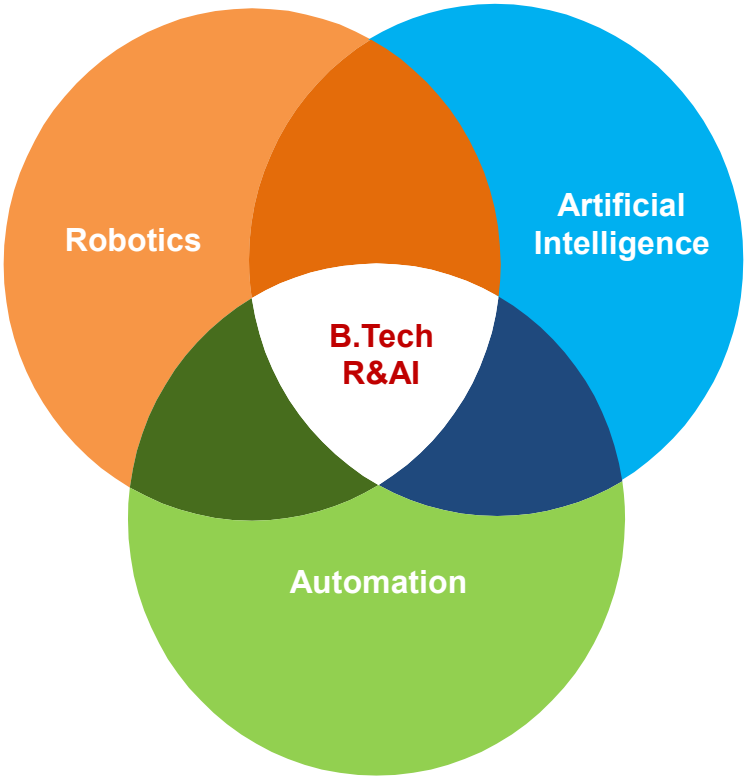
AMRITA VISHWA VIDYAPEETHAM | School of Engineering

DEPARTMENT OF MECHANICAL ENGINEERING



B.Tech

ROBOTICS AND ARTIFICIAL INTELLIGENCE (R&AI)

2024

CURRICULUM & SYLLABUS
(2024 admission onwards)

B.Tech Programme
ROBOTICS AND ARTIFICIAL INTELLIGENCE (R&AI)

Programme Overview

The Robotics and Artificial Intelligence (R&AI) undergraduate programme amalgamates multiple engineering disciplines such as Mechanical Engineering, Electrical Engineering, and Computer Science and Engineering. R&AI programme introduces the leading technologies underlying the development of Robotic and Intelligent systems, including Machine Learning (ML) and AI, that sense and interact with their physical environment. AI empowers the robots making them more efficient to perceive, learn and make decisions like humans. Industries are going through the fourth industrial revolution (Industry 4.0), which utilizes Robotics and AI to perform the data- intensive and repetitive tasks to achieve human-robot collaboration. Hence, the need for a skilled workforce in industries with knowledge of Robotics & AI is in growing demand.

The students will get trained in Robotics and AI through a well-structured curriculum designed with the participation of industry experts and academicians. Students can study and implement multidisciplinary concepts such as machine vision, machine learning, edge computing, IoT, Cobots, and Industry 4.0. The coursework, such as mathematics for intelligent systems, fundamentals of AI, Deep learning, Big Data Analytics, Reinforcement Learning, etc., equip students to implement several AI projects to hone skills such as critical thinking, problem-solving, and practical implementation of AI in robotic technologies. Students also get an opportunity to avail of exchange programs at other universities where similar research on Robotics & AI is being focused. The interdisciplinary lab experience gained by the students through the projects and group activities imparts the necessary knowledge to fetch either a job or admission to higher studies aspired by the students.

After completing the program, the students will have strong knowledge of designing, developing, and testing algorithms for implementing AI in robotic systems for industrial and societal applications. The graduating students can create highly efficient machines and human-friendly interfaces for intelligently automating robotic systems addressing the modern challenges in automation. In addition to the core engineering courses, the students are exposed to imparting human values and life-long learning skills.

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
C	-	Credits
RAI	-	Robotics and Artificial Intelligence
ENG	-	Engineering Sciences
SCI	-	Basic Sciences (including Mathematics)
GEC	-	General Engineering (including programming foundations)
HUM	-	Humanities (including Languages and others)
PRJ	-	Project Work (including mini project/internship)
CSE	-	Computer Science and Engineering
CUL	-	Cultural Education
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
MAT	-	Mathematics
MEE	-	Mechanical Engineering
ELE	-	Electives (Professional electives, Free electives, Open Electives)
ADC	-	Audit Courses (P/F)
LIV	-	Live-in-Labs
ADM	-	Amrita Darshanam

Program Educational Objectives (PEOs) - Program educational objectives are the broad statements describing the career and professional accomplishments the program prepares graduates to achieve. Student outcomes are statements that describe what students are expected to know or be able to do by the time they complete an academic program.

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

Program Specific Outcomes (PSOs) – Program Outcomes are statements describing what students are expected to acquire specific knowledge, skills, and attitudes through the program. PSOs are written by the department offering the program.

Course Outcomes (COs) – Statements that describe what students are expected to know and can do at the end of each course. These relate to the skills, knowledge, and behavior students acquire in their progress through thecourse.

VISION AND MISSION OF THE DEPARTMENT

Vision

To transform our students into outstanding mechanical engineers with strong domain knowledge and skills, society-centric research intent, and exemplary ethical values, making them the most desired professionals by research institutions, industry, and society.

Mission

- To develop in each student a profound understanding of fundamentals, motivation for continuous learning, and practical problem-solving skills for building a successful career.
- To create and share technical knowledge and collaborate with Industry and Institutions for the betterment of society.
- To imbibe ethical values, leadership skills, and entrepreneurial skills in students.
- To sustain a conducive environment to involve students and faculty in research and development.

PROGRAM EDUCATIONAL OBJECTIVES

PEO1: Apply their Knowledge in Science, Mathematics, and Engineering to address Industrial and Societal problems with a strong emphasis on creativity, confidence, ethics, and responsibility.

PEO2: Apply the latest computational, analytical, and simulation tools and techniques to develop and improve products and processes.

PEO3: Solve multidisciplinary problems by working in cross-functional teams.

PEO4: Develop and upgrade technical, intellectual, and emotional skills for life-long learning to compete in a rapidly evolving world.

PEO5: Nurture entrepreneurial ventures and foster research activities that support sustainable economic development to enhance the quality of life.

PROGRAM OUTCOMES FOR ENGINEERING

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, andengineering 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 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 toprovide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling 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 theengineering practice.
9. **Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams and 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 anddesign documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering andmanagement principles and apply these to one's own work as a member and leader in a team, to manageprojects 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.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1: Design and develop cost-effective robotic systems catering to Industrial and Societal requirements.
PSO 2: Develop cost-effective, safe, and efficient AI-based automation systems for manufacturing applications, focusing on product development and process improvement.
PSO 3: Apply the acquired knowledge and skills in AI to address real-life multidisciplinary engineering problems.

CREDIT STRUCTURE OF THE PROGRAMME

Categories of Courses & Credit Breakups

S.No.	CATEGORY	Semester wise Credits									% share
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**Total**	
1.	Humanities & Social Science Courses	7	2	1	3	2	2	-	-	17	11
2.	Basic Science (including Mathematics) & General Engineering courses	15	13	10	3	3	-	-	-	44	27
3.	Engineering Core Courses	-	7	11	13	14	12	7	-	64	40
4.	Professional Elective Courses, Free Electives & Open Elective Courses, Live-in-Labs	-	-	-	2	3	6	6	3	20	13
5.	Project work, Seminar, and Internship in Industry or elsewhere	-	-	-	-	-	2	5	8	15	9
6.	Audit Courses [Environmental Sciences, Research Methodology, Indian Constitution]	ES	-	IC	-	RM	-	-	-	-	-
Total		**22**	**22**	**22**	**21**	**22**	**22**	**18**	**11**	**160**	**100**

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CURRICULUM

BTECH R&AI

SEMESTER I

Cat.	Code	Title	L T P	Credit
SCI	23MAT126	Mathematics for Intelligent Systems - 1	2 0 3	3
SCI	24PHY104	Engineering Physics	2 1 0	3
GEC	23CSE116	C Programming	2 0 3	3
GEC	23EEE105	Basic Electrical and Electronics Engineering	3 0 3	4
GEC	23MEE106	Engineering Graphics and 3D Modelling	1 0 3	2
HUM	22AVP103	Mastery Over Mind	1 0 2	2
HUM	22ADM101	Foundations of Indian Heritage	2 0 1	2
HUM	23ENG101	Technical Communication	2 0 3	3
HUM	23ENV300	Environmental Science	--	(P/F)
		TOTAL		**22**

SEMESTER II

Cat.	Code	Title	L T P	Credit
SCI	23MAT131	Mathematics for Intelligent Systems – 2	2 0 3	3
GEC	23CSE117	Object Oriented Programming	2 0 3	3
GEC	23MEE112	Elements of Mechanical Engineering	3 0 0	3
GEC	24MEE113	Computational Engineering Mechanics	2 0 3	3
GEC	23MEE182	Manufacturing Practices-B	0 0 3	1
ENG	23ECE118	Sensors and Signal Processing	3 0 3	4
ENG	23RAI111	Fundamentals of Artificial Intelligence	3 0 0	3
HUM	22ADM111	Glimpses of Glorious India	2 0 1	2
		TOTAL		**22**

SEMESTER III

Cat.	Code	Title	L T P	Credit
SCI	23MAT221	Mathematics for Intelligent Systems - 3	2 0 3	3
GEC	23CSE207	Python Programming	1 0 3	2
GEC	23MEE207	Design Thinking	1 0 3	2
GEC	23MEE208	Materials Science	2 0 3	3
ENG	23MEE209	Theory of Mechanisms and Machines	3 0 3	4
ENG	23EEE206	Actuators and Drives	3 0 0	3
ENG	23ECE207	Micro Controllers and Embedded Systems	3 0 3	4
HUM		Amrita Value Program I	1 0 0	1
ADC	23LAW300	Indian Constitution		P/F
HUM	23LSE201	Life Skills for Engineers I	1 0 2	P/F
		TOTAL		**22**

SEMESTER IV

Cat.	Code	Title	L T P	Credit
SCI	23MAT226	Mathematics for Intelligent Systems - 4	2 0 3	3
ENG	23CSE215	Data Science	2 0 3	3
ENG	23RAI211	Kinematics of Robotic Systems	3 0 0	3
ENG	23EEE216	Control Systems	3 0 0	3
ENG	23MEE216	Manufacturing Processes	2 0 3	3
ENG	23RAI281	Robot Kinematics and Control System Lab	0 0 3	1
ELE		Free Elective**	2 0 0	2
HUM	23LSE211	Life Skills for Engineers II	1 0 2	2
HUM		Amrita Value Program II	1 0 0	1
		TOTAL		**21**

SEMESTER V

Cat.	Code	Title	L T P	Credit
SCI	23MAT307	Graph Theory Algorithms for Robotics	2 0 3	3
ENG	23RAI301	Fluid Power Systems	2 0 0	2
ENG	23RAI302	Dynamics and Control of Robotic Systems	3 0 0	3
ENG	23RAI303	Machine Learning	3 0 3	4
ENG	23RAI304	Robot Operating System	1 0 3	2
ENG	23RAI381	Fluid Power Systems and Robot Dynamics & Control Lab	0 0 3	1
ENG	23RAI305	Introduction to Drones	1 0 3	2
ADC	23RAI300	Research Methodology	-	P/F
ELE	23LIV390*	Professional Elective 1 / Live-in-Lab I*	3 0 0	3
HUM	23LSE301	Life Skills for Engineers III	1 0 2	2
		TOTAL		**22**

SEMESTER VI

Cat.	Code	Title	L T P	Credit
ENG	23MEE316	Additive Manufacturing	1 0 3	2
ENG	23RAI311	Mobile Robots	3 0 0	3
ENG	23RAI312	Deep Learning	2 0 3	3
ENG	23RAI313	IoT and Automation	2 0 3	3
ENG	23RAI382	Mobile Robots Lab	0 0 3	1
PRJ	23RAI398	Mini Project	0 0 6	2
ELE	23LIV490*	Professional Elective 2 / Live-in-Lab II*	3 0 0	3
ELE		Professional Elective 3*	3 0 0	3
HUM	23LSE311	Life Skills for Engineers IV	1 0 2	2
		TOTAL		**22**

SEMESTER VII

Cat.	Code	Title	L T P	Credit
ENGG	23RAI401	Computer Integrated Manufacturing	3 0 0	3
ENGG	23RAI402	Reinforcement Learning	2 0 3	3
ENGG	23RAI481	CNC and System Simulation Laboratory	0 0 3	1
ELE		Professional Elective 4*	3 0 0	3
ELE		Professional Elective 5*	3 0 0	3
PRJ	23RAI497	Summer Internship	-	1
PRJ	23RAI498	Project Phase I	-	4
		TOTAL		**18**

SEMESTER VIII

Cat.	Code	Title	L T P	Credit
PRJ	23RAI499	Project Phase II	-	8
ELE		Professional Elective 6*	3 0 0	3
		TOTAL		**11**

		TOTAL CREDIT		**160**

*Professional Elective - Electives categorized under Engineering, Science, Mathematics, Live-in- Labs, and NPTEL Courses. Students can opt for such electives across departments/campuses. Students with a CGPA of 7.0 and above can opt for 2 NPTEL courses with credits not exceeding 8.

