost - inter-utility interchanges. Fundamentals of deregulated power systems: Requirements and key issues - restructuring models - Independent system operators (ISOs).

Unit 2

Electricity market: Evolution and types of electricity markets - Competitive market - supply and demand functions, Market equilibrium - Market power and mitigation. Transmission Open Access: transmission pricing - pricing schemes - Concept of distribution factors – Location based marginal pricing.

Unit 3

Transmission capacity, Available Transfer capability (ATC) – Open Access Same Time Information Systems (OASIS) - Transmission congestion management – Ancillary Services: classifications and definitions – Indian Electricity Acts and Policies – 2003 Acts – Availability Based Tariff (ABT).

Textbooks / References

1. *Kankar Bhattacharya, Math H.J. Bollen and Jaap E. Daalder, "Operation of Restructured Power Systems", Springer, 2001.*
2. *M. Shahidehpour and M. Alomoush "Restructured Electrical Power Systems – Operation, Trading and Volatility", CRC Press, 2001.*
3. *Loe Lie Lai "Power Systems Restructuring and Deregulation", John Wily, 2001.*

23EEE332	ENERGY STORAGE SYSTEMS	L-T-P-C: 3-0-0-3

Course objective

- To understand the different energy storage technologies and its applications to Electric Vehicle and Micro Grid.

Course Outcomes

CO1: Understand the role of energy storage systems and its technologies.
CO2: Apply energy storage technology in renewable energy integrations and micro grids.
CO3: Analyze the performance of Energy storage Systems in Electric Vehicles.
CO4: Expose to various management techniques applied to energy storage systems.

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	3	3	1	-	-	-	-	-	-	-	-	1	-	2
CO3	3	3	3	1	-	-	-	-	-	-	-	-	1	-	2
CO4	3	3	3	1	-	-	-	-	-	-	-	-	1	1	-

Syllabus

Unit 1

Introduction to energy storage for power systems: Applications of energy storage systems, Components of Energy Storage Systems, Types of storage technologies: Thermal, Mechanical, Chemical, Electrochemical, Electrical. Efficiency of energy storage systems. Overview on Electrical energy storage: Batteries, Super capacitors, Superconducting Magnetic Energy Storage (SMES).

Unit 2

Energy storage systems- configurations and applications. Charge and discharge mechanism of Batteries, Comparison of storage systems - Energy density, power density Storage for renewable energy Integration: Solar energy, Wind energy, Electric vehicle. Energy storage in Microgrid and Smart grid.

Unit 3

Management of storage systems, Battery Management Systems, Management of Hybrid Energy Storage Systems (HESS), Increase of energy conversion efficiencies by introducing energy storage, Storage technology for energy management, Economics of Energy storage.

Textbooks/ References

1. *A.G. Ter-Gazarian, "Energy Storage for Power Systems", 2nd Edition, The Institution of Engineering and Technology (IET) Publication, UK, 2011. (ISBN - 978-1-84919-219-4),*
2. *Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt, "Energy Storage in Power Systems" Wiley Publication, Mar 2016. ISBN: 978-1-118-97130-7,*
3. *A. R. Pendse, "Energy Storage Science and Technology", SBS Publishers & Distributors Pvt. Ltd., New Delhi, 2011. (ISBN - 13:9789380090122),*
4. *Electric Power Research Institute (USA), "Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits" (1020676), December 2010.*
5. *Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) - A National Laboratory of the U.S. Department of Energy - Technical Report NREL/ TP6A2-47187, January 2010.*

23EEE333 INSTRUMENTATION FOR RENEWABLE ENERGY SYSTEMS L-T-P-C: 3-0-0-3

Pre-requisites: Measurements and instrumentation, Control Systems.

Course Objective

- To acquaint with the theory and working principles of different types of instruments, monitoring, communication interfaces and controls used in power plants based on renewable energy technology.

Course Outcomes

CO1: Familiarize with various components/equipment in renewable energy-based power plants.
CO2: Understand the basic principles of transducers used in electrical and mechanical measurements in power plants.
CO3: Familiarize with monitoring and control of power plants.
CO4: Examine various communication interfaces for instrumentation systems in industries.

CO-PO Mapping

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

Syllabus

Unit 1

Significance of Instrumentation in Solar, Wind, Biomass, Tidal and Geothermal Power plants. Types of measurement and instrumentation in power plants- functions and classification. Mechanical measurements: Pressure, Torque, Vibration, Speed, Level and Flow. Anemometers – cup, hot wire, SODAR, LIDAR. Sunshine recorder, pyranometer and pyroheliometer.

Unit 2

Passive electrical transducers, Resistive, thermal radiation detectors, resistive strain, resistive pressure, linear variable differential transformer. Active electrical transducers, Thermoelectric-thermocouples, RTD, piezoelectric, Hall Effect, and photoelectric transducers.

Unit 3

SCADA, Smart meters (net metering), Phasor measurement unit, basic measurements/sensing with ADC, CCP modules in PIC microcontrollers. PLC: architecture, programming and ladder diagram. Communication Technologies: wired, wireless. RF-Zigbee, Bluetooth, WiFi, Ethernet, GSM, GPRS, Data acquisition systems, data loggers. CAN bus and MOD bus systems. Overview of IoT and Industry 4.0.

Textbooks / References

1. *D.V.S.Murty, "Transducers and Instrumentation", 2nd Edition, Prentice-Hall of India Private Limited, 2008.*
2. *ArunK.Ghosh, "Introduction to Measurements and Instrumentation", 3rd Edition, PHI Learning Private Limited, 2009.*
3. *S. K. Singh, "Computer Aided Process Control", Prentice-Hall of India Private Limited, 2003.*
4. *William Stallings, "Wireless Communications and Networks", 2nd Edition, Pearson Education, 2005.*
5. *K. Sawhney, Puneet Sawhney, "Mechanical Measurements and Instrumentation & Control", Dhanpat Rai and Co., 2015.*
6. *D. Patranabis, "Principles of Industrial Instrumentation", 3rd Edition, McGraw Hill Education Pvt Ltd., 2010.*

23EEE334 POWER SYSTEM OPERATION CONTROL AND STABILITY L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems / Energy Systems I & II.

Course Objective

- To provide an insight into the relevance and possibilities of economic operation, control and stability aspects of power system.

Course Outcomes

CO1: Understand the principles of power system operation, control, and stability.
CO2: Develop mathematical model of power system controls.
CO3: Perform economic load dispatch and power system stability studies.
CO4: Design power system controllers.

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	-	1	-	-	-	-	-	-	-	-	1	-
CO3	3	3	1	1	1	-	-	-	-	-	-	-	1	1	-
CO4	3	2	3	-	-	-	-	-	-	-	-	-	2	1	-

Syllabus

Unit 1

Power system operation – state transition and control, SCADA in power systems-data acquisition, state estimation, security assessment and security enhancement – functions of control centers, - system load variations – system load characteristics. Economic load dispatch with and without losses – solution by iteration method (no derivation of loss coefficient) – Base point and participation factor. Real and Reactive power flows and control.

Unit 2

Basic P-f and Q-V loops, Load frequency control- modeling, analysis and control of single and multi-area – tie line with frequency bias control. Economic controller added to LFC. Need for Automatic Voltage regulator – various excitation systems-Modeling – static and dynamic analysis – Reactive power-voltage control devices.

Unit 3

Power System stability – classifications – Rotor angle stability – small signal stability – Effects of excitation system – Power system stabilizer – sub synchronous oscillations – Voltage stability – Voltage collapse – Methods to improve stability.

Textbooks / References

1. *Olle I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing company, 2004.*
2. *Prabha Kundur, "Power System stability and control", Tata McGraw Hill, 2008.*
3. *Kothari, D. P. and Nagrath, I. J., "Modern Power System Analysis", Tata McGraw Hill Publishing Company, 2011.*
4. *Allen J. Wood and Bruce F. Wollenberg, "Power Generation Operation and Control", John Wiley & Sons, 1996.*
5. *L.K. Kirchmayer, "Economic operation of Power System", John Wiley & Sons, 1967.*

23EEE335	RENEWABLE ENERGY TECHNOLOGIES	L-T-P-C: 3-0-0-3

Course Objective

- To introduce different renewable energy sources, its characteristics, and analyse renewable energy conversion systems.

Course Outcomes

CO1: Understand the need and means for renewable energy utilisation.
CO2: Illustrate the schemes to produce electricity from renewable resources.
CO3: Assess renewable energy potential availability.
CO4: Analyse the characteristics and control of various energy storage systems and RE energy conversion systems.

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	2	1	-	-	-	-	-	-	-	-	1	-	-	1
CO3	3	2	1	2	-	-	-	-	-	-	-	1	-	1	1
CO4	3	2	1	-	-	-	-	-	-	-	-	1	-	-	1

Syllabus

Unit 1

Renewable energy sources: Renewable energy utilization in ancient times; classification of RE Technologies, Recent developments in renewable energy sector – global and national energy policies. Solar energy – Solar radiation and measurements; Solar thermal Collector and its types, Solar thermal energy conversion systems – concentrators, PV Cell – principle, types and construction; Modelling of PV cell; Maximum power tracking; SPV systems – stand-alone and grid-connected.

Unit 2

Wind energy – Global and local winds, resource assessment, wind regime modelling – Weibull parameters; WEG technologies for grid connection, small wind turbine. Energy Storage systems – need for energy storage with RE, types - Pumped hydro storage, battery, fly wheel storge, super capacitor and compressed air. Comparison of energy storage technologies.

Unit 3

Other renewable energy technologies: Introduction to Biomass – gasifiers, digester, Small hydro, Wave, Tidal, Ocean thermal and Geothermal energy systems.

Textbooks / References

1. *Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning; 3rd Edition, 2015.*
2. *John W Twidell and A D Weir, "Renewable Energy Resources", Routledge Publications, 2015.*
3. *N. K. Bansal, M Kleemann and M Mellis, "Renewable Energy Resources and Conversion Technology", Tata McGraw Hill, 1990.*
4. *S. N. Bhadra, D Kastha and S Banerji, "Wind Electrical Systems", Oxford University Press,2005.*
5. *Ter-Gazarian, "Energy Storage for Power Systems", 3rd Edition, IET Energy Series 6, London, 2020.*

23EEE336	DIGITAL POWER SYSTEM PROTECTION	L-T-P-C: 3-0-0-3

Pre-requisites: Energy Systems/ Electrical energy systems I and II.

Course Objective

- To impart knowledge on various digital power system protection schemes.

Course Outcomes

CO1: Understand the elements and principle of protection.
CO2: Apply signal processing and mathematical approach towards protection.
CO3: Develop suitable digital protection schemes for power system components.
CO4: Analyze the application of artificial intelligence (AI) in digital relaying.

CO-PO Mapping

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

Syllabus

Unit 1

Nature, Causes and Consequences of faults- Fault statistics- Need for protection – Essential qualities of protection- Types of protection – Primary and back up protection-, - Basics of Switch Gear – Fuses, isolators, Earthing Switches. Circuit breakers – Operating Principle – Arc phenomenon, principle, DC and AC Circuit Breaking- Problems of circuit interruption- Interruption of capacitive currents, current chopping, Resistance switching and methods of arc extinction- Arc interruption theories – Arc voltage, restriking voltage, Recovery voltage. Lightning Arrestors – Surge Absorbers-Insulation co-ordination.

Unit 2

Instrument Transformers: CT, VT, CT Saturation and DC Offset Current. Sequence Components and Fault Analysis, Sampling theorem, Fourier Analysis, Discrete Fourier Transform, Properties of Discrete Fourier Transform, Computation of Phasor from Discrete Fourier Transform, Estimation of System Frequency. Numerical Relaying: Fundamentals, Numerical Relaying DSP Perspective. Fundamentals of Overcurrent Protection, PSM Setting and Phase Relay Coordination (Tutorial), Overcurrent Protection, Directional Overcurrent Protection, Distance Protection, Power Swings and Distance Relaying.

Unit 3

Earth Fault Protection using Overcurrent Relays, Directional Overcurrent Relaying, Directional Overcurrent Relay Coordination (Tutorial), Introduction to Distance Relaying, Setting of Distance Relays, Differential Protection of Bus, Transformer and Generator, Introduction to wide area measurement (WAM).