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

*** 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.

Note:
Refer to the intranet page (intranet.cb.amrita.edu) for B.Tech. Programs Common Electives including a) Professional Electives – Sciences b) Free Electives – Management/Humanities/ Social Sciences

https://intranet.cb.amrita.edu/download/DeanEngg/Curriculum_Syllabus/Undergraduate_Programs/B_Tech_01/Engineering_Common_Electives.pdf

PROFESSIONAL ELECTIVES - LIST

Cat.	Code	Title	L T P	Credit
BASKET 1: FIELD / SERVICE ROBOTS				
ENG	23RAI331	Bio-Inspired Robots	3 0 0	3
ENG	23RAI332	Humanoid Robots	3 0 0	3
ENG	23RAI333	Medical Robots	3 0 0	3
ENG	23RAI334	Underwater Robots	3 0 0	3
ENG	23RAI335	Cognitive Robots	3 0 0	3
ENG	23RAI336	Advanced Drones Technology	2 0 3	3

BASKET 2: ADVANCED ROBOTICS TECHNOLOGIES				
ENGG	23RAI341	Intelligent Control Systems for Robots	3 0 0	3
ENGG	23RAI342	Optimization for Robot Modelling	2 0 3	3
ENGG	23RAI343	Computer Vision and Image Processing	3 0 0	3
ENGG	23RAI344	Advanced Materials for Robotics	3 0 0	3
ENGG	23RAI345	Advanced Robotics and Analysis	3 0 0	3
ENGG	23RAI346	Simulation Modeling of Engineering Systems	3 0 0	3

BASKET 3: AI/ INTELLIGENT SYSTEMS				
ENGG	23RAI351	Big Data Analytics	3 0 0	3
ENGG	23RAI352	Big Data and Database Management	3 0 0	3
ENGG	23RAI353	Al in Natural Language Processing	3 0 0	3
ENGG	23RAI354	Al in Speech Processing	3 0 0	3
ENGG	23RAI355	Machine Learning Based Condition Monitoring	3 0 0	3
ENGG	23RAI356	Digital Twins	2 0 3	3
ENGG	23RAI357	Cloud Computing	3 0 0	3
ENGG	23RAI358	Mobile Application Development	3 0 0	3
ENGG	23RAI359	Virtual and Augmented Reality	3 0 0	3
ENGG	23RAI360	Cyber Security	2 0 3	3

BASKET 4: ADVANCED SENSORS AND COMMUNICATION SYSTEMS				
ENGG	23RAI371	Smart Sensors	3 0 0	3
ENGG	23RAI372	E Nose for Robots	3 0 0	3
ENGG	23RAI373	Human Computer Interaction	3 0 0	3
ENGG	23RAI374	UAV Networks	3 0 0	3
ENGG	23RAI375	Introduction of Cyber Vehicle System	3 0 0	3
ENGG	23RAI376	V2X Connected Cars	3 0 0	3
ENGG	23RAI377	Introduction to Computer Networks	3 0 0	3

BASKET 5: ADVANCED MANUFACTURING TECHNOLOGIES				
ENGG	23MEE356	Advanced Manufacturing Processes	3 0 0	3
ENGG	23MEE320	Advanced Metrology and Sensing Systems	3 0 0	3
ENGG	23MEE326	Smart Manufacturing	3 0 0	3
ENGG	23MEE328	Micro and Nano Electromechanical Systems	3 0 0	3
ENGG	23MEE329	Intelligent Manufacturing Systems	3 0 0	3
ENGG	23MEE357	Advanced Materials and Processes	3 0 0	3
ENGG	23MEE325	Simulation Modeling of Manufacturing Systems	3 0 0	3
ENGG	23MEE327	Sustainable Manufacturing	3 0 0	3
ENGG	23MEE330	Functional and Conceptual Design	3 0 0	3

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

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

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

FREE ELECTIVES

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

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS				
Cat.	**Course Code**	**Title**	**L T P**	**Credit**
HUM	23CUL230	Achieving Excellence in Life - An Indian Perspective	2 0 0	2
HUM	23CUL231	Excellence in Daily Life	2 0 0	2
HUM	23CUL232	Exploring Science and Technology in Ancient India	2 0 0	2
HUM	23CUL233	Yoga Psychology	2 0 0	2
HUM	23ENG230	Business Communication	1 0 3	2
HUM	23ENG231	Indian Thought through English	2 0 0	2
HUM	23ENG232	Insights into Life through English Literature	2 0 0	2
HUM	23ENG233	Technical Communication	2 0 0	2
HUM	23ENG234	Indian Short Stories in English	2 0 0	2
HUM	23FRE230	Proficiency in French Language (Lower)	2 0 0	2
HUM	23FRE231	Proficiency in French Language (Higher)	2 0 0	2
HUM	23GER230	German for Beginners I	2 0 0	2
HUM	23GER231	German for Beginners II	2 0 0	2
HUM	23GER232	Proficiency in German Language (Lower)	2 0 0	2
HUM	23GER233	Proficiency in German Language (Higher)	2 0 0	2
HUM	23HIN230	Hindi I	2 0 0	2
HUM	23HIN231	Hindi II	2 0 0	2
HUM	23HUM230	Emotional Intelligence	2 0 0	2
HUM	23HUM231	Glimpses into the Indian Mind - the Growth of Modern India	2 0 0	2
HUM	23HUM232	Glimpses of Eternal India	2 0 0	2
HUM	23HUM233	Glimpses of Indian Economy and Polity	2 0 0	2
HUM	23HUM234	Health and Lifestyle	2 0 0	2
HUM	23HUM235	Indian Classics for the Twenty-first Century	2 0 0	2
HUM	23HUM236	Introduction to India Studies	2 0 0	2
HUM	23HUM237	Introduction to Sanskrit Language and Literature	2 0 0	2
HUM	23HUM238	National Service Scheme	2 0 0	2
HUM	23HUM239	Psychology for Effective Living	2 0 0	2
HUM	23HUM240	Psychology for Engineers	2 0 0	2
HUM	23HUM241	Science and Society - An Indian Perspective	2 0 0	2
HUM	23HUM242	The Message of Bhagwat Gita	2 0 0	2
HUM	23HUM243	The Message of the Upanishads	2 0 0	2
HUM	23HUM244	Understanding Science of Food and Nutrition	2 0 0	2
HUM	23HUM245	Service Learning	2 0 0	2
HUM	23JAP230	Proficiency in Japanese Language (Lower)	2 0 0	2
HUM	23JAP231	Proficiency in Japanese Language (Higher)	2 0 0	2
HUM	23KAN230	Kannada I	2 0 0	2
HUM	23KAN231	Kannada II	2 0 0	2
HUM	23MAL230	Malayalam I	2 0 0	2
HUM	23MAL231	Malayalam II	2 0 0	2
HUM	23SAN230	Sanskrit I	2 0 0	2
HUM	23SAN231	Sanskrit II	2 0 0	2
HUM	23SWK230	Corporate Social Responsibility	2 0 0	2
HUM	23SWK231	Workplace Mental Health	2 0 0	2
HUM	23TAM230	Tamil I	2 0 0	2
HUM	23TAM231	TAMIL II	2 0 0	2

Course Evaluation Pattern

<table>
<tr><td>Course Type</td><td>Int : Ext</td><td colspan="6">Evaluation Scheme</td><td colspan="2">Total (100)</td></tr>
<tr><td colspan="10">Theory, Lab integrated and Pass/Fail (P/F) Courses</td></tr>
<tr><td rowspan="2">L T P</td><td rowspan="5">60 : 40</td><td>CA1</td><td>CA2</td><td>MT</td><td>CA3</td><td>CA4</td><td>ES</td><td colspan="2">Internal (60)</td><td>External (40)</td></tr>
<tr><td>Q1 / A1</td><td>Q2/A2</td><td>Exam</td><td>Q3/A3</td><td>Q4/A4</td><td>Exam/ Project*</td><td colspan="2">CA1+CA2+CA3+CA4</td><td>ES</td></tr>
<tr><td>X 0 0</td><td rowspan="4">7.5</td><td rowspan="4">7.5</td><td rowspan="4">30</td><td rowspan="4">7.5</td><td rowspan="4">7.5</td><td rowspan="4">40</td><td colspan="2" rowspan="4">60</td><td rowspan="4">40</td></tr>
<tr><td>X Y 0</td></tr>
<tr><td>X 0 Z</td></tr>
<tr><td>P/F</td></tr>
<tr><td colspan="10">Lab Based Courses</td></tr>
<tr><td rowspan="2">0 0 Z</td><td rowspan="3">60 : 40</td><td colspan="2">6 weeks Task or Exp. (CA1)</td><td rowspan="2">MT</td><td colspan="2">6 weeks Task or Exp. (CA2)</td><td>ES</td><td colspan="2">Total (100)</td></tr>
<tr><td colspan="2">No. of Task based on the course</td><td colspan="2">No. of Task based on the course</td><td>Exam/ Project*</td><td colspan="2">Internal (60)</td><td>External (40)</td></tr>
<tr><td>1 0 Z</td><td colspan="2">20</td><td>20</td><td colspan="2">20</td><td>40</td><td colspan="2">CA1+MT+CA2</td><td>ES</td></tr>
<tr><td colspan="10">Project / Internship</td></tr>
<tr><td rowspan="5">PRJ</td><td rowspan="5">60 : 40</td><td colspan="5">CA (60)</td><td>ES (40)</td><td colspan="2">Total (100)</td></tr>
<tr><td colspan="7">Mini Project / Project Phase 1 & Phase 2</td></tr>
<tr><td colspan="5">Based on Review by panel of experts</td><td>External review</td><td colspan="2">CA+ES</td></tr>
<tr><td colspan="7">Internship</td></tr>
<tr><td colspan="5">External report (Industry / Research Organization)</td><td>Presentation & Internship Report</td><td colspan="2">CA+ES</td></tr>
</table>

Notes

L	:	Lecture	T	:	Tutorial
P	:	Practical	Int	:	Internal
Ext	:	External	CA	:	Continuous Assessment
MT	:	Mid-Term	ES	:	End Semester Examination
Exp.	:	Experimental work	X	:	No. of Lecture hours per week
Y	:	No. of Tutorial hours per week (1)	Z	:	No. of practical hours per week
Q	:	Quiz	A	:	Assignment

* : Project component (in-lieu of end semester examination) only for the selected courses as decided by the department level committee

SYLLABUS

SEMESTER 1

23MAT126	MATHEMATICS FOR INTELLIGENT SYSTEMS - 1	L-T-P-C: 2-0-3-3

Course Objectives

- To lay down the basic concepts and techniques of linear algebra, calculus and probability theory needed for subsequent study.
- To introduce the concepts of computational experiments and understand the theory behind them.
- To provide an appreciation of the wide application of these disciplines within thescientific field.
- To provide the connection between linear algebra, differential equation and probability theory concepts.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Apply the introductory concepts and techniques of linear algebra, calculus, complex functions and probability theory.
CO2: Summarise mathematical concepts commonly used in data science and AI.
CO3: Apply the combinations of learned mathematical concepts in the form of computational and algebraic methods.
CO4: Computationally model electrical and mechanical systems.

CO-PO Mapping

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

Syllabus

Basics of Linear Algebra - Linear Dependence and independence of vectors - Gaussian Elimination - Rank of set of vectors forming a matrix - Vector space and Basis set for a Vector space - Dot product and Orthogonality - Rotation matrices - Eigenvalues and Eigenvectors and its interpretation - Projection matrix and Regression –Singular Value Decomposition Fields.