Textbooks / References

1. *A. G. Phadke and J. S. Thorp, "Computer relaying for power systems", John Wiley and Sons Ltd., 2009.*
2. *Ravindra P Singh, "Switchgear and power system protection", Prentice Hall of India,2009.*
3. *Badriram, D.N. Vishwakarma, "Power system protection & switchgear" Tata McGraw Hill Publishing Company Ltd 2011.*
4. *Modern Solutions for Protection, Control and Monitoring of Electric Power Systems, Hector Altuve Edmund O. Schweitzer III, Quality Books, Inc., 2010.*
5. *S. H. Horowitz and A. G. Phadke, "Power system relaying", John Wiley and sons ltd., 2008.*
6. *G. Ziegler, "Numerical differential protection: Principles and Applications", Wiley, 2012.*
7. *Sunil S Rao, "Switchgear protection & power system", Khanna Publications.*
8. *A. S.Ingole, "Switchgear and protection" Umesh publications,2006.*

9. *C. Christopoulos & A Wright, "Electrical Power Systems Protection", Springer International, 2010.*
10. *Bhuvanesh A. Oza, "Power System Protection and Switchgear", Tata McGraw Hill, 2010.*
11. *Hadley, et al. "Securing Wide Area Measurement Systems", Pacific Northwest National Laboratory, June 2007.*

23EEE337	HIGH VOLTAGE ENGINEERING	L-T-P-C: 3-0-0-3

Course Objective

- To impart knowledge on high voltage generation, measurement, and testing.

Course Outcomes

CO1: Formulate uniform and non-uniform electric field scenarios in different geometric boundaries.
CO2: Analyze the breakdown behavior of gas, liquid, and solid dielectric materials.
CO3: Familiarize with non-destructive test techniques for measuring dielectric properties.
CO4: Comprehend power apparatus testing as per standards and procedures for high voltage 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	-	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-	-	1	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	1	-

Syllabus

Unit 1

Introduction: different types of dielectrics, uniform and non-uniform electric field, electric field in some geometric boundaries.

Conduction and breakdown in gases: Collision process, ionization process, Townsend's theory, streamer theory, Pashen's law, breakdown in non-uniform fields and corona discharges- Vacuum insulation.

Conduction and breakdown in liquid dielectrics; Classification of liquid dielectrics, breakdown in liquid dielectric. Different types of solid dielectric materials-breakdown in solid dielectrics-field configuration in the presence of voids.

Breakdown in composite dielectric.

Unit 2

Generation of high voltages- ac voltages, dc voltages, impulse voltages. Generation of impulse currents.

Measurement of high voltages and currents – High DC, AC and impulse voltages, Direct, Alternating and Impulse currents.

Unit 3

Non-destructive insulation test techniques, measurement of insulation resistance under dc voltage, measurement of loss angle and capacitance, partial discharge measurement.

Testing of high voltage apparatus based in International and Indian standards-non-destructive testing-testing of insulators- bushings-cables-isolators and circuit breakers-transformers-surge arresters.

Textbooks / References

1. *M.S.Naidu and V.Kamaraju, "High voltage Engineering", 2nd Edition Tata McGraw-Hill, Publishing Company Limited, 2014.*
2. *C.L.Wadhwa , "High voltage Engineering", New age international (p) Ltd, Publishers, Reprint, 2007.*
3. *Kuffel.E and Abdullah.M, "High Voltage Engineering", Paragamon press, Oxford, London, 1970.*
4. *Gallghar.P.J. and Pearmain.A.J, "High voltage measurement, Testing and Design", John Wiley & Sons, NewYork, 1982.*
5. *Kuffel.E. and Zaengl.W.S, "High voltage Engineering. Fundamentals", Paragamon press, Oxford, London, 1986.*

23EEE338	COMPUTER AIDED ELECTRICAL MACHINE DESIGN	L-T-P-C: 3-0-0-3

Course Objective

- To equip students with the knowledge and skills necessary to design efficient, reliable, and cost-effective machines using modern computer-aided design and analysis tools.

Course Outcomes

CO1: Understand the basic design concepts of electrical machines.
CO2: Develop comprehensive design of DC and AC machines.
CO3: Formulate design problem based on the performance requirement of electrical machines.
CO4: Develop computer aided design 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	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO4	3	-	-	-	3	-	-	-	-	-	-	2	2	1	-

Syllabus

Unit 1

Introduction to Computer aided machine design, different approaches of computer aided design, Advantages and Limitations of Computer aided machine design, Mathematical formulation of general machine design problem, review of different electrical machines for overall design and flow chart of the design problem, review of Programming techniques (LP & NLP only), Methods of solution, Unconstrained optimization problems, constrained optimization problems.

Unit 2

Optimization problems-constrained optimization problems, Selection of variables for optimal design, Formulation of design equations- Objective function; Constraint functions, Algorithms for optimal design. Design of armature, Windings and field systems of DC machines – Programming techniques (LP & NLP only), Methods of solution, Unconstrained.

Unit 3

Optimal design of power transformer: Design of magnetic circuit, Design of windings, Selection of variables for optimal design, Formulation of design equations, Objective function, Constraint functions, Algorithms for optimal design. Optimal design for 3-phase alternator: Design of stator, windings, field system, selection of variables for optimal design, Algorithms for optimal design.
Optimal design of 3-phase induction motor: Design of stator, Windings Design of rotor.

Textbooks / References

1. *A. K. Sawhney, "A Course in Electrical Machine Design" 10th Edition, - Dhanpat Rai and sons, New Delhi.*
2. *M. V. Deshpandey, "Design and Testing of Electrical Machines", PHI Learning.*
3. *M. G. Say, "Performance and Design of A.C. Machines", East West Press Pvt. Ltd., New Delhi.*
4. *M. Ramamoorthy, "Computer- Aided Design of Electrical Equipment", Prentice Hall.*
5. *R. K. Agarwal, "Principles of Electrical Machine Design", 5th Edition, S. K. Kataria & Sons, New Delhi, 2016.*
6. *S. K. Sen, "Principles of Electrical Machine Design with Computer Programmes", Oxford & IBH Publishing Co.*

23EEE339	HIGH VOLTAGE TRANSMISSION SYSTEMS	L-T-P-C: 3-0-0-3

Course Objective

- To impart knowledge on EHVAC and HVDC transmission systems

Course Outcomes

CO1: Familiarize with the AC and DC transmission systems.
CO2: Understand EHVAC transmission system and reactive power compensation.
CO3: Analyse converter control of HVDC transmission systems.
CO4: Examine various faults and protection schemes in HVDC systems.

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	1	-	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	1	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-

Syllabus

Unit 1

Comparison of EHV AC and DC transmission, modern trends in AC and DC transmission, Corona and corona loss in transmission lines.

EHV AC Systems: Limitations of extra-long AC transmission, Voltage profile and voltage gradient of conductor, Electrostatic field of transmission line, Reactive Power planning and control, traveling and standing waves, EHV cable transmission system.

Reactive VAR requirements, Static VAR systems, design concepts and analysis for system dynamic performance.

Unit 2

Introduction of HVDC power transmission technology, Analysis and Control of HVDC converter and systems: Necessity of control of a DC link, rectifier control, compounding of rectifiers, power reversal of DC link, voltage dependent current order limit(VDCOL) characteristics of the converter, inverter extinction angle control, pulse phase control, starting and stopping of DC link, constant power control.

Unit 3

Harmonics and filters: Generation of harmonics by converters, characteristic variation of harmonic currents with variation of firing angle and overlap angle.

Fault and protection schemes in HVDC systems: Nature and types of faults, faults on AC side of the converter stations, converter faults, fault on DC side of the systems, protection against over currents and over voltages, protection of filter units.

Textbooks / References

1. *Begamudre R.D., "EHV AC Transmission Engineering", 2nd Edition, Wiley Eastern Ltd., New Delhi, 1991.*
2. *Arrillaga J., "HVDC Transmission", IEE Press, London, 1983.*
3. *Kimbark E., "Direct Current Transmission", Vol-I, John-Wiley & Sons, N.Y., 1971.*
4. *Padiyar K.R., "HVDC Power Transmission Systems", Wiley Eastern Ltd., New Delhi,1990.*
5. *Arrillaga J. and Smith B.C., "AC-DC Power System Analysis", IEE Press, London,1998.*
6. *Hingorani N.G. and Gyugyi L., "Understanding Facts", IEEE Press, New York,1999.*

23EEE340	SWITCHED MODE POWER CONVERTERS	L-T-P-C: 3-0-0-3

Prerequisites: Power Electronics/ Power Electronics & Drives.

Course Objective

- To introduce the concepts and design of converters, feedback controllers, protection circuits, driver circuits and magnetic elements for switched mode power supply applications.

Course Outcomes

CO1: Understand the principles of steady state and dynamic operation of isolated and non-isolated converters and various control techniques of power supplies.

CO2: Analyse the operation of isolated and non-isolated switch mode converters and resonant converter.

CO3: Evaluate the performance of isolated and non-isolated switch mode converters and control schemes, and resonant converters.

CO4: Design converters, controller, protection, driver circuits and high frequency magnetic elements for SMPS.

CO5: Validate isolated and non-isolated switch mode converters, various control schemes, protection, driver circuits and high frequency magnetic elements for SMPS using simulation and hardware.

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
CO2	3	3	-	1	-	-	-	-	-	-	-	-	3	3	2
CO3	3	2	1	1	1	-	-	-	-	-	-	-	3	3	2
CO4	3	1	3	1	1	-	-	-	-	-	-	-	2	3	3
CO5	3	1	2	2	2	-	-	1	2	1	-	-	3	2	3

Syllabus

Unit 1

DC-DC Switched Mode Converters: Operating principles, Steady state analysis for continuous and discontinuous current operations, Performance calculations of Boost converter, Buck-boost converter, Cuk converter, SEPIC and Interleaved Converters, Comparison of DC-DC converters.

Unit 2

Switched Mode DC Power Supplies: Overview of linear and switched mode power supplies, Isolated converters: Flyback converter, Forward converter, Push pull converter, Half bridge converter & Full bridge converter.

Unit 3

Design of snubbers, drive circuits, design of high frequency inductors and transformers, Voltage feed forward - PWM control and current mode control, Feedback compensators and design, unity power factor rectifiers.

Introduction to resonant converters – classification of resonant converters – Basic resonant circuit concepts. Zero current and Zero voltage switching, introduction to ZVT.

Textbooks / References

1. *Ned Mohan et.al, "Power Electronics", 3rd Edition, John Wiley and Sons, 2003.*
2. *Robert Erickson, Maksimovic D, "Fundamentals of Power Electronics", Springer Science, 2007.*
3. *L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.*
4. *George C. Chryssis, "High Frequency Switching Power Supplies", McGraw-Hill International, 1999.*
5. *Abraham I. Pressman, "Switching Power Supply Design", McGraw-Hill Company Inc, 1999.*
6. *Rashid, "Power Electronics circuits, Devices, and Applications", 3rd Edition, Pearson Education, 2003.*

23EEE341	ENERGY AUDIT AND CONSERVATION	L-T-P-C: 3-0-0-3

Course Objective

- To familiarize with energy audit by identifying energy conservation and management opportunities in various sectors.

Course Outcomes

CO1: Understand energy scenario and policies of India and World in the past, present and future.
CO2: Estimate energy efficiency in electrical appliances and thermal systems.
CO3: Evaluate techno-economic feasibility of various energy management techniques in domestic, commercial, and industrial sectors.
CO4: Analyze energy audit observations.

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	1	-	-	-	2	-	-	-
CO2	3	2	1	2	1	2	3	1	-	-	-	1	1	2	-
CO3	3	3	2	1	2	2	3	1	1	1	2	2	2	2	-
CO4	3	3	2	2	2	2	3	2	2	2	2	2	2	2	-

Syllabus

Unit 1

Historical development of commercial energy supply: Industrial revolution, Realization of environmental concerns, Developments in Renewable Energy Sector; Concept of Energy Efficiency and Clean Production. Energy Conservation Act 2001 and its features. Energy Conservation Policies and Regulations.