Complex Functions: Complex Numbers, Complex Plane, Polar Form of Complex Numbers. Powers and Roots.Derivative: Analytic Functions, Cauchy - Riemann Equations, Laplace Equation, Conformal mapping, Exponential Function, Trigonometric Functions, Hyperbolic Functions, Logarithms, Linear Fractional Transformation.

Convolution sum, Convolution Integral, Ordinary Linear differential equations, formulation, analytical andNumerical solutions, Impulse Response Computations, formulating state space models of Physical systems.

Examples of ODE modelling in falling objects, satellite and planetary motion, Electrical and mechanicalsystems.
Multivariate calculus, Taylor series, Introduction to Optimization.

Introduction to Probability Distributions and Monte Carlo Simulations.

Lab Practice: Computational Exercises related to topic discussed in course.

Text Books / References:

Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.
William Flannery, Mathematical Modelling and Computational Calculus, Berkeley Science Books, Vol-1, 2013.
William Flannery, Mathematical Modelling and Computational Calculus, Vol-1, Berkeley Science Books, 2013.
Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, 2018.
Ray Wylie and Louis Barrett, Advanced Engineering Mathematics, McGraw Hill, Sixth Edition, 2016.

24PHY104 ENGINEERING PHYSICS L-T-P-C: 2-1-0-3

Course Objectives

- To expose the essentials of Newtonian and Quantum mechanics, Wave optics and basic electro-magnetism & electro-dynamics to the Engineering students to enable them to apply in their engineering applications relating to Robotics & AI

Course Outcomes

At the end of the course, the student will be able to:

CO1: Apply the principles of Newtonian mechanics to solve engineering problems.
CO2: Understand the principles of quantum mechanics in engineering domain
CO3: Understand the fundamentals of wave optics and its applications in engineering.
CO4: Interpret the application of Electromagnetism in Robotics application
CO5: Realize the concepts of electrodynamic principles and their applications in Robotics domain

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

Syllabus

Unit 1

Classical Mechanics: Review of Newton's third law and Free Body diagrams. Work, power, and energy. Conservation of momentum. Conservation of energy. Elastic and inelastic collisions.
Introduction to Quantum Mechanics (Qualitative): Dual nature of matter: Black body Radiations, Photoelectric effect, de-Broglie hypothesis, Wave function, Heisenberg's uncertainty principle, Time independent Schrodinger wave equation, Eigen function and Eigen values. (18 hours)

Unit 2

Fundamentals of Wave optics: Theory of superposition -Qualitative: Superposition of two and many Wave trains of the Same Frequency and random phase, Vector addition of amplitudes, Fresnel and Fraunhofer Diffraction - Diffraction by a single and double Slit, intensity variation in single and double slit interference, Effect of increasing the number of Slits(Grating), Intensity distribution from an Ideal grating. Resolving power of grating and grating spectra. Principles of interferometry- Theory of Michelson's Interferometer and its applications. (12 hours)

Unit 3

Electromagnetism: Magnetostatics: Lorenz Force, Biot-Savart and Ampere's Laws and their applications, Magnetic vector potential, force and torque on a magnetic dipole. **Electrodynamics:** Ohms law, motional emf, Faraday's law, Lenz's law, Mutual induction, energy storage in magnetic fields, Maxwell's equations. Applications in robotic domain (15 hours)

Textbooks

Richard Wolfson, "Essential University Physics", Vols. 1 and 2. Pearson Education, Singapore, 2011

References

Halliday D., Resnick R. and Walker J., "Fundamentals of Physics", Wiley Publications, 2008.
Francis A. Jenkins, Harvey E.White, "FUNDAMENTALS OF OPTICS" Forth edition- McGraw-Hill Publications.
D.J. Griffiths, Introduction to Electrodynamics, 3rd edition, Prentice-Hall of India 2005
Beiser A., "Concepts of modern physics", McGraw-Hill India, 2006.

23CSE116	C PROGRAMMING	L-T-P-C: 2-0-3-3

Course Objectives

- To provide the foundations of computational problem solving and the foundations of programming.
- To familiarize the programming languages using C as a tool for implementation.
- To write programs that provide solutions to practical engineering problems.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Apply algorithmic thinking to understand, define and solve problems.

CO2: Interpret the typical programming constructs such as data (primitive and compound), control, modularity, and recursion in a program.

CO3: Analyze a given program by tracing, identifying coding errors, and debugging them.

CO4: Develop computer programs that implement suitable algorithms for problem scenarios and applications.

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

Syllabus

Unit 1

Problem Solving and Algorithmic Thinking: Overview – problem definition, logical reasoning; Algorithmic thinking – Sequence, Selection and Repetition, Problem solving with algorithms – Searching and Sorting, modularization.

Lab Practice: Exercise on Algorithmic thinking and algorithms.

Unit 2

C for problem solving: Structure of C programs, data types, data input, output statements, control structures. Functions – inter function communication, standard functions, scope. Recursion – recursive definition, recursive solution, designing recursive functions, limitations of recursion. Arrays – 1D numeric, searching and sorting, 2D numeric arrays.

Lab Practice: Exercise on data types, control structures, functions and arrays.

Unit 3

Pointers: Introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic. **Structures:** Structure vs array comparison, complex structures, structures and functions, Union.

Lab Practice: Problem solving using C with Arrays, pointers, structures, and Union

Text Books

Riley DD, Hunt KA. Computational Thinking for the Modern Problem Solver. CRC Press; 2014.

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

Reference Books

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

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

Byron Gottfried. Programming With C. Fourth Edition, McGraw-Hill; 2018.

Brian W. Kernighan and Dennis M. Ritchie. The C Programming Language. Second Edition, Prentice-Hall, 1988.

Eric S. Roberts. Art and Science of C. Addison Wesley; 1995.

Jeri Hanly and Elliot Koffman. Problem Solving and Program Design in C. Fifth Edition, Addison Wesley (Pearson); 2007.

23EEE105 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L-T-P-C: 3-0-3-4

Course Objectives:

- To impart basic knowledge of electric circuits
- To understand the construction and working principle of DC and AC machines.
- To facilitate understanding of basic electronics and operational amplifier circuits.
- To understand the basic gates and their applications
- To impart basics on microprocessor/microcontroller with basics programming skills.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Familiarize the basic concepts in electrical circuits
CO2: Comprehend the study on construction and working of various electrical machines
CO3: Illustrate the working of basic electronic circuits.
CO4: Design, connect and test electrical 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	1					
CO2	3	2							1	1					
CO3	3	2	1		1				1	1					
CO4	3	2	2	1	2				1	1					

Syllabus

Unit 1

Review of Electrical Engineering: Current and Voltage sources, Resistance, Inductance and Capacitance; Ohm's law, Kirchhoff's law, Series parallel combination of R, L and C components, Voltage Divider and Current Divider Rules. Faraday's Laws of Electro-magnetic Induction, Definition of Self and Mutual Inductances, Generation of sinusoidal voltage, Instantaneous & RMS values of sinusoidal signals, Introduction to 3-phase systems- Quantitative Treatment Only.

Unit 2

Electrical Machines: DC Motor: Construction, principle of operation, Different types of DC motors, significance of back EMF, Torque-Speed characteristics, Output Power, Efficiency and applications. Single Phase Transformer: Construction, principle of operation, EMF Equation. Regulation and Efficiency of a Transformer. Induction Machine: Three Phase Induction Motor: Construction and Principle of Operation, Slip and Torque, Speed Characteristics. Stepper motor: Construction, working principle and modes of operation.

Unit 3

Basic Electronic Circuits: Review of PN junction diodes, Voltage regulator, BJT- Transistor as a switch, 555 Timers, Operational Amplifiers – Inverting and Non-inverting amplifier – Instrumentation amplifiers

Unit 4

Introduction to microprocessor and microcontrollers. Case study on applications of microprocessors and microcontrollers.

Lab Practice

1. a) Wiring practices b) Study of Electrical protection systems.
2. Speed control of DC shunt motor
3. Load test on single phase transformer
4. Load test on three phase induction motor
5. Transistor as a switch
6. Implementation of inverting and non-inverting amplifier using Op-amp
7. Full adder and subtractor
8. Program on addition and subtraction
9. Program to storing and retrieving a data

Text Books

Alexander C K and Sadiku M N O, "Fundamentals of electric circuits", 5th edition, New York, McGraw-Hill, 2013.
Adel S. Sedra, ,Kenneth Carless SmithTony Chan Carusone, "Microelectronic Circuits" 7th Edition, Oxford University Press, 2020
Edward Hughes. "Electrical Technology".7th Edition, Pearson Education Asia, 2011

Reference Books

Vincent Del Toro, 'Electrical Engineering Fundamentals', Prentice Hall of India Private Limited, 2003, 2nd Edition.
David A Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2008.
D. P. Kothari, I J Nagrath, "Electric Machines", 5th Edition, Tata McGraw Hill, 2017.
A. P. Malvino, "Electronic Principles", 7th Edition, Tata McGraw Hill, 2007. References S. K.
Bhattcharya, "Basic Electrical and Electronics Engineering", Pearson, 2012.
Michael Tooley B. A., "Electronic circuits: Fundamentals and Applications", 3rd Edition, Elsevier Limited, 2006.

23MEE106 ENGINEERING GRAPHICS AND 3D MODELLING L-T-P-C: 1-0-3-2

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

At the end of the course, the student will be able to:

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: Develop 3D solid models using the software.

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

Syllabus

Unit 1

Introduction to Engineering Graphics and 3D Modeling. Introduction to BIS of Engineering Drawing – Line type, dimensioning, Significance of 3D modeling, Introduction to 3D Modeling Software.

Unit 2

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.

Unit 3

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.

Unit 4

Module 4: 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.

Text Books

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

Work Book

Engineering Graphics Workbook - Created by Department of Mechanical Engineering Faculty Members at Amrita School of Engineering, Coimbatore Campus.

Reference Books

Jain, Maheshwari, Gautam (2021), Engineering Graphics & Design, Khanna Book Publishing.
Autodesk Fusion 360 For Beginners: Part Modeling, Assemblies, and Drawings – Tutorial Book
Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing.
John K.C., "Engineering Graphics for Degree", 1e, Prentice Hall India, 2009
Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson.

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

Course Objectives

- To 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 introduces immediate and long-term benefits of MAOM 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

At the end of the course, the student will be able to:
CO1: To be able to describe what meditation is and to understand its health benefits
CO2: To understand the causes of stress and how meditation improves well-being
CO3: To understand the science of meditation.
CO4: To learn and practice MAOM meditation in daily life.
CO5: To understand the application of meditation to improve communication and relationships.
CO6: To be able to understand the power of meditation in compassion-driven action.

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		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	3		3			

Syllabus:

Unit 1

Describe Meditation and Understand its Benefits (CO1)
A: Importance of meditation. How does meditation help to overcome obstacles in life (Pre-recorded video with Swami Shubhamritananda Puri)
Reading 1: Why Meditate? (Swami Shubamritananda ji)

Unit 2

Causes of Stress and How Meditation Improves Well-being (CO2)
A: Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced diet in 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 (CO3)
A: A preliminary understanding of the Science of meditation. What can modern science tell us about this tradition-based method? (Pre-recorded video with Dr. Shyam Diwakar)
B: How meditation helps humanity according to what we know from scientific research (Pre-recorded video with Dr. Shyam Diwakar)
Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)
Reading 2: 'Science and Spirituality.' Chapter 85 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit 4
Practicing MA OM Meditation in Daily Life (CO4)
Guided Meditation Sessions following scripts provided (Level One to Level Five)
Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami Atmananda Puri)
Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Unit 5
Improving Communication and Relationships (CO5)
How meditation and mindfulness influence interpersonal communication. The role of meditation in improving relationship quality in the family, at the university and in the workplace. (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 Amritanandamayi Mission Trust.

Unit 6
Meditation and Compassion-driven Action (CO6)
Understand how meditation can help to motivate compassion-driven action. (Pre- recorded video with Dr. Shobhana Madhavan)
Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: What do we (not) know?. Current Opinion in Psychology, 44, 151-156.
Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). Mata Amritanandamyi Mission Trust

Text Books/Reference Books:
Meditation and Spiritual Life-Swami Yatiswarananda, Ramakrishna Math
The Complete Works of Swami Vivekananda Vol Vii by Advaita Ashram Mayavati Almora Himalayas
Dhyana Yoga-Holy Gita Swami Chinmayanda
Voice of God, Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
Hindu Dharma-Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
Mind: It's Mysteries and control-Swami Sivananda Saraswati
Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.
Books on Amma's teachings like Awaken children, From Amma's Heart etc.
The Science of Meditation: How to Change Your Brain, Mind and Body by Daniel Goleman and Richard. J. Davidson.
Allen, Cynthia (2020) The Potential Health Benefits of Meditation
Seppala E (2022, June 30th Unexpected Ways Meditation Improves Relationships a Lot.Psychology Today
Sharma, Hari (2022) Meditation: Process and Effects
Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress.
Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: Current Opinion in Psychology

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 culture and knowledge traditions.
- 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

At the end of the course the student will be able to

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 multi-dimension 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	PSO1	PSO2	PSO3
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)
India: In the Views of Other Scholars and Travellers

Unit 4
Persona2lity Development Through Yoga.
Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness
Conversations on Compassion with Amma

Text Book
Foundations of Indian Heritage- In house publication

Reference Book(s)
The beautiful tree by Dharampal
Peasants and Monks in British India by William Pinch
India, that is Bharat: Coloniality, Civilisation, Constitution by J Sai Deepak
Awaken Children Dialogues with Mata Amritanandamayi
Man, and Nature by Mata Amritanandamayi Devi
What Becomes of the Soul After Death, Divine Life Society

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

Course Objectives

- To introduce the students to the fundamentals of mechanics of writing.
- To facilitate them with the style of documentation and specific formal written communication.
- To initiate in them the art of critical thinking and analysis.
- To help them develop scanning techniques for specific information, comprehension and organization of ideas.
- To enhance their technical presentation skills.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Gain knowledge about the mechanics of writing and the elements of formal correspondence.
CO2: Understand and summarize technical documents.
CO3: Apply the essential elements of language in formal correspondence.
CO4: Interpret and analyze information and organize ideas logically and coherently.
CO5: Compose project reports/documents, revise them for language accuracy and make technical presentations.

CO/PO Mapping

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

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 & punctuationScientific Reading & Listening Comprehension

Unit 3

Technical paper writing: documentation style - document editing – proof reading - Organizing and formattingMechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation
Language Lab : Reading and listening comprehension of technical documentsMini Technical project (10 -12 pages)
Technical presentations

Text Books / Reference Books

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

23ENV300	ENVIRONMENTAL SCIENCE	L-T-P-C: P/F

Course Objectives

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

Course Outcomes

At the end of the course, the student will be able to:
CO1: Describe the various aspects of nature and environment.
CO2: Analyse impact of environment on human world.
CO3: Comprehend pollution control and waste management.

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				1			
CO2						3	2	3				1			
CO3						3	2	3				1			

Syllabus

Unit 1

Over view 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 -Overpopulation – 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.

Text / Reference Books

R. Rajagopalan, "Environmental Studies – From Crisis to Cure", Oxford University Press, 2005.
G.T.Miller Jr., "Environmental Science", 11th Edition, Cenage Learning Pvt. Ltd., 2008.
Benny Joseph, "Environmental Studies", Tata McGraw-Hill Publishing company Limited, 2008.

SEMESTER 2

23MAT131	MATHEMATICS FOR INTELLIGENT SYSTEMS - 2	L-T-P-C: 2-0-3-3

Pre-requisite: Mathematics for Intelligent Systems 1 (Knowledge level)

Course Objective

- To lay down the basic concepts and techniques of linear algebras applied to signal processing.
- To introduce the concepts of computational experiments and understand the theory behind them.
- To provide an appreciation of the wide application of these disciplines within thescientific field.
- To provide a connection between the concepts of linear algebra, differential equation and probability theory.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Develop an understanding of linear algebra's basic concepts and techniques applied to signal processing.

CO2: Identify and describe the connection between the concepts of linear algebra, differential equation and probability theory.

CO3: Develop an insight into the applicability of linear algebra in business and scientific domains.

CO4: Apply the concepts of calculus and linear algebra in modelling electrical and mechanical elements.

CO5: Apply the concepts of probability theory in providing data sets for computationalexperiments in data science.

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

Syllabus

Gaussian elimination, LU decomposition. Vector Spaces, Bases, Orthogonal bases Infinite dimensional vector spaces. Convolution Vector spaces associated with Matrices Projection matrices and its properties Cayley Hamilton theorem Diagonalizability of matrices Eigenvalues and Eigen vectors of Symmetric matrices Eigenvalues and Eigen vectors of A^TA, AA^T Relationship between vector spaces associated with A, A^TA, AA^T.

Fourier Series and Fourier Transform and its properties

Formulation of ordinary differential equation with constant coefficients in various engineering domains, Converting higher order into first order equations Numerical solution with Rungekutta method.

Taylor series expansion of multivariate functions, conditions for maxima, minima and saddle points, Concept of gradient and hessian matrices Multivariate regression and regularized regression, Newton methods for optimization, Signal processing with regularized regression.

Complex Integration: 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.

Random variables and distributions, Expectation, variance, moments cumulants, Sampling from univariate distribution-various methods, Concept of Jacobian and its use in finding pdf of functions of Random variables (RVs), box-muller formula for sampling normal distribution, Concept of correlation and Covariance oftwo linearly related RVs, Multivariate Gaussian distribution, Bayes theorem, Introduction to Bayesian estimation process, Markov chain, Markov decision process.
Lab Practice: Computational Exercises related to topic discussed in the course

Textbooks / References

Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.
William Flannery, "Mathematical Modeling and Computational Calculus", Vol-1, Berkeley Science Books, 2013.
A. Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.
Ray Wylie and Louis Barrett, Advanced Engineering Mathematics, McGraw Hill, Sixth Edition, 2016.

23CSE117	OBJECT ORIENTED PROGRAMMING	L-T-P-C: 2-0-3-3

Course Objectives

- To enrich the concept of object-oriented software using C++.
- To train the students to create objects and interact among objects using C++.
- To enable the student to use ADT and STL for implementing data structures.
- To inculcate the problems in an object-oriented way using appropriate tools

Course Outcomes

At the end of the course, the student will be able to:

CO1: Summarize the object-oriented concepts.
CO2: Design object-oriented systems using UML.
CO3: Apply the concepts of class and objects in a program.
CO4: Apply the usage of early and late binding, exception handling, and generic programming.
CO5: Develop computer programs that implement suitable algorithms for problem scenarios and applications performance.

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

Syllabus

Unit 1

Objects, classes, Abstraction, Encapsulation, Inheritance and Polymorphism. Dynamic Binding, Message Passing. Attributes, methods, C++ class declaration, Local Class and Global Class, Scope resolution operator, Friend Functions, Inline functions.

Unit 2

Constructors and destructors, instantiation of objects, Types of Constructors, Static Class Data, Array of Objects, Constant member functions and Objects, Memory management Operators. Inheritance, Types of Inheritance, access modes – public, private & protected. Abstract Classes, Ambiguity resolution using scope resolution operator and Virtual base class, Overriding inheritance methods.

Unit 3

Constructors in derived classes, Nesting of Classes. Polymorphism Polymorphism, Type of Polymorphism – Compile time and runtime, Function Overloading, Operator Overloading (Unary and Binary) Polymorphism by parameter, Pointer to objects, this pointer, Virtual Functions, pure virtual functions. Strings, Files and Exception Handling Manipulating strings. Overview of Standard Template Library, Containers, Algorithms, Iterators, Vectors.

Lab Prectice: Problem solving using C++.

Text Books / Reference Books

Walter Savitch, "Problem Solving with C++: Global Edition", 10th edition, Pearson Education, January 2018.
Bjarne Stroustrup, "Programming: Principles and Practice Using C++", Second edition, Addison Wesley, 2014.
Stanley B Lippman, Josee Lajoie, Barbara E. Moo, C++ Primer, Sixth edition, Addison Wesley, 2015.

23MEE112	ELEMENTS OF MECHANICAL ENGINEERING	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize certain fundamental topics related to mechanical engineering systems viz. thermal systems, power transmission systems, and mechanics of materials.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Apply the laws of thermodynamics in applications of thermal systems.
CO2: Understand working principles of internal combustion engines.
CO3: Describe and comprehend the various elements of power transmission systems.
CO4: Compute stresses, strains, and deformation of various mechanical components.
CO5: Compute bending stress, shear stress in beams and analyze stresses and deformation in circular shafts due to torsion.

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

Syllabus

Unit 1

Basic Concepts of Thermodynamics: Introduction, states, concept of work, heat, temperature; Zeroth, 1st, 2nd and 3rd laws of thermodynamics; concept of internal energy, enthalpy and entropy – Simple Numerical problems.
Energy Sources and Power Plants: Review of energy sources; Working of hydel power plant, thermal power plant, nuclear power plant, solar power plant, tidal power plant, wind power plant.
Internal Combustion Engines: Classification, IC engine parts, working of two-stroke & four-stroke petrol engines and four-stroke diesel engines. Application of IC engines.

Unit 2

Simple Machines: Definition of a machine, velocity ratio, mechanical advantage, efficiency, laws of machines, reversibility of machine, simple & differential wheel and axle, pulleys, screw jacks, numerical problems.
Power Transmission Systems: Introduction to power transmission systems. Flat belt, V-belt, chain & rope drives and their applications, gears and gear trains and their application, simple numerical problems.

Unit 3

Simple Stress and Strain: Introduction, properties of materials, Stress, Strain, Hook's law, Poisson's Ratio, Stress-Strain Diagram for structural steel and nonferrous materials, Principles of superposition, Thermal stresses. Volumetric strain, expression for volumetric strain, Elastic constants, relationship among elastic constants.
Bending of Beams: Bending equation, calculation of stresses in a beam due to bending.
Torsion of Shafts: Pure torsion - torsion equation of circular shafts, strength and stiffness, power transmitted by shaft of solid and hollow circular sections.

Textbooks

John Bird and Carl Ross, "Mechanical Engineering Principles", Newnes, 2002
Jonathan Wickert and Kemper Lewis, "An Introduction to Mechanical Engineering", Third Edition, 2012.

Reference Books

K.P.Roy, S.K.Hajra Choudhury, Nirjhar Roy, "Elements of Mechanical Engineering", Media Promoters & Publishers Pvt Ltd,Mumbai,7th Edition,2012
V.K.Manglik, "Elements of Mechanical Engineering", PHI Publications, 2013.
Cengel Y. A. & Boles M. A. "Thermodynamics - an Engineering Approach," 8/e, Tata McGraw Hill, 2016
Ganesan. "Internal Combustion Engines," 4/e, Tata McGraw Hill, 2012.
V.B. Bhandari, "Design of Machine Elements", 4e, TMH, 2016.
R. C. Hibbeler, - 'Mechanics of Materials' - Prentice Hall - 2017 - 10th Edition.
Rajput R. K., "Thermal Engineering,"9/e, Laxmi Publications (P) Ltd., New Delhi, 2013.

24MEE113 COMPUTATIONAL ENGINEERING MECHANICS L-T-P-C: 2-0-3-3

Course Objectives

- To inculcate the concepts of basic mechanics and problem-solving capabilities using vector approach.
- To explore the concepts through computational experiments and then try to understand the concepts/theory behind them.
- To help the students to perceive engineering problems using the fundamental concepts in physics.
- To provide the connection between the concepts of physics, mathematics, and computational thinking.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Apply the principles of statics to solve elementary problems in engineering mechanics.
CO2: Evaluate the support-reactions and the internal forces in rigid body systems such as beams, frames, trusses, etc.
CO3: Compute the properties of areas and bodies of composite sections.
CO4: Compute the kinematic variables of particles and rigid bodies.
CO5: Analyze the motion of particles and rigid bodies by applying fundamental principles.

CO-PO Mapping

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

Syllabus

Unit 1

Statics of particles in two and three dimensions: Newton's Laws of Motion, force as a vector (Cartesian and Polar coordinates form), resolution and resultant of forces, free body diagrams, equilibrium of a particle in two and three dimensions, moment of force about a point, force-couple systems.

Unit 2

Rigid body equilibrium, Degree-of-freedom (DOF) and Constraints at Supports (pin, roller, fixed), Beams and Frames, Application of trusses, Analysis of trusses using method of joints, application of friction in mechanisms and robotics.

Unit 3

Properties of surfaces & solids: Centroid and center of gravity: centroid of lines, areas and volumes – composite bodies. Second moment of area – polar moment of inertia – mass moment of inertia – radius of gyration.

Unit 4

Kinematics of particles, assumptions, Cartesian, Cylindrical and Spherical frames, and motion of particles in them. Translation and rotation of rigid bodies in 2D – Translation and rotation of rigid bodies in 3D.