Unit 2

Energy conservation on demand side: Efficient Lighting; Energy Efficiency in motors, pumps and fans. Power quality issues related to Energy Efficient Technologies. Energy saving and trading Evaluation of thermal performance – calculation of heat loss – heat gain, estimation of heating & cooling loads, factors that influence thermal performance, waste heat recovery and co-generation, analysis of existing buildings setting up an energy management programme – electricity saving techniques. Energy Management in Electrical Power Systems: Demand Response; Microgrids and Smart grid. DC microgrids and energy efficiency.

Unit 3

Energy Audit: Definition, need, functions and methodologies of preliminary as well as detailed energy audits; Pre-audit, audit and post-audit measures, Benchmarking, optimizing the input energy requirements, fuel and energy substitution, Instruments for energy audit, Energy Service Companies (ESCOs), Energy Conservation Practice – Case Studies. Overview of Blockchain Technology, Renewable energy large capacity grid support using batteries.

Textbooks / References

1. *Hamies, "Energy Auditing and Conservation; Methods, Measurements, Management and Case Study", Hemisphere Publishers, Washington, 2003.*
2. *C.W. Gellings and J.H. Chamberlin, "Demand-Side Management Planning", 2nd Edition, Prentice Hall, 1993.*
3. *Wayne C Turner, "Energy Management Handbook", 9th Edition, River Publishers, 2018.*
4. *Bureau of Energy Efficiency Study Material for Energy Managers and Auditors Examination: Paper I to IV, www.energymanagertraining.com*
5. *S. Pabla, "Electric Power Systems Planning, 2nd Edition, McGraw Hill, Second Edition, 2015.*
6. *Moncef Krarti, "Energy Audit of Building Systems: An Engineering Approach", 3rd Edition, CRC Press,2020.*
7. *Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.*

23ELC341	ROBOTICS AND AUTOMATION	L-T-P-C: 3-0-0-3

Pre-requisite: Microcontrollers & Applications.

Course Objective

- Introduction to robotics, control of manipulators and mobile robots.

Course Outcomes

CO1: Understanding building blocks of robots.
CO2: Learning on kinematic and inverse kinematic models of manipulators.
CO3: Exposure to systems and navigation of wheeled mobile robots.
CO4: Exposure to applications of robotics.

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	3	1	-	1	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	1	-	-	-	-	-	-	-	1	1	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1

Robotics: Definitions, Types, Applications, Generic Architecture, Sensors, Actuators, Control, Operating System. Recent Trends in Robotics: Stand-alone and Networked Robots, ROS, MATLAB Robotics Toolbox.

Unit 2

Robot manipulator – Anatomy, Types, Configurations. Fundamentals of kinematics, Symbolic representation of robots: representation of joints, link representation using D-H parameters, Direct kinematics of serial robot. Inverse Kinematics: inverse (back) solution by Geometric approach with co-ordinate transformation and manipulation of symbolic T and A matrices, Closed form technique.

Unit 3

Mobile Robots: Anatomy, Mobility, Types based on mobility mechanisms. Navigation: Mapping, Localization, Path planning

Case Study: Autonomous robots, Swarm robots, Collaborative robots, Applications of robotics.

Textbooks/ References

1. *Thomas Bräunl, "Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems", Third Edition, Springer-Verlag Berlin Heidelberg, 2008.*
2. *R.K.Mittal and I.J.Nagrath, "Robotics and Control", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2003.*
3. *John J. Craig, "Introduction to Robotics: Mechanics and Control", 4th Edition, Pearson, 2018.*
4. *Anis Koubaa, "Robot Operating System (ROS) The Complete Reference", Vol. 1, Springer, 2016.*
5. *Richard Murray, Zexiang Li and S. Shankar Sastry, "A Mathematical Introduction to Robotic Manipulation", 2015.*
6. *W. Bolton, "Mechatronics", 6th Edition, Pearson, 2015*

23EEE352	ADVANCED MICROCONTROLLERS	L-T-P-C: 3-0-0-3

Pre-requisite: Microcontrollers and Applications

Course Objective

- To acquire in-depth knowledge of advanced microcontrollers with equal emphasis on hardware and software, to design and develop state-of-the-art embedded applications.

Course Outcomes

CO1: Understand the architecture and functional modules of advanced microcontrollers.
CO2: Ability to program dsPIC/MSP430 microcontrollers in assembly language and C.
CO3: Learn and program various peripherals of dsPIC/MSP430 microcontrollers.
CO4: Implement dsPIC/MSP430 based system for various 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	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	1	2	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	-	1	1	-

Syllabus

Unit 1

dsPIC30F series Digital Signal Controllers (DSC): Introduction to 16-bit microcontrollers – dsPIC30F DSC – CPU, Data memory, Program Memory – Instruction set- Programming in Assembly and C. Lab practice: Familiarization of dsPIC programming environment.

Unit 2

Peripherals of dsPIC30F DSC: I/O Ports, Timers, Input Capture, Output Compare, Motor Control PWM, Quadrature Encoder Interface (QEI), 10-bit A/D Converter, UART, CAN Module. Lab practice: Programming and simulation of dsPIC peripherals using dsPIC programming environment.

Unit 3

MSP430 microcontrollers and peripherals: MSP430F2274- MSP430X22X2 device pin out, DA Package, Functional block diagram description, Inputs, Outputs, Timers, ADC.

Textbooks/References

1. *dsPIC30F Family Reference manual, Microchip 2008.*
2. *dsPIC30F Programmer's Reference manual, Microchip 2008.*
3. *Chris Nagy, "Embedded System Design using the TI MSP 430 serie"s, 1st Edition. Newnes, 2003.*
4. *Avtar Singh and S. Srinivasan, "Digital signal Processing Implementations using DSP microprocessors with examples from TMS320C54XX".*
5. *B.Venkat Ramani and Bhaskar, "Digital Signal Processors".*
6. *MSP430f2274, Reference Manual, Texas Instruments.- www.ti.com*

23EEE353	DIGITAL SIGNAL PROCESSORS	L-T-P-C: 3-0-0-3

Pre-requisites: Microcontrollers and Applications, Digital Signal Processing.

Course objective

- To familiarise about digital signal processors and implement signal processing algorithms for real time applications.

Course Outcomes

CO1: Understand the architecture of Digital Signal Processors (DSPs).

CO2: Analyse instruction set and addressing modes of DSPs.
CO3: Implement basic signal processing operations.
CO4: Develop real time signal processing applications.

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	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	-	1	-	-	-	-	-	-	-	1	2	2
CO4	3	2	2	3	1	-	-	1	1	1	-	-	1	2	2

Syllabus

Unit 1

TMS320C67xx: Basic building blocks of a typical DSP processor – Hardware Multiplier – Barrel Shifter –MAC unit –Modified Harvard architecture - Pipelining. Architecture of TMS320C67xx DSP- Instruction set – Addressing modes.

Unit 2

Programming using TMS320C67xx : Assembly language and C programming – Integrated Development Environment - Code Composer Studio and Visual DSP++ - Application development.

Unit 3

Blackfin Processor: Blackfin 5xx DSP – Architecture- Instruction set – Addressing modes.

Textbooks / References

1. *Texas Instruments, C6000 Online reference Manual Available Online, http://processors.wiki.ti.com/index.php/Category:C6000.*
2. *Woon Seng Gan and Sen M Kuo, "Embedded Signal Processing with the Micro Signal Architecture", IEEE Computer Society Press, 2008.*
3. *Dahnoun N, "Digital signal processing implementation using the TMS320C6000 DSP platform", Prentice Hall, 2000.*
4. *Andy Bateman, Iain Paterson-Stephens, "The DSP Handbook, Algorithms, Applications and Design Techniques", Prentice-Hall, 2002.*
5. *www.ti.com and www.analog.com .*

23ELC342	UNMANNED AERIAL VEHICLE	L-T-P-C: 3-0-0-3

Pre-requisites: Control systems, Microcontrollers and applications.

Course Objective

- To understand UAVs with focus on quadcopters from system perspective and the subsystems involved.

Course Outcomes

CO1: To develop specialist knowledge and to understand the dynamics of Unmanned Air Vehicle (UAV) systems.
CO2: To understand the design and working principle of Drones.
CO3: To enable the students to identify sensors, actuators, and the control structure of Drones.
CO4: To enable students to develop real world applications and case studies using Drones.

CO-PO Mapping

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

CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	1	2
CO3	3	2	2	-	-	-	-	-	-	-	-	1	2	2	2
CO4	3	3	3	2	2	1	-	-	2	2	2	1	3	3	3

Syllabus

Unit 1

Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology, UAV fundamentals, Examples of UAV systems – very small, small, Medium and Large UAV. Air Vehicle Basic Aerodynamics: Basic Aerodynamics equations, Aerodynamics control, pitch control, lateral control.

Unit 2

Definitions of Drone, Quad copters -Basic Components and Categories – Principles of Flight – Flight Maneuvers, sensor, controller, actuator, airframe control, inner and outer loops, Flight-Control Classification, Modes of Operation, Autopilots, Sensors Supporting the Autopilot.

Unit 3

Real World Applications and Case Studies: Beneficial Drones, Aerial Photography, Mapping and Surveying, Precision Agriculture, Search and Rescue, Infrastructure Inspection, Conservation. Case Studies: Agriculture Weed Classification, Microdrone surveillances.

Textbooks / References

1. *Introduction to UAV Systems-Paul Gerin Fahlstrom, Thomas James Gleason, John Wiley Publications.*
2. *Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones ", Maker Media, Inc, 2016.*
3. *VasilisTzivaras, "Building a Quadcopter with Arduino", Packt Publishing, 2016.*
4. *Donald Norris, "Build Your Own Quadcopter -Power Up Your Designs with the Parallax Elev-8", McGraw-Hill, Education, 2014.*
5. *Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016.*
6. *Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment. Wiley, 2010.*
7. *Sebbane, Smart Autonomous Aircraft: Flight Control and Planning for UAV. CRC Press, 2015.*
8. *Zavrsnik, Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance. Springer, 2015.*

23ELC343	FPGA BASED SYSTEM DESIGN	L-T-P-C: 3-0-0-3

Pre-requisite: Digital System Design.

Course Objective

- To provide understanding of digital system design using FPGA.

Course Outcomes

CO1: Understand the complex digital logic circuits and its design issues.
CO2: Model, simulate, and synthesize and analyse digital system.
CO3: Design of sequential circuits and FSM.
CO4: Implement digital circuits on FPGA.

CO-PO Mapping

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

Syllabus

Unit 1

Digital system Design – Top-down Approach to Design, Data Path, Control Path, Controller behavior and Design, Case study Mealys & Moore Machines, Timing of sequential circuits, Pipelining, Resource sharing, FSM issues (Starring state, Power on Reset, State diagram optimization, State Assignment, Asynchronous Inputs, Output Races, fault Tolerance).

Unit 2

VHDL for Synthesis – Introduction, Behavioral, Data flow, Structural Models, Simulation Cycles, Process, Concurrent Statements, Sequential Statements, Loops, Delay Models, Sequential Circuits, FSM Coding, Library, Packages, Functions, Procedures, Operator Inferencing, Test bench.

Unit 3

Digital FPGA's – Introduction, Logic Block Architecture, Routing Architecture, Programmable Interconnections, Design Flow, Xilinx/Altera FPGA, Boundary Scan, Programming FPGA's – Constraint Editor, Static Timing Analysis, Hardware-software co-simulation, Debugging FPGA Design, Chipscope Pro, Case Study.

Textbooks / References

1. *Jon F Wakerly, "Digital Design: Principles and Practices", 4th Edition, Prentice Hall, 2005.*
2. *Kevin Skahil, "VHDL for programmable logic", 2nd Edition, Addison Wesley, 2011.*
3. *Zainalabedin Navabi, "VHDL, analysis and modeling of digital systems", 2nd Edition, McGraw-Hill, 2004.*

23EEE354	INDUSTRIAL AUTOMATION	L-T-P-C: 3-0-0-3

Course Objective

- To understand various control architecture and its communication employed for industrial automation.