Lab Components:

Computational tools such as GeoGebra and/or MATLAB (or equivalent) to be used to conduct lab sessions, not limited to the following topics:

1. Polar form to represent a vector (2D and 3D)
2. Point moving on a circle (2D) at centered at origin and at any other point
3. Animation of a ceiling fan (rigid body shape rotation)
4. Representation of a solar system (Sun, Earth, Moon) and their animation
5. Modelling of a wall clock (hands movement) and its animation
6. Resultant of vectors and validation using graphical method
7. Solving and validating problems on equilibrium in 2D and 3D
8. Solving problems on Truss
9. Solving problems on Friction
10. Solving problems on mass and inertia properties. Rotation about mass center to understand radius of gyration
11. Projectile motion and other examples of kinematics of particles
12. Motion of a particle in a helical trajectory
13. Representation of homogenous transformation to translate, rotate a coordinate frame and combined motion

14. A game developed by the student(s) that uses kinematics of particles

Text books

Hibbeler, R.C., "Engineering Mechanics- Statics and Dynamics", 14/e, Pearson Education Pvt. Ltd., 2017.
Beer,F.P. &Johnston,E.R., "Vector Mechanics for Engineers-Statics and Dynamics", 11/e, McGraw Hill International Book Co., 2017.

Reference Books

Meriam, J.L and Kraige, L.G, "Engineering Mechanics - Statics", 7/e, John Wiley & sons, 2013.
Meriam, J.L and Kraige, L.G, "Engineering Mechanics - Dynamics", 7/e, John Wiley & sons, 2013.
Shames,I.H, "Engineering Mechanics-Statics and Dynamics", 4/e, Prentice-Hall of India Pvt. Ltd., 2005.
Jayakumar, V and Kumar, M, "Engineering Mechanics", Prentice-Hall of India Pvt. Ltd., 2014.

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

Course Objectives:

- Imparting 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 in edge preparation, plate, wire and sheet joining operations.
- Explain the different tools and equipment used for basic manufacturing processes.
- Get familiar with the essential components for automation and pneumatic circuit design.
- Discuss the components and functioning of various sub-systems of automobiles, such as the power train, steering system, suspension system, and braking system.

Course Outcomes

At the end of the course, the student will be able to

CO1: Practice safety procedures in a shop floor environment.
CO2: Select appropriate tools and methods for basic manufacturing processes.
CO3: Realize the functionality of parts in an assembly through dismantling and assembling.
CO4: Perform basic metals joining using welding and soldering.
CO5: Fabricate sheet metal components using lateral surface development principles.
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	PSO1	PSO2	PSO3
CO1	3	1	1			1			2	1		1	1		
CO2	2	3				2			2	2		1	1		
CO3	2	2	1		3	1	1		2	2	1	1	1		
CO4	2	3	2						2	2	1	1	1		
CO5	3	2	2		3				2	2	1	1	1		
CO6	3	2	2		3				2	3	1	1	1		

Syllabus

Workshop Safety Measures and Practices - Proper training and supervision before operating unfamiliar or complex equipment.

Product Workshop –12 hours

Disassemble the product or sub-assembly - Measure various dimensions using measuring instruments- Free hand sketching of the assembly and components - Prepare the bill of materials - Study the functioning of the assembly and parts-Assemble the product or subassembly.

Sheet Metal Fabrication –12 hours

Study of tools and equipment - Sheet Metal cutting and bending techniques – Sheet metal design principles and practices-Joining & finishing of sheet metal parts. Introduction to Mechanical/Hydraulic press.

Metals joining practice –12 hours

Manual arc welding practice for making Butt and Lap joints - Soldering Practice

Automobile Engineering lab –9 hours

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.

Reference Books: Lab Manual

23ECE118	SENSORS AND SIGNAL PROCESSING	L-T-P-C: 3-0-3-4

Pre-requisite: Elements of Electrical and Electronics Engineering (Knowledge Level)

Course Objectives

- To learn about the basics and performance of measurement systems
- To learn in detail about different sensors
- To learn about signal conditioning circuits
- To learn about various digital signal processing techniques

Course Outcomes

At the end of the course, the student will be able to

CO1: Identify the functional elements, concepts and performance of various measurement systems
CO2: Evaluate the performance characteristics of different types of sensors and transducers for robotic applications.
CO3: Perform preprocessing of signals for improving the quality of the sensor signature.
CO4: Analyze the sensor signatures in time domain and extract frequency components.
CO5: Select suitable sensor and associated signal-processing methods for applications in robotics and automation.

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

Syllabus

Unit 1

Measurements and measuring systems: Methods of Measurement-Instruments- Classification of Instruments-Functions of instruments and measurement Systems-Elements of a generalized measurement system. Measurement system performance: Static characteristics- Dynamic characteristics. Errors in measurement and their statistical analysis.

Unit 2

Sensors/Transducers: Definition, Types, Basic principle and applications. Potentiometers - Inductance transducers - Capacitance transducers - Piezoelectric transducers - Hall effect transducers - rotary encoders – Accelerometers – Gyroscope. Photo Diode/ Photo Transistor as sensors, LVDT, Strain Gauge, Tactile, IR and Ultrasonic sensors. Vision and motion Sensors. Digital transducers: Principle and Construction. Temperature, Flow, velocity, pressure, displacement, position, force and torque measurement.

Unit 3

Signal Conditioning: Need for pre-processing, identification of signal conditioning blocks and their characteristics. Analysis of DC and AC bridges. Offset and drift compensation circuits. Introduction to Active filters. First order, Second order and higher order filters. Necessity and applications of isolation amplifiers, Grounding and Shielding. Digital Signal Processing: Discrete Sequences and Systems, Periodic Sampling, Discrete Fourier Transform, Fast Fourier Transform. Analog to digital conversion.

Lab Experiments: Sensor and associated signal conditioning circuits for applications in robotics and automation will be studied through the following experiments on sensors as listed below (reprentative):

1. Calibration curve and time constants (for sensors: mercury in glass thermometer, bimetal dial thermometer, RTD, thermistor and thermocouple)
2. Seebeck effect for thermocouple
3. Temperature transmitter and its calibration
4. Study and calibration of displacement sensors: LVDT and potentiometer
5. Study of Strain Gauge
6. Study of accelerometer and gyroscope
7. Vision based sensing
8. Ultrasonic, IR and Hall effect sensor-based proximity and range sensing

9. Analog to digital and digital to analog conversion.
10. Experimentation with Active Filters
11. Experimentation with DC bridge
12. Experimentation with AC bridge
13. Implementation of convolution and digital filters (Can be done with Raspberry Pi on any analog signal acquired using ADC)
14. Fourier Transforms (Can be done with Raspberry Pi on any analog signal acquired using ADC)

Text / Reference Books

Doebelin, E.O. and Manic, D.N., "Measurement Systems: Applications and Design", 7th Edition, McGraw Hill, 2019.
Richard G. Lyons, "Understanding Digital Signal Processing", 3rd Edition, Pearson, 2011.
A.K. Sawhney, "A Course in Electronic Measurements and Instrumentation", Dhanpat Rai & Co. (P) Limited, 2015.
Murthy, D.V.S., "Transducers and Instrumentation", 2nd Edition, Prentice Hall of India, 2011.
Nakra, B.C. and Chaudhry, K.K., "Instrumentation, Measurement and Analysis", 4th Edition, Tata McGraw Hill, 2016.
Curtis D Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson Education India, 2015.

23RAI111 FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE L-T-P-C: 3-0-0-3

Course Objectives:

- To introduce classical AI and rational intelligent agents.
- To introduce techniques for problem solving by search and adversarial games.
- To introduce constraints, logic, and inference techniques
- To introduce planning, acting, and multi-agent systems.
- To introduce knowledge-representation and reasoning.

Course Outcomes

After completing this course, students will be able to

CO1: Understand different elements of an AI system.
CO2: Interpret elementary principles of AI for problem solving and search.
CO3: Formulate constraints and logic for intelligent systems.
CO4: Apply knowledge representation and reasoning for defining intelligent systems using computational tools.

CO/PO Mapping

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

Syllabus

Unit 1

History and Foundations of AI, Rational Intelligent Agents, Agents and Environments, Nature of Environments, Structure of Agents.

Unit 2

Problem Solving by Search: Uninformed and Informed Search Strategies, Heuristic Functions; Adversarial Search: Games, Optimal Decisions in Games, Alpha-Beta Pruning.

Unit 3

Constraint Satisfaction Problems, Inference in CSPs, Backtracking Search; Knowledge-Based Agents, Propositional and First-Order Logic, Resolution Theorem Proving, Unification Forward and Backward Chaining.

Unit 4

Classical Planning: Algorithms for Planning, Planning Graphs, Hierarchical Planning, Planning and Acting in Nondeterministic Domain, Multi-Agent Planning; Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Reasoning with Default Information.

Use of computational tools for solving problems related to the course (one of the internal evaluation component).

Textbooks/ References:

Russell, Stuart Jonathan, Norvig, Peter, Davis, Ernest. Artificial Intelligence: A Modern Approach. United Kingdom: Pearson, 2010.
Deepak Khemani. A First Course in Artificial Intelligence. McGraw Hill Education (India), 2013.
Denis Rothman. Artificial Intelligence by Example, Packt, 2018.

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 the mankind, the current stature of Indian in the geopolitics and Indian approach to science and ecology.

Course Outcomes

At the end of the course the student will be able to

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	PSO1	PSO2	PSO3
CO1			1	2				2							
CO2	2	1				1		3	1						
CO3	2		1	2	1	1		3							
CO4	2			3				3	2						

Syllabus

Unit 1

Face the Brutes
Role of Women in India
Acharya Chanakya
God and Iswara

Unit 2

Bhagavad Gita: From Soldier to Samsarin to Sadhaka
Lessons of Yoga from Bhagavad Gita
Indian Soft powers
Preserving Nature through Faith

Unit 3

Ancient Indian Cultures (Class Activity)
Practical Vedanta
To the World from India (For Continuous Assessment)
Indian Approach to Science

Text Book / Reference Book(s)

Textbook Name: Glimpses of Glorious India- In-house publication
Reference Course material

SEMESTER 3

23MAT221	MATHEMATICS FOR INTELLIGENT SYSTEMS - 3	L-T-P-C: 2-0-3-3

Pre-requisite: Mathematics for Intelligent Systems 2 (Knowledge level)

Course Objectives

- To lay down the basic concepts and techniques of linear algebra, calculus and basicprobability theory needed for subsequent study.
- To introduce the concepts of computational experiments and understand the theory behind them.
- To provide an appreciation of the wide application of these disciplines within the scientific field.
- To provide the connection between the concepts of linear algebra, differential equation and probability theory.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Illustrate the basic concepts and techniques of linear algebra, calculus and basicprobability theory needed for AI & AI-enabled robots.

CO2: Integrate the application of these disciplines within the scientific field.

CO3: Develop an insight into the applicability of linear algebra in business and scientific domains.

CO4: Apply the concepts of calculus and linear algebra in modelling electrical and mechanical elements.

CO5: Apply the concepts of probability theory for building datasets for computational experiments in data science

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

Syllabus

Linear Algebra -3 - Highlights of Linear Algebra: Four Fundamental Spaces, Eigenvalues and Eigenvectors,SVD, PCA and best low-rank matrix. Raleigh Quotients and Generalized Eigenvalues, Norms of vectors and matrices, Factoring matrices and tensors. Computation with Large matrices: Krylov subspaces and Arnoldi iteration, Linear System solution by Arnoldi and GMRES, Conjugate gradient method.

Calculus -3 - Theory of Optimization: (Convex and Non-convex basics) - Unconstrained optimization methods, Direct methods for convex functions, sparsity inducing penalty functions, Newton methods for non-convex functions. Constrained Convex Optimization problems, Formulating problems as LP and QP, support vector machines, solving by packages (CVXOPT), Lagrangian multiplier method, KKT conditions, Introduction to Alternating direction method of multipliers-the algorithm. Applications in signal processing and pattern classification.

Introduction to PDEs arising in Physics and Engineering (problem formulations and simple numerical methods for solutions).

Probability and Statistics-3 - Moments, cumulants, and inequalities of statistics, Covariance matrices and joint probabilities, Multivariate Gaussian and weighted least squares, Markov chains, Markov decision process - advanced aspects.
Lab Practice: Computational Exercises based on the topic discussed in the course

Text Books / Reference Books

'Differential Equations and Linear Algebra', Gilbert Strang, Wellesley, Cambridge press, 2018.
'Linear Algebra and learning from data', Gilbert Strang, Wellesley, Cambridge press, 2019.
'Convex Optimization', Stephen Boyd and Lieven Vandenberghe, Cambridge University Press, 2018.
'Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares', Stephen Boyd andLieven Vandenberghe, Cambridge University Press, 2018.
'Probability, Random Variables and Stochastic Processes', A. Papoulis, and Unnikrishna Pillai, Fourth Edition, McGraw Hill, 2002.