Course Outcomes

CO1: Illustrate the architecture of automation system for industrial processes.
CO2: Understand the operating principles of various sensors used in the controlled process.
CO3: Comprehend the role of controller and PLC in industrial automation.
CO4: Apply suitable communication systems for automation.
CO5: Identify suitable electric drives for an industrial 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	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	2	-	2	-	-	-	-	-	-	-	2	2	1
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO5	3	2	3	-	2	-	-	-	-	-	-	-	2	2	-

Syllabus

Unit 1

Introduction to industrial automation and control architecture of industrial automation system, measurement systems specifications, Sensors and transducers, Data acquisition, signals conditioning. Introduction to process control, PID control, controller tuning method, implementation of PID controllers, feed forward and ratio control, special control structures: predictive control, control of systems with inverse response.

Unit 2

Programmable logic control systems: introduction to sequence or logic control and programmable logic controllers, the software environment and programming of PLCs, formal modelling of sequence control specifications. Programming, programming of PLCs: sequential function charts, the PLC hardware environment. Principles of interface, serial interface and its standards, Parallel interfaces, and buses. Fieldbus: Use of fieldbuses in industrial plants, functions, international standards, performance, use of Ethernet networks, fieldbus advantages and disadvantages, Fieldbus design, installation, brief introduction to types of communication protocols: HART & MODBUS.

Unit 3

Electrical machine drives: Energy savings with variable speed drives, electrical actuators, principles, construction and drives, stepper motors, DC motor drives, induction motor drives, BLDC motor drives. Design and analysis of Real time automation applications.

Textbooks / References

1. *A. K. Shawney, "Electrical and Electronics Measurement and Instrumentation", Dhanpatrai & sons publications.*
2. *John W. Webb and Ronald A. Reiss, "Programmable logic controllers-Principle and applications", 5th Edition, PHI.*
3. *Gopal K., "Fundamentals of Electrical Drives", Narosa publishing house pvt.*
4. *Bimal K. Bose, "Modern Power Electronics and AC Drives", pea*rson Publishing pvt.
5. *E.O. Doebelin, "Measurement Systems – Application and Design", TMH Publication.*
6. *Hackworth and Hackworth F.D, "Programmable logic controllers- Programming Method and applications", Pearson, 2004.*
7. *Liuping Wang, "PID and Predictive Control of Electric Drives and Power Supplies Using MATLAB / Simulink".*

23ELC344	WIRELESS SENSOR NETWORKS	L-T-P-C: 3-0-0-3

Pre-requisite: Microcontrollers & Applications.

Course Objective

- To study WSN protocols and implementation aspects for networked applications.

Course Outcomes

CO1: Understand Adhoc networks and their applications.
CO2: Comprehend protocols of wireless sensor networks.
CO3: Identify node architecture in wireless sensor networks.
CO4: Design applications using wireless sensor networks.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction: Wireless Ad-Hoc networks – Topology – Architecture – self organizing behaviour – cooperation in mobile Ad-Hoc network. Wireless sensor networks: Introduction – Applications – Challenges Protocol Stack – Cross-layered optimization – Design principles. MANET vs WSN.

Unit 2

Wireless sensor networks – Physical layer, MAC layer, Link Layer, Naming & Addressing, Localization, Routing, WSN coverage and placements, topology management – mobile wireless sensor networks – Congestion and flow control – Security.

Unit 3

Sensor node: Architecture, Components, Design Challenges – Real life deployment of WSN. Case study: Real world applications – Agriculture/ Home automation/ Smart City/ Health care/ Smart Grid/ Smart Transportation/ Wildlife monitoring/ Forest fire monitoring/ Weather monitoring.

Textbooks / References

1. *Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley and Sons Ltd., 2005.*
2. *Zhao and L. Guibas, "Wireless Sensor Networks", Morgan Kaufmann, San Francisco, 2004*
3. *C. S. Raghavendra, K.M.Shivalingam and T.Znati, "Wireless Sensor Networks", Springer, New York, 2004*
4. *Anna Hac, "Wireless Sensor Network Designs", John Wiley & Sons, 2004.*
5. *Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley Inter Science, 2007.*

23EEE355	BIOMEDICAL INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre-requisites: Sensors and Sensor Circuit Design/Electrical Measurements.

Course Objective

- To introduce the concept of signals, its acquisition, conditioning and imaging techniques used in bio-medical instrumentation.

Course Outcomes

CO1: Understand the basics of bio-medical signals and sensors.

CO2: Apply the concepts of sensors and transducers for acquiring bio-signals and related signal conditioning circuits.

CO3: Familiarize the therapeutic and diagnostic methods used in bio-medical instrumentation systems.

CO4: Comprehend the modern methods of imaging techniques used for bio-medical applications.

CO-PO Mapping

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

Syllabus

Unit 1

Cell resting potential and action potentials – Origin of bio potentials – characteristics – Frequency and amplitude ranges – ECG – Einthoven's triangle – 3 lead ECG system – EEG – 10- 20 electrode system – Origin and characteristics of EMG – EOG – ERG electrodes and transducers. Electrode-electrolyte interface – Electrode – skin interface – Half cell potential – Impedance - Polarization effects of electrode – Nonpolarizable electrodes. Types of electrodes – Surface; needle and micro electrodes – ECG – EMG – EEG Electrodes.

Unit 2

Diagnostic and Therapeutic Equipment: Blood pressure monitors – Electrocardioscope –Pulse Oximeter –pH meter - – Pacemakers – Defibrillator – Heart-lung machine –Nerve and muscle stimulators – Dialysis machines – Surgical diathermy equipment – Nebulizer; inhalator –Aspirator – Humidifier –Ventilator and spirometry.

Unit 3

Medical imaging techniques: Basics of diagnostic radiology – X-ray machine – Block diagram – Digital radiography – CT - Basic Principle - Block diagram – Radioisotopes in medical diagnosis — Gamma Camera. Block diagram – SPECT Scanner – PET Scanner – Principles of NMR Imaging systems – Block diagram of NMR Imaging System – Ultrasonic Imaging Systems – Doppler effect – Medical Ultrasound – Robotic Surgery – Advanced 3D surgical techniques - Electrical Safety codes and standards – Protection of patients. Case study – wireless health monitoring.

Textbooks / References

1. *R S Khandpur, "Handbook of Biomedical Instrumentation", 1st Edition, Tata McGraw Hill Publishing Company Limited, 2014.*
2. *John G Webster, "Medical Instrumentation - Application and Design", 4th Edition, John Wiley and Sons, 2007.*
3. *Leslie Cromwell, Fred. J. Weibell, Erich. A. Pfeiffer, "Biomedical Instrumentation & Measurements", 2nd Edition, Pearson Education, 2001.*

23EEE356	ADVANCED CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requite: Control Systems.

Course Objective

- To introduce the basics of linear and nonlinear control systems in state space framework.

Course Outcomes

CO1: Understand the concept of state space, dynamics of nonlinear system and adaptive control.
CO2: Model linear and nonlinear systems in state space framework.
CO3: Examine the characteristics of non-linear systems.
CO4: Analyze the stability of non-linear systems.
CO5: Design state feedback controller and state observers.

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	3	2	-	2	-	-	-	-	-	-	-	2	-	-
CO3	3	3	-	-	2	-	-	1	-	-	-	-	-	-	-
CO4	3	3	2	3	2	-	-	1	-	-	-	-	2	1	-
CO5	3	3	3	2	2	-	-	1	-	-	-	-	3	2	-

Syllabus

Unit 1

State space modelling: Introduction, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations. State space representation using physical variables, phase variables & canonical variables.

Unit 2

State space analysis: Derivation of transfer function from state model, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation, state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley-Hamilton method, concept of controllability & observability, methods of determining the same.

Unit 3

State space design- Pole placement technique: stability improvements by state feedback, necessary and sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer, Controllers- P, PI, PID. Non-linear systems: Introduction, behavior of non-linear system, common physical non linearity-saturation, friction, backlash, dead zone, relay, multi- variable non-linearity.

Phase plane method, singular points, stability of nonlinear system, limit cycles, Liapunov stability criteria. Introduction to adaptive and optimal control techniques. State space modelling, design and analysis of advanced controllers using Simulation /Online platforms.

Textbooks / References

1. *Katsuhiko Ogata, "Modern Control Engineering", 5th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2015.*
2. *Franklin and Powell. "Feedback Control of Dynamics Systems", 7th Edition Addison-Wesley, 2017.*
3. *Di Stefano, "Feedback Control Systems. Schaum's outline", 7th Edition, McGraw- Hill Education, 2014.*
4. *Luenberger. "Introduction to Dynamic Systems", Wiley.*
5. *Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson, 2011.*

23EEE357	DIGITAL CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requite: Control Systems.

Course objective

- To characterize the discrete-time system in both time and frequency domains and design digital controllers.

Course Outcomes

CO1: Understand the concepts of sampling and Z-transform.
CO2: Solve the pulse transfer function of discrete time systems.
CO3: Analyze the behavior and stability of discrete time systems in Z-plane.
CO4: Develop lag-lead compensators in closed loop systems for the desired time/frequency response.
CO5: Design digital state-feedback controllers and state-observers.

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	2	3	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	3	2	1	-	-	-	-	-	-	-	1	1	-
CO4	3	3	3	2	1	-	-	-	-	-	-	-	2	1	-
CO5	3	3	3	2	1	-	-	-	-	-	-	-	2	1	-

Syllabus

Unit 1

Review of Z-transforms. Pulse transfer function. Digital control system: sampling, quantization, data reconstruction and filtering of sampled signals. Mathematical modeling of sampling process. Simulation examples – effect of sampling rate.

Unit 2

Stability analysis of closed loop systems in the z- plane: root loci, frequency domain analysis, Stability tests. Discrete equivalents. Digital controller design for SISO systems: design based on root locus method in the z-plane, design based on frequency response method, design of compensators, design of PID Controller.

Unit 3

2DOF discrete PID controller – software approach. State space representation in discrete system. Controllability, observability, control law design, decoupling by state variable feedback, effect of sampling period. Estimator/ Observer Design: full order observers, regulator design. Discrete LQR design. Simulation experiments in controller, observer/estimator, discrete LQR design and so on.

Textbooks / References

1. *K. Ogata, "Discrete-Time Control Systems", Pearson Education, 2011.*
2. *Gene F. Franklin, J. David Powell, Michael Workman, "Digital Control of Dynamic Systems", 3rd Edition, Pearson, 2006.*
3. *M. Sami Fadali, Antonio Visioli, "*Digital Control *Engineering: Analysis and Design", Elsevier, 2013.*
4. *IoanDoré Landau, GianlucaZito, "*Digital Control *Systems: Design, Identification and Implementation", Springer, 2006.*
5. *Cheng Siong Chin, "Computer-Aided Control Systems Design" CRC Press, 2013.*
6. *Hemchandra Madhusudan Shertukde, "Digital Control Applications-Illustrated with MATLAB" CRC Press Inc., 2015.*
7. *C. L. Philips, Troy Nagle, Aranya Chakrabortty, "Digital Control System Analysis and Design", Prentice-Hall, 2014.*
8. *M. Gopal, "Digital Control and State Variable Methods", Tata McGraw-Hill, 2012.*

23EEE358	PROCESS CONTROL AND INSTRUMENTATION	L-T-P-C: 3-0-0-3

Pre-requite: Control Systems.

Course Objective

- To model and design controllers for process control systems.

Course Outcomes

CO1: Understand the feedback and feedforward controllers.
CO2: Develop transfer function and state-space models of linear processes.
CO3: Design single loop and multi loop controllers.
CO4: Outline the automation in process control.

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	2	2	2	-	-	-	-	-	-	-	-	1	1	-
CO3	3	2	2	2	-	-	-	-	-	-	-	-	2	-	-
CO4	3	1	2	-	-	-	-	-	-	-	-	-	2	1	-

Syllabus

Unit 1

Process Modelling: hierarchies. Theoretical models: transfer function, state space models, and time series models. Development of mathematical models for level, pressure and thermal process. Final control elements. SISO process: Feedback control - PID design, tuning, cascade control, selective control loops, override, auctioneering, ratio control, feed forward control, adaptive and inferential controls.

Unit 2

Multi-loop and multivariable control: process interactions, Singular value decomposition, Relative gain array, I/O pairing. Decoupling and design of noninteractive control loops. tuning of multiloop PID control systems. Decoupling control: strategies for reducing control loop interactions.

Unit 3

Instrumentation for process monitoring: codes and standards, P&I diagrams. Statistical process control: Control charts, Overview of direct digital control & distributed control, PC based automation. Programmable logic controllers: organization, programming aspects, ladder programming.
Supervisory Control: SCADA in process automation. Case studies.

Textbooks / References

1. *Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle "Process Dynamics and Control", John Wiley & Sons, 2015.*
2. *Stephanopoulos, G., "Chemical Process Control: An Introduction to Theory and Practice ", Prentice-Hall, New Jersey, 2012.*
3. *Surekha Bhanot, "Process Control—Principles and Applications", Oxford University Press, 2007.*
4. *Ernest O. Doebelin, "Measurement Systems Application and Design", McGraw Hill International Editions, 5th Edition, 2014.*
5. *Johnson D Curtis, "Process Control Instrumentation Technology", Prentice Hall India, 2013.*
6. *W. Bolton, "Mechatronics", 6th Edition, Pearson, 2015.*

23EEE361	SYSTEMS ENGINEERING FOR ELECTRIC VEHICLE	L-T-P-C: 3-0-0-3

Pre-requites: Mathematics – Differential Calculus, Numerical Solutions to Differential Equations, Power Electronics, Electrical Machines I&II/ Electrical Machines and Control Systems.

Course Objective

- To impart knowledge on electric drives, energy storage, energy management and vehicular communication in electric vehicles.

Course Outcomes

CO1: Familiarize with electric vehicles, drives, energy storage, and energy management systems.
CO2: Apply electric drive concepts in electric vehicles.
CO3: Develop charging and regeneration systems.
CO4: Design electric drive systems with different topologies.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to Electric Vehicles, System Engineering and Simulation. Overview of electric vehicles, including the history of EV, EV Components, Performance specifications and basic design concepts, Benefits and limitation of EV as compared with IC Engine based Vehicles. The basics of system engineering, definition, and principles of system engineering, system requirement specification, simulation techniques, and its application in EV design and validation Various forces acting on the moving vehicle (Rolling resistance force, Aerodynamic drag force, Acceleration force, Climbing force, etc.), Vehicle motion equations, Longitudinal vehicle dynamics modelling and simulation, EV component sizing, Drive cycle analysis.

Unit 2

Basics of Electro Chemistry, working principle of Li-ion cell, Electrode potential, Gibbs free energy, Nernst Equation, materials for electrodes, electrolyte, separator, current collector. Battery cell performance parameters, performance comparison for different cell chemistries Different form factors for Li-ion battery cell, battery pack sizing, Modularized design of battery pack. Battery management system, Basic BMS hardware features Sensors and its interface with BMS hardware, Communication protocols. RC equivalent circuit model for Li-ion cell. Cell characteristics, Offline methods for cell parameter identifications. BMS Functions: SoC and SoH estimation, Cell balancing techniques. Battery safety, thermal management of batteries, advanced battery technologies. Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Battery Chargers- Basic requirements for charging systems, Classification of Charging Architectures, Charging Controls, Current Regulations, charging standards and technologies.

Unit 3

3 Phase traction inverter topologies, overview of inverter h/w design and various h/w components, SPWM and SVPWM technique's for switching, Comparison of switching strategies, modulation index and output voltage, over modulation techniques, Harmonics and switching losses considerations, Harmonics and switching losses considerations. Overview of Electrical machines used for EV applications. Importance of PMSM machines, working principle, factors influencing torque production SPM and IPM machines. Concept of reluctance torque, D-q axis model for PMSM machines, concept of rotor reference frame and its usage in simplifying control analysis. Steady state voltage and torque equations for PMSM machines. Clarke and Park transformations. Control schemes in Constant torque and constant power region. Flux weakening and MTPA Control strategy for PMSM machines. The

integration of electric vehicle systems, including powertrain, Battery and regenerative braking systems and overall control systems. Performance analysis under different drive cycles. Simulation study for overall vehicle systems.

Textbooks / References

1. *James Larminie, John Lowry, "Electric Vehicle Technology Explained", 2nd Edition, Wiley, 2012.*
2. *Goodarzi, Gordon A., Hayes, John G, "Electric powertrain: Energy systems, Power electronics & Drives for hybrid, electric & fuel cell vehicles", 1st Edition, Wiley, 2018.*
3. *Mehradad Eshani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Fundamentals, Theory and Design", 3rd Edition, CRC Press, 2018.*
4. *Iqbal Husain, "Electric and Hybrid Electric Vehicles: Design Fundamentals", CRC Press, 3rd Edition, 2021.*
5. *De Doncker, Rik, Pulle, Duco W.J., Veltman, Andre, "Advanced Electrical Drives – Analysis, Modeling and Control", 1st Edition, CRC Press, 2020.*

23EEE369	ELECTRIC VEHICLE TECHNOLOGY	L-T-P-C: 3-0-0-3

Pre-requisites: Electrical machines, Power electronics & Drives

Course Objective

- To impart knowledge on electric drives, energy storage and energy management in electric vehicles with special reference to big data analytics and communication networks.

Course Outcomes

CO1: Understand the electric vehicles architecture, vehicle propulsion system and vehicular communication protocols.

CO2: Apply the concepts of electric drives, energy storage and communication in xEV.

CO3: Demonstrate big data analytics in vehicular network control.

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	2	1	1	-	-	-	-	-	-	-	3	3	3
CO3	3	3	2	1	1	-	-	-	-	-	-	-	3	3	3

Syllabus

Unit 1

xEV: Introduction to xEV's :BEV, HEV, PEV, FCEV- Configuration of Electric Vehicles, Performance of Electric Vehicles, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains. Basics different EV motor drives, Configuration and control of Drives-Energy Storage and power electronics for battery charging and grid interface: Energy Storage Requirements in (Hybrid and) Electric Vehicles:- Battery based energy storage, Fuel Cell based energy storage , Hybridization of different energy storage devices. EV and PHEV Battery Charging: Grid and Renewable Energy Interface topologies, Regenerative braking. Energy Management Strategies: classification, comparison and implementation issues of EMS, On-board power electronic battery Management.

Unit 2

Vehicular Networks: Cross-System Functions, Requirements For Bus Systems, Classification Of Bus Systems, Application In The Vehicle, Coupling Of Networks, Examples Of Networked Vehicles; Bus Systems: CAN Bus , CAN-FD, LIN Bus, MOST Bus Bluetooth, Flex Ray, Diagnostic Interfaces: Implementation Of Body Electronics Functionalities Using Controllers. Control Systems for the HEV and EVs:, On-Board Diagnostics (OBD), Introduction to autonomous driving.

Unit 3

Vehicular network (VN) model– Cluster-based vehicular networks, Vehicle platooning, Vehicular cloud, Hybrid sensor – vehicular networks, Information distribution, Internet of Vehicles, Vehicular cloud networking: architecture and design principles, Hybrid sensor and vehicular networks, Vehicular network as business model in Big Data- Big Data technology in vehicular networks, Data validation in Big Data, Real-time analysis of Data in VANET, Vehicular density analysis using Big Data, Vehicular carriers for Big Data, Big Data technologies in support of real-time capturing and understanding of electric vehicles, Future trends and challenges in ITS, Introduction to security and privacy issues in vehicular networks.

Textbook / References

1. *M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2015.*
2. *Iqbal Hussain, "Electric & Hybrid Vechicles – Design Fundamentals", Second Edition, CRC Press, 2011.*
3. *Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.*
4. *James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.*

5. *Paul, A., Chilamkurti, N., Daniel, A. and Rho, S. Intelligent Vehicular Networks and Communications. Elsevier Science and Technology Books, Inc. 2017.*
6. *Wai Chen, "Vehicular Communications and Networks: Architectures, Protocols, Operation and Deployment", Elsevier Science and Technology Books 2015.*
7. *Laun T.H, Shen X. and Bai F, "Enabling Content Distribution in Vehicular AdHoc Networks", Springer, 2014.*
8. *Bob McQueen, "Big Data Analytics for Connected Vehicles and Smart Cities", Artech.*

23EEE362	AUTOMOTIVE CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisite: Control Systems.

Course Objective

- To impart knowledge on modeling and analysis of vehicle dynamics and design controllers for automotive systems.

Course Outcomes

CO1: Understand vehicle dynamics and road-driver models.
CO2: Diagnose vehicle faults using fault models.
CO3: Analyze the ABS control systems.
CO4: Develop a complete driver model with path, road surface and wind strength.

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	1	-	2	-	-	-	-	-	-	-	2	2	2
CO3	3	2	1	1	2	-	-	-	-	-	-	-	2	2	2
CO4	3	1	3	2	2	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1

Overview of Control System: Modeling, Time/Frequency Response Analysis and Stability Analysis: PID, State Variable Analysis. Model Based Diagnosis: Characteristics, Faults, Fault Modeling, Principles of Model Based Diagnostics – Residual Generator Design, Residual Evaluation, Engineering of Diagnosis Systems, Application Example.

Unit 2

Vehicle Control Systems: ABS Control Systems- Torque Balance at Vehicle- Road Contact, Control Cycles of the ABS System, ABS Cycle Detection; Control of Yaw Dynamics- Deviation of Simplified Control Law, Derivation of Reference Values.

Unit 3

Road and Driver Models: Road Model- Requirements of The Road Model, Definition of the Course Path, Road Surface and Wind Strength; PID Driver Model; Hybrid Driver Model – Vehicle Control Tasks, Characteristics of Human as a Controller, Information Handling, Complete Driver Model.

Textbooks/References

1. *Kiencke, Uwe and Nielsen, Lars, "Automotive Control Systems for Engine, Driveline and Vehicle", Springer, 200.5*
2. *I.J Nagrath and M. Gopal, "Control Systems Engineering", Wiley Eastern Limited, New Delhi, 2008.*
3. *M.Gopal, "Modern Control System Theory", New Age International, 2005.*
4. *Katsuhiko Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall, 2010.*

23EEE363	VEHICULAR DYNAMICS AND CONTROL	L-T-P-C: 3-0-0-3

Pre-requisite: Control Systems.

Course Objective

- To understand the concept of vehicle dynamics and analyze the parameters for adaptive vehicular control

Course Outcomes

CO1: Understand concepts in vehicle dynamics and control.
CO2: Illustrate control system architecture and adaptive vehicular control.
CO3: Design and develop controllers for braking system in Electric vehicle.
CO4: Analyze the electronic stability control in Electric Vehicles.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction To Driver Assistance Systems, Active Stability Control, Ride Quality, Technologies For Addressing Traffic Congestion, Emissions And Fuel Economy; Lateral Vehicle Dynamics: Kinematic Models, Dynamic Bicycle Model, From Body Fixed To Global Coordinates: Lateral Vehicle Control: State Feedback, Steady State Analysis: Understanding Steady State Comering, The Output Feedback Problem, Compensator Design With Look Ahead Measurement; Longitudinal Vehicle Dynamics: Longitudinal Vehicle Model, Driveline Dynamics, Mean Value Engine Models.

Unit 2

Longitudinal Vehicle Control: Introduction: Cruise Control, Control System Architecture, Adaptive Cruise Control, Individual Vehicle Stability and String Stability, String Stability with Constant Spacing, String Stability with Constant Time Gap, Controller for Transitional Maneuvers, Automated Highway Systems, Longitudinal Control for Vehicle Platoons, String Stability with Inter- Vehicle Communication, Adaptive Controller for Unknown Vehicle Parameters.

Unit 3

Electronics Stability Control: Vehicle Model, Control Design for Differential Braking Based Systems, Control Design for Steer-By-Wire System, Independent All Wheel Drive Torque Control: Active Automotive Suspensions: H2 Optimal Control, LQR Formulation for Active Suspension Design, Analysis of Trade-Offs Using Invariant Points, Performance of The Sky-Hook Damping Controller, Control with Hydraulic Actuators;
Lab Experiments Based on Simulation Tools.