23CSE207	PYTHON PROGRAMMING	L-T-P-C: 1-0-3-2

Course Objectives

- Introduce the python language, its modules system, its recommended programming styles and idioms
- Demonstrate problem solving using Python language
- Demonstrate principles of object oriented programming in a well-written modular code

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the given programming language constructs.
CO2: Develop simple programs with scripts and control statements.
CO3: Analyse the structures of list, tuples and maintaining dictionaries.
CO4: Apply advanced libraries 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	2	2		3				2	2		1	1	2	2
CO2	3	2	2		3				2	2		1	1	2	2
CO3	3	2	2		3				2	2		1	1	2	2
CO4	3	2	2		3				2	2		1	1	2	2

Syllabus

Unit 1

Introduction to Python: motivation for learning Python in scenarios like rapid prototyping. Installing Python: basic syntax, interactive shell, editing, saving, and running a script. The concept of data types: variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages; Conditions, boolean logic, logical operators: ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation.

Unit 2

Working with text files: manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated). Lists, tuples, and dictionaries: basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries.

Unit 3

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Recursive functions.

Use of popular Python packages for scientific computing: Exercises to understand usage of libraries like *Numpy*, *SciPy*, *Pandas*, *Scikit-learn* in interpreted and script modes.

Text Books & References

Guttag, John, Introduction to Computation and Programming Using Python: With Application to Understanding Data, Second Edition. MIT Press, 2016. ISBN: 9780262529624.

William McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython, Second edition, Shroff/O'Reilly, 2017. ISBN-10: 9789352136414.

Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning, First Edition, Cambridge University Press, 2014. ISBN-10: 1107057132.

23MEE207	DESIGN THINKING	L-T-P-C: 1-0-3-2

Course Objectives

- To introduce to the students the concept of design thinking.
- To make the students as sound designers by imparting creativity and problem-solving ability.
- To conceive, conceptualize, design, and demonstrate innovative ideas using prototypes.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Examine critical theories of design, systems thinking, and design methodologies.

CO2: Produce great designs and communicate effectively and intellectually.

CO3: Apply the diverse methods employed in design thinking and establish a workable design thinking framework to use in their practices.

CO4: Conceive, organize, lead and implement projects in the interdisciplinary domain and address social concerns with innovative approaches.

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

Syllabus

Design process: Traditional design, design thinking, existing sample design projects, study on designs around us, compositions/structure of a design.

Innovative design: Breaking of patterns, reframe existing design problems, principles of creativity.

Empathy: Customer needs, insight-leaving from the lives of others/standing on the shoes of others, observation.

Conceptualization: Visual thinking, concept generation methodologies, Concept Selection, Concept Testing, Prototyping. Design projects for teams.

Text Books / References

Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins Publishers Ltd.

Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons Inc

Brenda Laurel Design Research methods and perspectives MIT press 2003

Terwiesch, C. & Ulrich, K.T., 2009. Innovation Tournaments: creating and identifying Exceptional Opportunities, Harvard business press.

Ulrich & Eppinger, Product Design and Development, 3rd Edition, McGraw Hill, 2004.

Stuart Pugh, Total Design: Integrated Methods for Successful Product Engineering,

Bjarki Hallgrimsson, Prototyping and model making for product design, 2012, Laurence King Publishing Ltd

Kevin Henry, Drawing for Product designers, 2012, Laurence King Publishing Ltd.

23MEE208	MATERIALS SCIENCE	L-T-P-C: 2-0-3-3

Course Objectives

- To impart knowledge on fundamental concepts of metallic materials behaviour and crystal structures.
- To inculcate the theory of fracture mechanics, fatigue and creep properties.
- To facilitate an understanding of various strengthening mechanisms, heat treatment, for specific materials and requirements.
- To familiarize with the properties and applications of non-ferrous materials, composite materials, and advanced materials.

Course Outcomes

At the end of the course, the student will be able to:

C**O1**: Analyze the structure and mechanical properties of engineering materials and apply them to engineering problems.

CO2: Assess different types of ferrous and non-ferrous materials and determine the appropriate material for the given application.

CO3: Investigate the effects of heat treatment on microstructures and mechanical properties.

CO4: Understand the characteristics and applications of advanced materials and material selection concepts for Robotics.

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

Syllabus

Unit 1

Classification of Engineering Materials, Structure of Crystalline Solids - Crystal Systems - unit cells - Metallic Crystal Structures - Miller indices - Crystallographic planes and directions - Linear and Planar Atomic Densities.
Imperfections in Solids: Point – Linear - Interfacial defects - Surface and Volumetric defects.
Mechanical properties: Elastic, Anelastic and Plastic behaviour - Stress-strain curves for Ductile and Brittle alloys - Ductility – Resilience – Toughness - Hardness and testing.

Unit 2

Dislocations and Plastic deformation - Slip phenomenon - Slip in single crystals.
Strengthening mechanisms - grain boundary hardening - solid solution hardening - Hume-Rothery rule - work hardening - Precipitation hardening – recovery recrystallization and grain growth.
Failure of Materials: Ductile and Brittle Fracture - fracture mechanics - Impact fracture - Ductile to brittle transition - Fatigue - Creep properties.

Unit 3

Overview of Heat treatment of steels - Classification of cast iron and steels - properties, microstructures, and applications.
Classification of Non-ferrous alloys properties, microstructures, and applications. Introduction to polymers.
Introduction to composite materials – ceramics - electronic materials - smart materials.
Introduction to material selection process – Ashby's chart. Materials for soft robotics.

Lab Components

Mechanical Testing of materials - Stress-strain curves for Ductile and Brittle alloys - Ductility – Resilience – Toughness - Hardness and testing.
Failure of Materials: Ductile and Brittle Fracture - fracture mechanics - Impact fracture - Fatigue - Creep properties.
Heat treatment of steels. Study of microstructure of ferrous and non-ferrous materials.

Text Books

Callister W. D. "Materials Science and Engineering", 10/e, John Wiley & Sons, 2018.
Avner S. H., "Physical Metallurgy", 2/e, McGraw Hill Education, 2017.

References

Shackelford J. F., "Introduction to Materials Science for Engineers", 8/e, Prentice Hall, 2014.
JavedHashemi, Smith F. W., "Foundations of Materials Science and Engineering", 6/e, McGraw Hill Education, 2022.
Dieter G. E., "Mechanical Metallurgy", 3/e, Tata McGraw Hill, 2013.
Michael F. Ashby, "Materials Selection in Mechanical Design", 5/e, Butterworth-Heinemann, 2016.

23MEE209 THEORY OF MECHANISMS AND MACHINES L-T-P-C: 3-0-3-4

Pre-requisite: Knowledge on Engineering Mechanics

Course Objectives

- To familiarize with fundamental definitions and classification of mechanisms.
- To enable the students to perform kinematic synthesis and analysis of planar mechanisms with lower and higher pairs.
- To impart knowledge on dynamic analysis and balancing of masses.
- To familiarize with mathematical modelling and analysis of mechanical vibration systems.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the fundamentals of mechanisms to design mechanisms and machines.
CO2: Perform kinematic analysis and synthesis of planar mechanisms.
CO3: Conduct kinematic study of cams, gears and gear trains.
CO4: Perform static force analysis of planar mechanisms and its application in robotics.
CO5: Formulate the dynamic equilibrium equations of free longitudinal, transverse and torsional vibration systems and solve them.

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

Syllabus

Unit 1

Basics of Mechanisms: Definitions - link, kinematic pair, kinematic chain, mechanism and machines. Degrees of freedom - mobility – Kutzbach criterion - Grashoff's law. Kinematic inversions - four-bar chain and slider-crank - mechanical advantage - transmissionangle.
Kinematics Analysis of Mechanisms: Displacement, velocity and acceleration in simple planar mechanisms - Graphical method (Relative velocity method) - Coriolis component of acceleration.
Synthesis of Mechanisms: Types of synthesis - Three-position synthesis of planar mechanisms - Freudenstein equation.

Unit 2

Kinematics of Cams: Classification of cams and followers, nomenclature – Cams with different follower motions.
Kinematics of Gears and Gear Trains: Gears – terminology, fundamental law of gearing. Interference and undercutting. Gear Trains – simple, compound and epicyclic gear trains.

Unit 3

Static force analysis – Analytical / graphical approach: Calculation of stalling and dynamic torque in robot manipulators; selection of Gear boxes / reducers in robot manipulators.
Vibrations: Basic concepts and types of vibration - single degree of freedom system. Free longitudinal vibrations: Equations of motion, undamped and damped free vibration of single degree of freedom system, logarithmic decrement. Natural frequency of free transverse vibrations, critical speed of simple shafts. Natural frequency of free torsional vibrations.

Lab Components

- Identification of kinematics links, pairs, and chains in a mechanism & demonstration of various mechanisms using MAKIT - MASTER Mechanisms Kit and MAKIT - HITECH Controller Kit.
- Using ADAMS software, modelling and analysis of various planar mechanisms viz. slider-crank mechanism and its inversions, four-bar mechanism and its inversions, 6-bar chains, crank and slotted lever and Whitworth quick return mechanisms.
- Analysis of cam profiles
- Free vibration of spring-mass system
- Critical speed of shafts
- Bifilar, trifler and compound pendulums

Text Books

Uicker, John Joseph, Gordon R. Pennock, and Joseph Edward Shigley. Theory of machines and mechanisms. Vol. 1.New York, NY: Oxford University Press, 2011.
Ambekar A.G., Mechanism and Machine Theory, Prentice Hall of India, New Delhi, 2007.

Reference Books

Norton, Robert L. Kinematics and dynamics of machinery. McGraw-Hill Higher Education, 2011.
Rattan, Sarjit S. Theory of machines.Tata McGraw-Hill Education, 2014.
Ghosh, Amitabha, and Asok K. Mallik.Theory of mechanisms and machines. Affiliated East-West Press Private Limited, 2002.
David H. Myszka, Machines and Mechanisms: Applied Kinematic Analysis, 4th Edition, Prentice Hall, 2012.

23EEE206	ACTUATORS AND DRIVES	L-T-P-C: 3-0-0-3

Course Objectives

- Introduction of electrical and non-electrical actuators.
- Sizing of pneumatic and hydraulic actuators.
- The terminology, characteristics and construction of electrical actuators.
- The classification of electric drives and their performance characteristics.
- Selection of actuators and drives for robotics and automation applications.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the concepts of hydraulic, pneumatic and electrical actuators to industrial applications.
CO2: Determine the specifications of hydraulic, pneumatic actuators for a given application.
CO3: Evaluate the performance characteristics of electrical actuators.
CO4: Select suitable actuators and drives for robotics and automation applications.
CO5: Analyze the performance characteristics of drives for different actuators.

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

Syllabus

Unit 1

Pneumatic Actuators and Hydraulic Linear Actuator types - Single acting, Double Acting, Diaphragm, tandem, telescopic cylinder and cylinders with cushions. Rotary Actuator types - gear, vane, screw, piston types. Sizing of Actuators for industrial applications, Valves, Electro-hydraulic and Electro-pneumatic control devices. Symbols and circuits.

Unit 2

Introduction to Electrical actuators, Solenoids, Rotating electrical machines, operating principles, main terminology and industrial standards. DC, Synchronous, Induction, Stepper, BLDC, Servo motor: principle of operation, main characteristics and construction, Types, Starting, Speed Control and braking, Efficiency, Testing, Selection considerations.

Unit 3

Drives: Introduction, classification of electric drives, Dynamics of Electric drives: Types of loads, Multi quadrant operations, motor dynamics, steady state stability and transient stability. Electrical drives with DC, synchronous, induction, stepper, BLDC motors: Basic characteristics, Operating modes, Different control schemes. Gear boxes and harmonic drives.

Case study/projects – automation and robotics applications.

Text / Reference Books

S. R. Deb; Sankha Deb. Robotics Technology and Flexible Automation, Second Edition McGraw-Hill Education: New York, 2010.
Kothari D.P. and Nagrath I.J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2004.
Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2016.
Nathan Ida, Sensors, Actuators, and Their Interfaces- A multidisciplinary introduction, 2nd Edition, IET Digital Library, 2020.
Pillay. S.K, A First Course on Electric Drives, Wilely Eastern Limited, Bombay, 2012
Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.
Jagadeesha T., "Hydraulics and Pneumatics", 1st edition, I K International Publishing House, New Delhi, 2015.

23ECE207 MICROCONTROLLERS AND EMBEDDED SYSTEMS L-T-P-C: 3-0-3-4

Course Objectives

- To enable the students to differentiate between 8 bit, 16 bit and 32 bit microcontrollers.
- To explore embedded C programming for configuring various peripherals of a microcontroller.
- To acquire knowledge to develop microcontroller-based solutions for solving real world problems.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the basics concepts microprocessors and microcontrollers.
CO2: Acquire knowledge on hardware and software architectures of ARM based embedded processors.
CO3: Develop assembly language programs and embedded C programs.
CO4: Illustrate the need for interfaces and configure the various peripherals in a microcontroller.
CO5: Develop microcontroller-based system for robotics 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	3		2				2	2			1		
CO2	3	2							2	2			1		
CO3	3	3	3		2				2	2			1		
CO4	3	3	3	3	2	2	2	2	3	3			1		
CO5	3	3	3		3								3		

Syllabus

Unit 1

Introduction to Embedded Systems; Architecture – Sensors, Processor: Microprocessor & Microcontroller, Actuator; Classifications of embedded systems; Design process; Applications; Processor - evolution and types. CPU Performance, Performance Metrics and Benchmarks.

Unit 2

An introduction to Embedded Processors. ARM Architecture – Programmer's Model, Instruction Set, Addressing modes, Assembly Programs. Pipelined data path design - Pipeline Hazards. Memory system design- Cache Memory, Memory Management unit, Virtual Memory.

Unit 3

Overview of 8-bit and 16-bit microcontrollers. Introduction to ARM based Microcontrollers – Architecture, Peripherals - Input/output ports, Timers, ADC, DAC, PWM, Quadrature Encoder, UART, I2C, SPI, Advanced communication interfaces. Interfacing of sensors and actuators. Application development – Robotics & Automation.

Lab Components

1. Familiarization of IDE, simulator, development boards and kits
2. Assembly Language Programs
3. Embedded C Program to configure and use Input/output ports & Timers
4. Embedded C Program to configure and use ADC and DAC
5. Embedded C Program to configure and use PWM
6. Embedded C Program to configure and use UART
7. Embedded C Program to configure and use SPI
8. Embedded C Program to configure and use I2C
9. Interfacing of sensors and actuators to microcontroller
10. Development of robotic and automation applications

Text Books

I. Scott Mac Kenzie, Raphael C.-W. Phan, "The 8051 Microcontroller" Fourth Edition, Pearson Education, 2007.
Joseph Yiu, "The Definitive Guide to ARM Cortex M3 and Cortex M4 Processors", Third Edition, Elsevier Inc., 2014.

References

Saurabh Chandrakar Nilesh Bhaskarrao Bahadure, "Microcontrollers and Embedded System Design", First Edition, Dreamtech Press, 2019.
Joseph Yu, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", Third Edition, Newness, 2013.
Steve Furber, "ARM System-on-chip Architecture", Second Edition, Addison Wesley, 2000.
Andrew Sloss, Dominic Symes and Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Morgan Kaufumann Publisher, 2011.
William Hohl and Christopher Hinds, "ARM Assembly Language: Fundamentals and Techniques", 2nd Edition, CRC Press, 2016.
ARM Technical Reference Manual, NXP LPC 17xx datasheet.

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

At the end of the course the student will be able to

CO1: Appreciate the significance of *Rāmāyaṇa* as an *itihāsa,* and important aspects of *Bālakāṇḍa*.

CO2: Understand the family values and ideal human relationships portrayed in the *Ayodhyakāṇḍa* and *Aranyakāṇḍa* of *Rāmāyaṇa*.

CO3: Understand *dharma* and its nuances, emphasizing its applicability in an individual's life through *Kishkindhakāṇḍa* and *Sundarakāṇḍa* of Ramayana.

CO4: Appreciate the triumph of *dharma* over *adharma* through *Yuddhakāṇḍa* of *Rāmāyaṇa*

CO5: Appreciate the spiritual values from *Rāmāyaṇa* in resolving personal and social conflicts through varied effective presentations of important episodes of the *Rāmāyaṇa.*

CO-PO Mapping

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

Syllabus

Unit 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.

Text Books / References

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

23LAW300	INDIAN CONSTITUTION	L-T-P-C: 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

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

CO-PO Mapping

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

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

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

Reference Books

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

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/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 4

23MAT226	MATHEMATICS FOR INTELLIGENT SYSTEMS - 4	L-T-P-C: 2-0-3-3

Pre-requisite: Mathematics for Intelligent Systems 3 (knowledge requirement)

Course Objectives

- To lay down the basic concepts and techniques of linear algebra, calculus and basicprobability theory needed for subsequent study.
- To explore the concepts initially through computational experiments and then try to understand theconcepts/theory behind it.
- To provide an appreciation of the wide application of these disciplines within thescientific field.
- To provide connection between the concepts of linear algebra, differentialequation and probability theory.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Illustrate the basic concepts and techniques of linear algebra, calculus and basic probability theory needed for AI.

CO2: Integrate the application of these disciplines within the scientific field.

CO3: Develop an insight into the applicability of linear algebra in business and scientific domains.

CO4: Apply the concepts of calculus and linear algebra in modelling electrical and mechanical elements.

CO5: Apply the concepts of probability theory for building datasets for computational experiments in data science

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

Syllabus

Linear Algebra-4 - Special Matrices: Fourier Transform, discrete and Continuous, Shift matrices and Circulant matrices, The Kronecker product, Toeplitz matrices and shift invariant filters, Graphs and Laplacians and Kirchhoff's laws, Clustering by spectral methods and K-means, Completing rank one matrices, The Orthogonal Procrustes Problem, Distance matrices.

Calculus-4 - Optimization methods for sparsity: Split algorithm for L2+ L1, Split algorithm for L1 optimization, Augmented Lagrangian, ADMM, ADMM for LP and QP, Matrix splitting and Proximal algorithms, Compressed sensing and Matrix Completion. Optimization methods for Neural Networks: Gradient Descent, Stochastic gradient descent and ADAM (adaptive methods), Loss function and learning function.

Probability and statistics – 4 - Basics of statistical estimation theory and testing of hypothesis. Design of Experiments. Lab Practice: Computational Exercises related to topics discussed in the course

Text Books / References

'Differential Equations and Linear Algebra', Gilbert Strang, Wellesley, Cambridge press, 2018.
'Linear Algebra and learning from data', Gilbert Strang, Wellesley, Cambridge press, 2019.
'Convex Optimization', Stephen Boyd and Lieven Vandenberghe, Cambridge University Press, 2018.
'Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares', Stephen Boydand Lieven Vandenberghe, Cambridge University Press, 2018.
'Probability, Random Variables and Stochastic Processes', A. Papoulis, and Unnikrishna Pillai, Fourth Edition, McGraw Hill, 2002.

23CSE215	DATA SCIENCE	L-T-P-C: 2-0-3-3

Course Objectives

- To familiarize the primary tools for exploration, visualizations, and descriptive statistics, for prediction are machine learning and optimization, and for inference are statistical tests and models.
- To train the students to ask appropriate questions about their data and correctly interpret the answers provided by inferential and computational tools through understanding of a particular domain.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Summarize the statistical foundations of data science.
CO2: Apply pre-processing techniques over raw data so as to enable further analysis.
CO3: Perform exploratory data analysis on the given datasets.
CO4: Apply various visualization techniques to identify the patterns.
CO5: Analyze the degree of certainty of predictions using statistical test and models.

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

Syllabus

Unit 1

Introduction, Causality and Experiments, Data Preprocessing: Data cleaning, Data reduction, Data transformation, Data discretization. Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions, Overlaid Graphs, plots, and summary statistics of exploratory data analysis, Randomness, Probability, Introduction to Statistics, Sampling, Sample Means and Sample Sizes.

Unit 2

Descriptive statistics – Central tendency, dispersion, variance, covariance, kurtosis, five point summary, Distributions, Bayes Theorem, Error Probabilities; Permutation Testing, Statistical Inference; Hypothesis Testing, Assessing Models, Decisions and Uncertainty, Comparing Samples, A/B Testing, P-Values, Causality.

Unit 3

Estimation, Prediction, Confidence Intervals, Inference for Regression, Classification, Graphical Models, Updating Predictions.

Lab Practice: Computational Exercises using Programming languages & Application packages

Text Book

Ani Adhikari. John DeNero, Computational and Inferential Thinking: The Foundations of Data Science. GitBook, 2019.

Reference Books

Shmuel G, Bruce PC, Yahav I, Patel NR, Lichtendahl Jr KC. Data mining for business analytics: concepts, techniques, and applications in R. John Wiley & Sons; 2018.
Schutt R, O'Neil C. Doing data science: Straight talk from the frontline. First Edition, O'Reilly Media, Inc.; 2013.

23RAI211	KINEMATICS OF ROBOTIC SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisite: **Theory of Mechanisms & Machines (Knowledge Level)**

Course Objectives

- To impart the basic knowledge of robot manipulators, robot anatomy, laws of robot and applications.
- To impart the concepts of serial and parallel robotic system, its components, forward and inverse kinematics related to robot manipulators.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Describe the fundamentals of robotics, robot anatomy and components of robot.
CO2: Formulate the forward kinematics problems of serial robot manipulators.
CO3: Solve for inverse kinematics of serial manipulators and understand Jacobian matrix used to determine singularity.
CO4: Understand the forward and inverse kinematics problems of parallel robot manipulators.
CO5: Simulate and analyze the forward, inverse kinematics problem of serial and parallel robot manipulator.

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

Syllabus

Unit 1

Introduction to robots, Brief history, laws of robots, Definitions, Robot classifications, Robot anatomy, Components of robots, robot sensing, actuators – Electric motors, servo motors, stepper motors, work envelope, End Effectors-Grippers-Types: Pneumatic, Hydraulic, Magnetic, Vacuum Grippers; Selection and Design Considerations, resolution, accuracy and repeatability of robot, applications, robot teaching, specification.

Unit 2

Robot manipulator kinematics, Degrees of freedom, links, joints, Rotation matrix, Euler angles, Homogeneous transformation matrix, D-H parameters, Forward and inverse kinematic problems of 2-link and 3-link robot manipulator, work volume simulation, singularities, analysis of singularities, Robot Exoskeleton, Jacobian, Inverse Jacobian.

Unit 3

Degrees-of-freedom of parallel mechanisms and manipulators, Active and passive joints, Constraint and loop-closure equations, Direct kinematics problem, Inverse kinematics of parallel manipulators and mechanisms, Introduction to direct kinematics of Gough-Stewart platform.

Unit 4

Introduction to Robot Programming Languages, Joint and Cartesian Motion Planning, Offline and Online Simulation of Industrial Robots, Robotic applications such as pick-and-place, assembling, welding, painting, etc.

Text Books

Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009.
Craig J. J., Introduction to Robotics: Mechanics and Control, 3rd Edition, Addison-Wesley, Reading, MA, 2005.
Odrey, Mikell P. Groover& Nicholas G., Mitchel Weiss, Roger N. Nagel, and Ashish Dutta. "Industrial Robotics, Technology programming and Applications.", McGraw Hill Education; 2nd edition (July 2017).

Reference Books

P. A. Janaki Raman, Robotics and Image Processing An Introduction, Tata MCGraw Hill Publishing company Ltd., 1995.
Shames I. H., Engineering Mechanics- Statics and Dynamics" $/e Prentice-Hall of India Pvt. Ltd., 2005.

23EEE216	CONTROL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-requisite: Mathematics for Intelligent Systems 1 (Knowledge level)

Course Objectives

- To impart the knowledge of the mathematical modelling of control systems.
- To familiarize the concept of stability of control systems.
- To familiarize the design control strategies for different applications.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Develop the mathematical model of the physical systems to design the control systems.
CO2: Analyze the response and stability of the closed and open loop systems.
CO3: Design and analyze the different kinds of compensator for desired response.
CO4: Design controllers based on stability and performance requirements.
CO5: Design and develop control algorithms for physical systems.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction: Motivation, examples of control systems, feedback control systems. Mathematical modelling of control systems: Mathematical modelling of electrical systems, mechanical systems, electromechanical systems. Laplace transforms, transfer functions, electrical analogues of other dynamical systems. Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula. Distributed parameter systems. Transient and Steady-State Response Analyses: Obtaining solutions from mathematical models. Poles and zeros and their effects on solutions.

Unit 2

Stability: Definition of stability. Routh-Hurwitz test. Lyapunov theory. Control Systems analysis and Design: Root Locus Method, Bode plot, Nyquist plot, Nyquist stability criterion, Relative Stability – Gain and Phase Margins, Lead,

Unit 3

Lag and Lag-Lead Compensation PID Controllers: Basic idea of PID controllers, Error analysis, Ziegler–Nichols Rules for Tuning PID Controllers, Design of PID Controllers with Frequency-Response Approach, Design of PID Controllers with Computational Optimization Approach, Modifications of PID Control Schemes.