Textbooks / References

1. *Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", SAE International, 1992.*
2. *R. Rajamani, "Vehicle Dynamics and Control", Second Edition, Springer Verlag 2012.*
3. *Uwe Kiencke and Lars Nielsen, "Automotive Control Systems: For Engine Driveline, and Vehicle", 2nd Edition, Springer, 2005.*
4. *John C Dixon, "Tyres, Suspension and handling", 2nd Revised Edition, SAE International, 1996.*
5. *Hans B. Pacejka, "Tyre and Vehicle Dynamics", 2nd Edition, Butterworth-Heinemann, 2006.*

23EEE364	AUTOMOTIVE ELECTRONICS	L-T-P-C: 3-0-0-3

Pre-requisites: Circuits Analysis and Control Systems.

Course Objective

- To introduce the electrical, electronics and communication networks and components used in Electric Vehicles

Course Outcomes

CO1: Understand the basic principles of electronic systems, power train control systems, electrical and communication systems in electric vehicles.

CO2: Analyze the performance of various control systems, engine management and electrical networks and components in electric vehicles

CO3: Design electronic systems, power train, engine management, battery, and communication systems for electric vehicles.

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	1	1
CO2	3	3	2	-	2	-	-	-	-	-	-	-	2	1	1
CO3	3	3	3	-	2	-	-	-	-	-	-	-	2	1	1

Syllabus

Unit 1

Introduction to Electronic systems in Automotives – Sensors and Actuators for body electronics, power train and chassis systems. Body electronics domain- Automotive alarms, Lighting, Central locking and electric windows, Climatic Control, Driver information, Parking, etc.

Unit 2

Power train and chassis control domain – Engine management, Transmission control, ABS, ESP, Traction Control, Active Suspension, passive safety, Adaptive Cruise Control, etc. Hardware implementation example of simple automotive systems using Sensors, Controller, Actuators etc.

Unit 3

Battery- types and maintenance, Alternators in vehicles, Starting motor systems, Electrical circuits and wiring in vehicles, vehicle network and communication buses – Digital engine control systems, Introduction to automotive controllers, On-Board Diagnostics (OBD).

Textbooks / References

1. *Bosch, "Automotive Electrics and Automotive Electronics. System and components, Networking and Hybrid drive", 5th Edition, Springer view 2014.*
2. *Najamuz Zaman, "Automotive Electronics Design Fundamental'' 1st Edition, Springer 2015.*
3. *Hillier's, "Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics", 5th Edition, Nelson Thrones, 2007.*
4. *William B. Ribbens, "Understanding Automotive Electronics" 6th Edition, Elsevier Newnes, 2002.*

23EEE365	ELECTRIC MACHINES FOR ELECTRIC VEHICLE	L-T-P-C: 3-0-0-3

Pre-requisites: Electrical machines and Power Electronics

Course Objective

- To impart knowledge on various electrical machines used in electric vehicles, its operation, control and design.

Course Outcomes

CO1: Understand the principle of various electrical machines used in electric vehicles.

CO2: Apply the concept of power electronic converters and its control for electrical machines used in electric vehicles.

CO3: Analyse the performance of various electric drive systems suitable for electric vehicles.

CO4: Design various electrical machines used in electric vehicles.

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	-	1
CO2	3	3	3	-	2	-	-	-	-	-	-	-	1	-	2
CO3	3	3	3	-	2	-	-	-	-	-	-	-	1	-	2
CO4	2	2	3	-	3	-	-	-	-	-	-	-	2	1	2

Syllabus

Unit 1

Introduction to Motor Drive technology, DC Motor Drives – Converter, Control, Design Criteria and Examples for EV, Induction Motor Drives – Converter (PWM, Soft-switching), Control (VVVF, FOC, DTC), Design Criteria and Examples for EV, Permanent Magnet Brushless Motor Drives – Inverter requirements, Control (PMSM, Brushless DC), Design Criteria and Examples (Planetary geared for PMSM, Outer rotor for Brushless DC).

Unit 2

Switched Reluctance Motor Drives – Converter topologies, Control, Design Criteria and Examples.

Stator Permanent Magnet Motor Drives – Types, Magnetic Geared Motor Drives – Magnetic gears, Inverter and Control, Vernier Permanent Magnet Motor Drives – Structure, Principle, Inverter and Control, Advanced Magnetless Motor Drives.

Unit 3

Integrated Starter-Generator Systems, Planetary Geared Electric Variable Transmission System, Double Rotor Electric Variable Transmission System, Magnetic Geared Electric Variable Transmission System.

Finite Element Analysis: Induction Motor, PMSM.

Textbooks / References

1. *Chau, Kwok Tong, "Electric Vehicle Machines and Drives: Design, Analysis and Application", John Wiley & Sons, 2015.*
2. *Emadi Ali, "Advanced electric drive vehicles", CRC Press, 2014.*
3. *Hayes, John G., and G. Abas Goodarzi, "Electric powertrain: energy systems, power electronics and drives for hybrid, electric and fuel cell vehicles", 2018.*
4. *M. Ehsani, Y. Gao, S. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2015.*
5. *Iqbal Hussain, "Electric & Hybrid Vechicles – Design Fundamentals", 2nd Edition, CRC Press, 2011.*

23EEE366	AUTONOMOUS VEHICLES	L-T-P-C: 3-0-0-3

Pre-requisites: C/Python, Microcontrollers & Applications.

Course Objective

- To gain knowledge on different systems and strategies of autonomous vehicles.

Course Outcomes

CO1: Familiarize the various electronic systems in autonomous vehicles.
CO2: Illustrate different sensor systems in autonomous mobility.
CO3: Understand communication networks in autonomous vehicles.
CO4: Comprehend operations and real-world applications in autonomous driving.

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	2
CO2	3	2	2	-	-	-	-	-	-	-	-	-	3	3	2
CO3	3	-	-	-	-	-	-	-	-	-	-	-	3	3	2
CO4	3	2	2	1	-	-	-	-	-	-	-	-	3	3	2

Syllabus

Unit 1

Introduction to Automated, Connected, and Intelligent Vehicles: Introduction to the Concept of Automotive Electronics, History & Evolution. Automotive Domains: Infotainment, Body, Chassis, Powertrain and Drivetrain. Advanced Driver Assistance Systems. Recent Trends in Autonomous mobility: Self-Driving Cars, Connected vehicles, Unmanned Aerial Vehicles (UAVs), Autonomous Underwater Vehicles (AUVs), etc.

Unit 2

Autonomous Vehicle Technology: Overview of Sensors, ECUs, and Actuators for Infotainment, Body, Chassis, Power train and Drivetrain domains. Sensors for autonomous mobility: Vision, RADAR, LiDAR and Ultrasonic Sonar Systems. In-Vehicle Communication Networks: LIN, MOST, CAN, FlexRay, Ethernet. Overview of CAN - Bus architecture - Physical Layer, Frames, Operation. V2X Communication - Service requirements of applications, Communication technologies, VANETs.

Unit 3

Autonomous Vehicle Operations: Blind Spot Detection, Cruise Control, Lane Changing, Platooning, Localization, Navigation – Pedestrian Detection, Obstacle Avoidance. Autonomous Vehicle Applications: Smart Transportation, Agriculture, Automated Guided Vehicles (AGVs), Autonomous Delivery Vehicles, Security, Surveillance, etc.

Textbooks / References

1. *William B. Ribbens, "Understanding Automotive Electronics – An Engineering Perspective", 8th Edition, Elsevier Inc., 2017.*
2. *Robert Bosch GmbH, "Bosch Automotive Electrics and Automotive Electronics -Systems and Components, Networking and Hybrid Drive", 5th Edition, Springer Vieweg, 2007.*
3. *J. Yoshida (Ed.)," Guide to Sensors in Automotive: Making Cars See and Think Ahead", Aspencore Media, 2020.*
4. *Hanky Sjafrie, "Introduction to Self-Driving Vehicle Technology", 1st Edition, Chapman & Hall/CRC, 2019.*
5. *H. Winner et al. (Eds.), "Handbook of Driver Assistance Systems", Springer Cham, 2016.*

23EEE367	BATTERY MANAGEMENT SYSTEM	L-T-P-C: 3-0-0-3

Pre-requisites: Basics of Electrical Engineering (or equivalent subject), Control System, Circuit Network, Chemistry,

Physics.

Course Objective

- Introduce batteries, their parameters, modelling, charging requirements and battery management system.

Course Outcomes

CO1: Understand the principle of battery and battery management system.
CO2: Interpret the concept associated with battery charging / discharging process.
CO3: Familiarize various cell balancing techniques and parameter estimation.
CO4: Design battery model for real-time applications.

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	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	-	2	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	-	1	1	2
CO4	3	2	1	1	-	-	-	-	-	-	-	-	2	1	2

Syllabus

Unit 1

Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods. Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging

Unit 2

Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of-charge estimation, Cell total energy and cell total power. Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium-ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing

Unit 3

Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, Simulating an electric vehicle, Vehicle range calculations, Case study- battery packs. Design principles of battery BMS, Battery dynamics based on life and BMS, energy balancing with multi-battery system.

Textbooks / References

1. *Pistoia, Gianfranco, and Boryann Liaw, "Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost", Springer International Publishing AG, 2018.*
2. *Plett, Gregory L., "Battery management systems, Vol. I: Battery modeling", Artech House, 2015.*
3. *Plett, Gregory L., "Battery management systems, Vol. II: Equivalent-circuit methods", Artech House, 2015.*
4. *Bergveld, H.J., Kruijt, W.S., Notten, P.H.L., "Battery Management Systems -Design by Modelling", Philips Research Book Series, 2002.*
5. *Davide Andrea,"Battery Management Systems for Large Lithium-ion Battery Packs", Artech House, 2010.*
6. *Pop Valer et al., "Battery management systems: Accurate state-of-charge indication for battery-powered applications", Vol. 9, Springer Science & Business Media, 2008.*

23EEE368	CONDITION MONITORING AND PREDICTIVE MAINTENANCE	L-T-P-C: 3-0-0-3

Pre-requisites: Electrical machines and Signal processing.

Course Objective

- To impart knowledge on condition monitoring of electrical machines through theoretical and practical approach using finite element analysis, signal processing and artificial intelligence.

Course Outcomes

CO1: Understand the occurrence of various faults and their causes in electrical machines.
CO2: Modelling of faults in electrical machines.
CO3: Analyze the faults using finite element and various signal-processing approaches.
CO4: Apply artificial intelligence techniques for fault diagnosis.

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	3	-	-	2	-	-	-	-	-	-	-	2	1	2
CO3	3	3	3	1	2	-	-	-	-	-	-	-	2	1	2
CO4	1	2	2	1	2	-	-	-	-	-	-	-	2	1	3

Syllabus

Unit 1

Principles of variable speed drives applied to electrical machines – Reliability of Machines and typical failure rates - Need for Condition Monitoring – Methodologies. Faults in induction and synchronous machines – stator, rotor, bearing, eccentricity, demagnetization. Modeling of electrical machines – winding function approach, magnetic equivalent circuit method.

Unit 2

Analysis of faults using finite element method – geometric modelling, analysis of airgap flux density, Fault diagnosis techniques based on frequency domain – vibration, current, power and flux, Fault diagnosis techniques based on model-based techniques.

Unit 3

Application of pattern recognition to fault diagnosis, Digital signal processing requirements for fault diagnosis, Application of artificial intelligence techniques for fault diagnosis.

Textbooks / References

1. *Toliyat, Hamid A., et al. Electric machines: modeling, condition monitoring, and fault diagnosis. CRC press, 2012.*
2. *Tavner, Peter, et al. Condition monitoring of rotating electrical machines. 3rd Edition, IET, 2020.*

23ELC361	DIGITAL IMAGE PROCESSING	L-T-P-C: 3-0-0-3

Course Objective

- To study the techniques of filtering, feature extraction and other methods for processing images in different domains.

Course Outcomes

CO1: Understand the 2D images.
CO2: Comprehend basic image processing operations.
CO3: Apply filters to images in spatial and frequency domain.
CO4: Analyze different image segmentation 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	-	1	-	-	-	-	-	-	-	2	1	-
CO2	3	3	3	-	1	-	-	-	-	-	-	-	2	1	-
CO3	3	3	3	2	1	-	-	-	-	-	-	-	3	2	1
CO4	3	3	3	2	1	-	-	-	-	-	-	-	3	2	1

Syllabus

Unit 1

Digital image fundamentals – Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception – simple image formation model; image contrast. Color image fundamentals: RGB, CMY, HIS models. Point processing. Intensity transformations. Histogram processing. Filtering in spatial domain: Average, Median and Laplacian filters.

Unit 2

2D Transforms – DFT, Walsh transform, Hadamard transform, Haar transform. Filtering in frequency domain: low pass filtering, high pass filtering, band-pass, band-reject filtering. Image compression: JPEG, wavelet-based image compression. Image restoration-Degradation model, Lagrange multiplier and constraint restoration.

Unit 3

Image segmentation – Classification of Image segmentation techniques, region approach, clustering techniques. Classification of edges, edge detection. Hough transforms. Morphological operations. Applications to real-world situations.

Textbooks / References

1. *Gonzalez Rafel C., "Digital Image Processing", Pearson Education, 2009.*
2. *S Jayaraman, S. Esakkirajan, T. Veerakumar, "Digital image processing", Tata Mc Graw Hill, 2015.*
3. *Kenneth R Castleman, Digital image processing", 2nd Edition, Pearson Education, 2003.*
4. *Pratt William K.,"Digital Image Processing", 4th Edition, John Wiley, 2007.*
5. *Jain Anil K.,"Fundamentals of digital image processing", PHI,1988.*

23ELC362	BIG DATA ANALYTICS	L-T-P-C: 3-0-0-3

Pre-requisites: Data Base Systems and Programming, Machine learning.

Course Objective

- To study handling of big data using large scale data storage technologies and streaming platforms.

Course Outcomes

CO1: Understand the core concepts of big data problems.

CO2: Comprehend the big data storage frameworks.
CO3: Apply big data analytics using Hadoop and Spark.
CO4: Analyse modern tools and applications for real world scenarios.

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	1	-	-	-	-	-	-	-	2	2	2
CO2	3	2	3	3	1	-	-	-	-	-	-	-	2	2	2
CO3	3	2	3	3	1	-	-	1	2	1	-	-	2	2	2
CO4	3	2	3	3	1	-	-	1	2	1	-	-	2	2	2

Syllabus

Unit 1

Introduction to bigdata, Challenges with Big data, Big data enabling technolgies, Hadoop stack for bigdata, RDBMS vs Hadoop, hadoop distributed file system (HDFS), Hadoop MapReduce 1.0, Hadoop MapReduce 2.0 (Part-I), YARN architecture, MapReduce Examples, Parallel Programming with spark, Introduction to Spark, Spark Built-in-Libraries, Design of Key-Value Stores, Pig on Hadoop.

Unit 2

Data Placement Strategies, CAP Theorem, Consistency Solutions, Design of Zookeeper, CRUD operations, CQL (Cassandra Query Language), Design of HBase, Spark Streaming, Sliding window analytics, Introduction to Kafka, Big Data machine learning, Machine learning algorithm K-means using Map Reduce for Big Data Analytics, Parallel K-means using Map Reduce on Big Data Cluster Analysis.

Unit 3

Decision Trees for Big Data Analytics, Big Data Predictive Analytics, Parameter Servers, Page Rank Algorithm in Big Data, Spark GraphX and Graph Analytics, Case study.

Textbooks /References

1. *Seema Acharya, Subhashini Chellappan , "Big Data and Analytics", Wiley Publication, 2015.*
2. *Judith Hurwitz,Alan Nugent, Dr.Fern Halper, Marcia Kaufman , "Big Data for Dummies", John Wiley & Sons, Inc., 2013.*
3. *Tom White, "Hadoop: The Definitive Guide", O'Reilly Publications, 2011.*
4. *Kyle Banker, "Mongo DB in Action", Manning Publications Company, 2012.*
5. *Russell Bradberry, Eric Blow, "Practical Cassandra A developers Approach", Pearson Education, 2014.*

23ELC363	**CLOUD COMPUTING**	**L-T-P-C: 3-0-0-3**

Pre-requisite: Computer Programming I.

Course Objective

- To understand the basics of cloud computing technology and services.

Course Outcomes

CO1: Understand basic concepts of cloud computing.
CO2: Familiarize the architecture of cloud services and deployment.
CO3: Apply virtualization techniques in cloud.
CO4: Analyse cloud applications, security and privacy.

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	1	-	-	-	-	-	-	-	2	2	2

CO2	3	2	3	3	1	-	-	-	-	-	-	-	2	2	2
CO3	3	2	3	3	1	-	-	1	2	1	-	-	2	2	2
CO4	3	2	3	3	1	-	-	1	2	1	-	-	2	2	2

Syllabus

Unit 1

Introduction to cloud computing: Evolution of cloud computing, Definition of cloud computing, NIST reference model, Service delivery model, Deployment models, Benefits and challenges of cloud adoption, Introduction to popular cloud platforms,

Unit 2

Virtualization and Cloud Computing Architecture: Introduction - Characteristic of Virtualized Environments – Taxonomy of Virtualization Techniques – Virtualization and Cloud Computing – Technology Examples. Containers: Docker, Linux containers

Unit 3

Distributed computing and cloud – Application of cloud computing: IoT, Big Data. Scientific Applications – Business and Consumer Applications – Third Party Cloud Services – Example AWS. Security and privacy issues. Cloud-centric regulatory compliance issues and mechanisms.

Textbook

1. *Anthony T Velte, "Cloud Computing: A practical Approach", Tata McGraw Hill, 2009.*

23ELC364	**DEEP LEARNING**	**L-T-P-C: 3-0-0-3**

Pre-requisite: Machine Learning.

Course Objective

- To study deep learning concepts and apply them to real-world applications.

Course Outcomes

CO1: Understand architecture and working of Convolutional Neural network.
CO2: Analyze the performance of different pretrained deep networks on latest software platforms.
CO3: Comprehend parameter tuning, regularization, training, and error optimization.
CO4: Familiarize with deep learning models with memory elements.

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	1	-	-	1	2	1	-	-	2	2	2
CO2	3	2	3	3	1	-	-	1	2	1	-	-	2	2	2
CO3	3	2	3	3	1	-	-	1	2	1	-	-	2	2	2
CO4	3	2	3	3	1	-	-	1	2	1	-	-	2	2	2

Syllabus

Unit 1

Neural Networks Review: Feed forward network, Gradient Descent based Back propagation algorithm.

Convolutional Neural Networks (CNN). Different layers and functionalities, data augmentation. Cost function, Training, parameters and hyper-parameters. Regularization, Vanishing Gradient, learning algorithms.

Unit 2

Pre-trained models AlexNet, VGGNet GoogleNet, ResNet and transfer Learning. YOLO. HuggingFace.
Different applications, latest pre-trained models can be undertaken in TensorFlow/Pytorch across the Units.

Unit 3

Introduction to different data including images, NLP, videos.
Models with memory elements and their variants: Recurrent Neural Networks (RNN), LSTM.
Autoencoders, transformers.

Reference/Textbook

1. *Goodfellow, Y, Bengio, A. Courville, "Deep Learning", MIT Press, 2016.*
2. *Aditi Majumder, M. Gopi, "Introduction to Visual Computing: Core Concepts in Computer Vision, Graphics, and Image Processing", CRC Press; 1st Edition, 2018.*

23ELC365	BLOCKCHAIN TECHNOLOGY	L-T-P-C: 3-0-0-3

Course Objective

- To understand the fundamentals of crypto currency and application of blockchain in implementing crypto currency.

Course Outcomes

CO1: Understand the concepts of crypto currency, blockchain, and distributed ledger technologies.
CO2: Comprehend the application and impact of blockchain technology in the financial and other industries.
CO3: Evaluate security issues relating to blockchain and crypto currency.
CO4: Design and analyse the impact of blockchain technology.

CO-PO Mapping

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

Syllabus

Unit 1

The story of a transaction: From Transactions to Blocks – Blocks and Distributed Consensus – Basic interaction with a Bitcoin node. Keys and Addresses: Basic cryptography – From private keys to addresses. The Bitcoin Script language: Introduction to the Bitcoin Script language – Script writing and execution – Tools and libraries to access Bitcoin's API and scripting capabilities.

Unit 2

Blockchain deployment: Mining and forking – Upgrading the network - Related BIPs - Segregated Witness (SegWit). Blockchain architectures: Abstract Architecture – Ways to dive deeper - Introduction to major blockchain platforms. Smart contracts and Ethereum: Technical introduction to smart contracts - Ethereum overview – Web3 proposition for a decentralized internet – Using Ethereum sub-protocols, storage and ways of interacting with the external world.

Unit 3

Comparing Bitcoin and Ethereum – Historical comparison – Conceptual distinction between a payment system and a decentralized applications platform - Differences in their architectures from security-first aspect to a rich feature set - Future roadmap for them, following their own paths with probable interconnections. Contract code walk-through: Demonstration of smart contract – Introduction to Solidity – Contract lifecycle – Solidity Building blocks – Popular contracts already in deployment.

Textbooks / References

1. *Andreas Antonopoulos, "Mastering Bitcoin", O'Reilly Publishing 2014 978-0691171692.*
2. *Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.*
3. *William Mougayar, "The Buisness Blockchain: Promise, Practice, and Application of the Next Internet Technology" Wiley; 1st Edition, 2016.*
4. *Bitcoin: A Peer-toPeer Electronic Cash System Satoshi Nakamoto Online 2009. https://bitcoin.org/bitcoin.pdf*
5. *Vitalik Buterin Ethereum White Paper Online 2017.*

23ELC366	CYBER SECURITY	L-T-P-C: 3-0-0-3

Pre-requisite: Computer Programming I.

Course Objective

- To understand the relevance and potential of computer security for ever increasing number of applications.

Course Outcomes

CO1: Understand and apply the fundamental concepts of computer security to different components of computing systems.

CO2: Identify the basic cryptographic techniques using existing software in information security.

CO3: Describe malicious attacks, threats, and protocols for security vulnerabilities and its impact on a systems infrastructure.

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	-	3	-	-	-	-	-	-	-	2	2	2
CO3	3	3	2	2	3	-	-	-	-	-	-	-	2	2	2

Syllabus

Unit 1

Basics of Computer Security: Overview - Definition of terms - Security goals - Shortcomings - Attack and defense - Encryption and Cryptography: Ciphers and codes - Public key algorithms - Key distribution - Digital signatures - Pretty good privacy

Unit 2

Authentication and Key Exchange Protocols: Directory authentication service v Diffie-Hellman key exchange – Kerberos – Software Security: Malicious code - Worms - Intruders – Error detection and correction – OS protection policies – Trusted Systems : Memory protection - Access control matrix – User authentication

Unit 3

Security models – Disaster recovery – Database Security: Integrity constraints – Multi-phase commit protocols - Networks Security: Threats in networks – DS authentication – Web and Electronic Commerce: Threats on the web - Secure socket layer – Client-side certificates – Applet security model

Textbooks / References

1. *Stallings William, "Cryptography and Network Security: Principles and Practice", 6th Edition, Pearson/Prentice- Hall, 2013.*
2. *Forouzan B. A., "Cryptography and Network Security", Special Indian Edition, Tata McGraw Hill, 2007.*
3. *Padmanabhan TR, Shyamala C K, and Harini N, "Cryptography and Security", 1st Edition, Wiley India Publications, 2011.*

23ELC367	NATURAL LANGUAGE PROCESSING	L-T-P-C: 3-0-0-3

Pre-requisites: Calculus, Linear Algebra, Probability and Random processes.

Course Objective

- To study the phonological, morphological and syntactic processing. These areas will be approached from linguistic and algorithmic perspective. Also focusses on the computational properties of natural languages and algorithms used to process them, and match between grammar formalisms and linguistic data that needs to be covered.

Course Outcomes

CO1: Understand the models, methods, and algorithms of statistical Natural Language Processing (NLP) for common NLP tasks.

CO2: Comprehend mathematical and statistical models for NLP.

CO3: Illustrate linguistic phenomena and linguistic features relevant to each NLP task.

CO4: Develop probabilistic models in code.

CO5: Apply learning models to NLP tasks such as speech recognition, machine translation, spam filtering, text classification, and spell checking.

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	-	-	-	-	-	-	-	-	1	2	2
CO2	3	2	3	2	-	-	-	-	-	-	-	-	1	2	2
CO3	3	2	3	2	-	-	-	-	-	-	-	-	1	2	2
CO4	3	1	2	2	3	-	-	-	-	-	-	-	1	2	2
CO5	3	1	2	2	3	-	-	-	-	-	-	-	1	2	2

Syllabus

Unit 1

Introduction- Human languages, models, ambiguity, processing paradigms; Phases in natural language processing, applications. Text representation in computers, encoding schemes. Linguistics resources- Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. Resource management with XML, Management of linguistic data with the help of GATE, NLTK. Regular expressions, Finite State Automata, word recognition, lexicon. Morphology, acquisition models, Finite State Transducer, N-grams, smoothing, entropy, HMM, ME, SVM, CRF.

Unit 2

Part of Speech tagging- Stochastic POS tagging, HMM, Transformation based tagging (TBL), Handling of unknown words, named entities, multi word expressions. A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, Context Free Grammar, spoken language syntax. Parsing- Unification, probabilistic parsing, Tree Bank. Semantics- Meaning representation, semantic analysis, lexical semantics, WordNet Word Sense Disambiguation- Selectional restriction, machine learning approaches, dictionary-based approaches.

Unit 3

Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure. Applications of NLP – Spell-checking, Summarization Information Retrieval – Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries. Machine Translation – EM algorithm – Discriminative learning – Deep representation learning – Generative learning.

Textbooks / References

1. *Martin J. H., Jurafsky D., "Speech and language processing: An introduction to natural language processing,computational linguistics, and speech recognition" Upper Saddle River: Pearson/Prentice Hall, 2009.*
2. *James A., "Natural language Understanding", 2nd Edition, Pearson Education, 1994.*
3. *Bharati A., Sangal R., Chaitanya V., "Natural language processing: a Paninian perspective", PHI, 2000.*
4. *Tiwary U. S., Siddiqui T., "Natural language processing and information retrieval", Oxford University Press, Inc., 2008.*

23ELC368	GREEN COMPUTING	L-T-P-C: 3-0-0-3

Course Objective

- Introduce the concept of green IT, environmental perspectives on IT use, standards and certifications related to sustainable IT products for sustainable development with environmental perceptive.

Course Outcomes

CO1: Understand the concepts of technologies that conform to low-power computation.

CO2: Comprehend green (power-efficient) technologies for components of one single computer, such as CPU, memory and disk and appreciate cutting edge designs for these components.

CO3: Describe variety of technologies applied in building a green system and to identify the various key sustainability and green IT trends.

CO4: Illustrate various laws, standards and protocols for regulating green IT.

CO5: Apply range of tools to monitor and design green 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	2	-	-	-	-	-	1	-	-
CO2	2	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	2	3	2	2	-	-	-	1	2	2
CO4	2	-	-	-	-	3	3	2	2	-	-	-	-	2	3
CO5	2	-	-	-	-	3	3	-	-	-	-	-	1	2	3

Syllabus

Unit 1

Green IT Fundamentals: Business, IT, and the Environment –Green computing: carbon foot print, scoop on power – Green IT Strategies: Drivers, Dimensions, and Goals – Environmentally Responsible Business: Policies, Practices, and Metrics. Green Assets: Buildings, Data Centers, Cloud, Networks, and Devices - Green Business Process Management: Modeling, Optimization, and Collaboration –Green Enterprise Architecture –Environmental Intelligence Green Supply Chains –Green Information Systems: Design and Development Models.

Unit 2

Virtualizing of IT systems –Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC –Green Data center – Green Grid framework.

Applying Computing towards Sustainability, Smart Buildings and the Smart Grid, sensing, modeling and controlling the energy usage of buildings, as well as new operating systems and software stacks for the smart infrastructure.

Unit 3

Socio-cultural aspects of Green IT –Green Enterprise Transformation Roadmap –Green Compliance: Protocols, Standards, and Audits –Emergent Carbon Issues: Technologies and Future. The Environmentally Responsible Business Strategies (ERBS) –Case Study Scenarios for Trial Runs – calculating the carbon footprint – greening mobile devices - CASE STUDIES –Applying Green IT Strategies and Applications to a Home, Hospital, Packaging Industry and Telecom Sector.

Textbooks / References

1. *Bhuvan Unhelkar, "Green IT Strategies and Applications-Using Environmental Intelligence", CRC Press, June 2011.*
2. *Woody Leonhard, Katherrine Murray, "Green Home computing for dummies", August 2009.*
3. *Alin Gales, Michael Schaefer, Mike Ebbers, "Green Data Center: steps for the Journey", Shoff/IBM rebook, 2011.*
4. *John Lamb, "The Greening of IT", Pearson Education, 2009.*
5. *Jason Harris, "Green Computing and Green IT-Best Practices on regulations & industry, Lulu.com", 2008.*
6. *Carl Speshocky, "Empowering Green Initiatives with IT", John Wiley & Sons, 2010.*

7. *Wu Chun Feng, "Green computing: Large Scale energy efficiency", CRC Press, 2012.*

23ELC369	EVOLUTIONARY OPTIMIZATION TECHNIQUES	L-T-P-C: 3-0-0-3

Course Objective

- To classify the problem around us as optimization or modelling or simulation problems and solve using evolutionary algorithms.

Course Outcomes

CO1: Understand the structure, components and adaptive parameter settings of evolutionary algorithms.

CO2: Design hybrid, multi-objective, interactive evolutionary algorithms for static/dynamic and constrained/unconstrained optimization problems.

CO3: Apply algorithms for evolutionary learning and neuroevloution strategies.

CO4: Analyze the performance of evolutionary algorithms for given toy and real-world problems.

CO-PO Mapping

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

Syllabus

Unit 1

Type of Problems - Introduction to Evolutionary Computation – Evolutionary Algorithms (*EAs*) – Different components of EAs– population representation techniques, mutation and crossover techniques, population management models, parent and survivor selection, fitness, fitness landscape, fitness sharing and crowding – Summary of popular variant of EAs.

Unit 2

Parameter of EAs – parameter control and parameter tuning, Working with EAs – Performance metrics and test problems. Hybridizing EAs – memetic algorithms, Nonstationary and Noisy optimization, Multi-objective EAs – Constraint handling – Interactive EAs.

Unit 3

Special forms of evolution – co-evolution and speciation, ensemble EAs, evolutionary learning, neuroevoluion, design and analysis of EAs – design of experiments, empirical and statistical comparison of EAs, applications of EAs – toy problems (viz., eight-queen problem and knapsack problem) and real-world problems.

Textbooks / References

1. *A. E. Eiben and J. E. Smith,"An Introduction to Evolutionary Computing", Natural Computing Series, 2nd Edition, Springer, 2015.*
2. *Iaroslav Omelianenko, "Hands-on neuroevolution with python: build high-performing artificial neural network architecture using neuroevolution based algorithm", Packt Publishing, 2019.*
3. *Slim Bechikh, Rituparna Datta and Abhishek Gupta, "Recent advances in evolutionary multi-objective optimization", Adaptation, learning and optimization book, Springer 2017.*
4. *Hitoshi Iba, "Evolutionary approach to machine learning and deep learning networks: neuro-evolution and gene regulatory networks", Springer 2018.*
5. *Kenneth A. De Jong," Evolutionary Computation - A Unified Approach", MIT Press, 2006.*
6. *Z. Michaelewicz and David B. Fogel "How to Solve it: Modern Heuristics", 2nd Edition, Springer, 2004.*
7. *Thomas Bartz-Beielstein, "Experimental Research in Evolutionary Computation: The New Experimentalism", Natural Computing Series, Springer, 2006.*
8. *. Back, David B. Fogel and Z. Michaelewicz (Eds), "Handbook of Evolutionary Computation", Oxford University Press,1997.*

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.

Sylla

bus

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) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler- Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - 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 properties
CO2: 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 sustainable products
CO2: Appreciate the need for Renewable energy and Feed stock along with carbon sequestration through the fundamentals 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

Syllabus Unit

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 of zero 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 analytical chemistry
CO2: To provide an understanding and skills in contemporary methods of separation and appropriate selection of instruments for the successful analysis of chemical compounds
CO3: To impart skills in the scientific method of planning, conducting, reviewing, reporting experiments and problem 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 and physical 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 Diffraction Studies - 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) indicator and 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 corrosion
CO2: 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	-

Syllabus Unit

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 - Galvanic and 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 laws and Scattering states

CO4: Able to solve problems in the Centre of Mass frame and connect it to Laboratory Frame of Reference

CO5: 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 law of 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	-

Syllabus Unit

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 of electronic 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 semiconductor parameters 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 of relativity – 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 - plank length 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 in Practice – 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 and outsourcing 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-bullwhip effect-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 a specific 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			

Syllabus Unit

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 moderntrends 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

Syllabus Unit

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 implementation issues. 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 HalI, 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 and material 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		

Syllabus Unit

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 isknown 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 within quality 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		

Syllabus Unit

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 completed Future 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 management for 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 and AOA-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 of multi-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 and derivatives
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

Syllabus Unit

1
Cash Flows and Fixed income securities: Investments and markets - Principal and interest - Present and future values of 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 structure of 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 on business decisions

Course Outcomes

CO1: Understand and evaluate the economic theories, cost concepts and pricing policies and draw inferences for the investment decisions for appraisal and profitability
CO2: Appraise the dynamics of the market and market structures and portray implication for profit and revenue maximization
CO3: Employ operations research and allied techniques in managerial economics for an enhanced analysis and decision 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 also understand 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

Syllabus Unit

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, value chain ,reengineering, virtual organization ,knowledge creation-Organizational Planning, The Scenario Approach, Planning for Competitive Advantage, SWOT Business Models and Planning, Business IT Planning, -Business/ IT Strategies 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 possibilities for manifesting excellence in life. This course presents to the students, an opportunity to study the Indian perspective of 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 enhance excellence.
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. Thecourse 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 in business contexts.

Course Outcomes

CO1: Familiarize and use appropriate business vocabulary and etiquettes in verbal communication in the professional context
CO2: Understand organizational structures, pay structures and performance assessments
CO3: Apply language skills in drafting various business documents and other necessary communications in the business context
CO4: Understand and address cross cultural differences in the corporate environment
CO5: 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 the societal 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 literaryinsights; 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 documentation
CO2: 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 to carry 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 language
CO2: Understand the structural aspects of Hindi language
CO3: Apply the knowledge of the grammatical structures to communicate in Hindi
CO4: 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 Hindi language, 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, Rabindranath Tagore; 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 supremacy in 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 of Surat and Porbander, businessmen of Bombay, etc. may be referred to here) – the evolution of the modern banking system; 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 the hoary 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 - 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 a whole
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 nurture healthy 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, Pvt 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.

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 Growing and Sharing Food in Plenty. Chennai: Centre for Policy Studies, 2001.*
9. *Bajaj, Jitendra & M. D. Srinivas. Annam Bahu Kurvita: Recollecting the Indian Discipline of Growing and 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 – Baredidi…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 Kerala
CO4: 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 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 the different cultural influences in linguistic translation CO2: Identify and appreciate the Romantic elements of modern literature CO3: Analyze the genre of autobiographical writing
CO4: Critically evaluate the significance of historical, political and socio cultural aspects in literature CO5: 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 the usefulness 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 veḻiyīṭṭakam 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 ofTamilliterature.
- To analyze different styles of Tamil Language.
- To strengthen thecreativity in communication, Tamilbasicgrammar and use of computer on Tamil Language.

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.
Aṟaṉūlkaḷ: 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 kaṇiṇi payaṉpāṭu. - Karuttu parimārṟam - 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.