Text Books

Katsuhiko Ogata, "Modern Control Engineering", 5th Edition, Pearson Education, New Delhi, 2010.
Norman S. Nise, "Control Systems Engineering", Wiley India Edition, 2018.

Reference Books

Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", 12th Edition, Pearson Education, New Delhi, 2011.
Norman S. Nise, "Control Systems Engineering", 7th Edition, John Wiley & Sons, New Delhi, 2015.
Pedro Albertos and Sala Antonio, "Multivariable Control Systems: An Engineering Approach", 1st Edition, Springer, 2004.

22MEE216	MANUFACTURING PROCESSES	L-T-P-C: 2-0-3-3

Course Objectives

- To impart the fundamental concepts in casting, forming, and joining process.
- To enable preparation of sand mould with proper gating and riser system.
- To provide basic skills in performing TIG / MIG welding process with the preparation of weld joints.
- To familiarize the forming processes such as deep drawing, blanking, piercing and power calculation.

Course Outcomes

CO1: Design and develop sand moulds with gating and riser systems for components with simple geometries/features.
CO2: Understand the basic principle and operations of different sheet metal forming process and design the sheet metal layout & load calculations for the metal forming process.
CO3: Identify suitable welding process for the given material and geometry and conduct metals joining operations using TIG/MIG process
CO4: Recognise the various casting, welding, and forming defects, along with strategies to prevent such defects.
CO5: Understand and adhere to safety rules and good practices during casting, welding, and metals forming operations.

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

Syllabus

Introduction to manufacturing processes, classifications.

Casting processes: Introduction to sand casting process- principle, process parameters, classifications, casting equipment and tools, moulding, melting, pouring, finishing processes -defects- other casting processes- applications and limitations.

Bulk and sheet metal forming processes: Introduction, types of forming processes, development drawing of simple sheet metal object, sheet forming processes – equipment and tools, process parameters, characteristics, defects, applications and limitations.

Metal joining processes: Gas welding, arc welding, resistance welding, solid state joining, brazing and soldering, processes – Principles, equipment, process parameters, tools and accessories, joint characteristics, defects, applications and limitations.

Lab Practice:

Metal Casting: preparation of mold; melting & casting of non-ferrous materials; Casting defect studies.
Metal Forming: Metal forming operations using hydraulic & mechanical press (demonstration), Sheet metal layout design and Forming load calculations.
Metals Joining process: Hands on practice on TIG and MIG welding processes; Robotic Welding; Welding defect studies.

Text Books

Serope Kalpakjian and Steven R. Schmid – 'Manufacturing Engineering and Technology' - Prentice Hall - 2013 - 7th Edition.
Mikell P. Groover, Fundamentals modern manufacturing: materials, processes, and systems, John Wiley & Sons, 2010, 4th Edition.

Reference Books

Roy A. Lindberg - 'Processes and Materials for Manufacture' - Prentice Hall of India Private limited – 2000.
Amitabh A. Ghosh and Ashok Kumar Mallik - 'Manufacturing Science' - Affiliated East-West, Press Private Limited – 2010.
E.Paul Degarmo, J.T.Black, Ronald A. Kohser, J. Temple Black, Materials and Processes in Manufacturing, Prentice hall Publications, 1997.
P. N. Rao. Manufacturing Technology – Volume I: Foundry, forming and Welding, Tata McGraw-Hill Education 2017 5th Edition.
P C Sharma, Text Book of Production Technology, S. Chand and Company Pvt Ltd. Publications, 2014, 8Th Edition.
Lab Manual (Internal)

23RAI281 ROBOT KINEMATICS AND CONTROL SYSTEMS LAB L-T-P-C: 0-0-3-1

A) ROBOT KINEMATICS LAB

Course Outcomes

At the end of the course, the student will be able to:

CO1: Describe the fundamentals of robotics, robot anatomy and components of robot.
CO2: Formulate the forward kinematics problems of serial robot manipulators.
CO3: Solve for inverse kinematics of serial manipulators and understand Jacobian matrix used to determine singularity.
CO4: Understand the forward and inverse kinematics problems of parallel robot manipulators.
CO5: Simulate and analyze the forward, inverse kinematics problem of serial and parallel robot manipulator.

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

Syllabus (Robot Kinematics Lab)

Students must be trained hands-on in designing and simulating the forward, inverse kinematics based on D-H conventions using MATLAB, ADAMS / RoboAnalyzer, MechAnalyzer, and GIM. The list of experiments to be followed but not limited to.

- Study of different types of robots based on configuration, number of joints and links.
- Study of components of robots with actuators and end effectors
- Visualization of D-H convention and maximum-minimum reach of manipulators
- Singularity analysis using Robot simulator
- Development of a work object for Industrial Robot using Robot simulator
- Verification of transformation (position and orientation) with respect to gripper
- Estimation of accuracy, repeatability, and resolution.
- Study of the various designs of serial manipulator with R and P configurations for 3, 4, 5 and 6 degrees of freedom robot manipulators
- Simulation of robot work volume based on D-H conventions
- Kinematic architecture and modeling of various robot Exo-skeletons
- Design and Motion study of Stewart platform using various configurations (Spherical, Planar, Rotation)
- Draw the work envelope for Five bar closed loop mechanisms (Parallel Manipulator)
- Joint and Cartesian Motion Planning on Industrial Robot

B) CONTROL SYSTEM LAB

Course Outcomes (Control System Lab)
At the end of the course, the student will be able to:
CO1: Develop the mathematical model of the physical systems to design the control systems.
CO2: Analyze the response and stability of the closed and open loop systems.
CO3: Design and analyze the different kinds of compensator for desired response
CO4: Design controllers based on stability and performance requirements.
CO5: Design and develop control algorithms for physical systems.

CO-PO Mapping

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

Syllabus
Lab Components:
The following lab exercises are performed to understand the closed-loop feedback control systems, transient response, steady state response, PID controllers, and stability.
1. QNET Rotary Inverted Pendulum
2. Mechatronic Systems Board for position control
3. QNET DC Motor Control Trainer
4. Coupled Tanks
5. QNET Vertical take-off and landing trainer
6. Flow and Level control
7. MATLAB control system Toolbox
8. Ball and Beam system control for stability analysis
9. 2 DOF Ball Balancer for stability analysis

Reference Books
Lab manuals

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

At the end of the course, the student will be able to

CO1: Understanding 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: Understanding 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	PSO1	PSO2	PSO3
CO1						1		3	1			3			
CO2						2	3	3	3	3		3			
CO3						3	3	3	3	3		3			
CO4						3		3	3	2		3			
CO5						3	1	3	1	1		3			

Syllabus

Unit 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

Text Books / References

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

SEMESTER 5

23MAT307	GRAPH THEORY ALGORITHMS FOR ROBOTICS	L-T-P-C: 2-0-3-3

Course Objectives

- To impart the basic knowledge of graph theory.
- To familiarize the concepts of various types of graphs and simple properties.
- To familiarize with basic results in graph algorithms and apply to networks for robotics.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the concepts of graph theory, shortest path and spanning tree algorithms for real-time problems.
CO2: Develop the graph connectivity algorithms for flow problems in robotic networks.
CO3: Formulate the graph spaces and methods in obstacle avoidance.
CO4: Apply the graph theory algorithms for robot motion and path planning.

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

Syllabus

Graphs and Sub graphs, isomorphism, matrices associated with graphs, degrees, walks,connected graphs, Paths and Circuits, Components and Connectedness algorithms, shortest path algorithm.

Tree: Trees, properties of trees, Pedant vertices in a tree, center of a tree, rooted binary trees, spanning trees and minimal spanning tree algorithms, Tree traversals. Graph connectivity: Graph connectivity, maximal flow algorithm. Euler and Hamiltonian graphs. Travelling salesman algorithm. Network flow problems, Ford-Fulkerson algorithm.

Planar Graph: Planar graph, Euler theorem and applications of planar graphs. Coloring of graphs.

Lab Practice: Graph theory applications in robotics motion and path planning, collision and obstacle avoidance.

Text Books / References

Stanisław Zawiślak, Jacek Rysiński, Graph-Based Modelling in Engineering: 42 (Mechanisms and Machine Science), Springer, 2018.
Narsingh Deo, Graph Theory with Applications, PHI, 2008
L.R.Foulds, "Graph Theory Applications", Springer, 2016
Kevin M. Lynch, Frank C. Park, "Modern Robotics: Mechanics, Planning, and Control", Cambridge University Press, 2017

23RAI301	FLUID POWER SYSTEMS	L-T-P-C: 2-0-0-2

Course Objectives

- To familiarize the student with basic skills useful in identifying the concepts of automation using hydraulics, pneumatics, industrial sensors, PLC and distributed control strategies.
- To inculcate the required skills in designing fluid power system circuits.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Demonstrate the functioning of fluid power components.
CO2: Design and simulate hydraulic system circuits for given applications.
CO3: Design and simulate pneumatic system circuits for given applications.
CO4: Develop PLC programs for given applications.
CO5: Simulate and analyze closed loop systems for automation.

CO/PO Mapping

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

Syllabus

Unit 1

Hydraulic and Pneumatic Systems in Automation:

Hydraulics: Fluid properties, Pascal's Law and applications, Fluid power symbols, Hydraulic pumps, Sizing of Pumps, Pump Performance, Characteristics and Selection, Control valves: Direction control valves, Pressure control valves, Flow control valves, Hydraulic Proportional Valves, Servo valves. Accumulator- types, application circuits. Design and analysis of typical Industrial hydraulic circuits. Accessories used in fluid power system, Filtration systems and maintenance of system.

Unit 2

Pneumatics: Gas laws, Preparation of air, Fluid-conditioning elements, Actuators, Sizing of Actuators, Control valves: Direction control valves, Pressure control valves, Flow control valves. Development of single and multiple actuator circuits. Valves for logic functions; Time delay valve; Exhaust and supply air throttling, Pneumatic circuit design: Cascade method, step – counter method. Fluid logic devices. Circuits using Fluid logic devices and applications

Unit 3

Programmable Logic Controllers: Basic Structure, Input / Output Processing, Programming with Timers, Internal relays and counters, Shift Registers, Master and Jump Controls. Data Handling, Analogs Input / Output. Electrical controls for Fluid power circuits.

Distributed Control System: Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

Text Books

Antony Espossito, "Fluid power with Applications ", Pearson, Sixth Edition., 2003.
W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" – Prentice Hall - 2013 - 5th Edition

Reference Books

Sullivan James A., "Fluid Power - Theory and Applications", Fourth Edition, Prentice Hall Int, New Jersey, 1998.
Petruzella, Frank D. Programmable logic controllers. Tata McGraw-Hill Education, 2005.
Watton, John. Fundamentals of fluid power control. Vol. 10. Cambridge University Press, 2009.
Mikell Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Edition, Pearson, 2019.
Jon Stenerson, Industrial Automation and Process Control, Pearson, 2003.
Frank Lamb, Industrial Automation: Hands On, McGraw-Hill Education, 2013.
Singh, Shio Kumar. Industrial Instrumentation & Control, Tata McGraw-Hill Education, 2010.

23RAI302 DYNAMICS AND CONTROL OF ROBOTIC SYSTEMS L-T-P-C: 3-0-0-3

Pre-requisite: **Kinematics of Robotic Systems**

Course Objectives

- To familiarize with the mathematical modelling of dynamic analysis and forces of robot manipulators.
- To impart the difficulties in planning and controlling the robot manipulators.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the concepts of dynamic analysis of the robot manipulators.
CO2: Apply various methods and algorithms for trajectory planning.
CO3: Analyze control algorithms and systems for robot motion control.
CO4: Design the control schemes for robot manipulators.
CO5: Formulate forward and inverse dynamics models followed by trajectory planning of robot manipulators.

CO-PO Mapping

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

Syllabus

Unit 1

Dynamics: Lagrange's equation kinetic and potential energy, link inertia Tensor, Jacobian inertia tensor, Newton-Euler and Lagrange-Euler Dynamic models, Dynamic model of 2-link and 3-link robot manipulators, Operational space dynamic model. General considerations and trajectory planning, Joint interpolated trajectories, Trajectory Interpolation, Set point tracking, Actuator Dynamics

Unit 2

Control Systems Analysis in State Space: Introduction to state variable and state space, State-Space Representations of Transfer-Function System. Controllability and Observability.

Control Systems Design in State Space: Design of controllers using root-locus, Pole placement with state feedback, Pole placement with output feedback, Robust control systems.

Multivariable Control Systems: Modeling, analysis, and design of linear multi-input, multi-output control systems, are including both state space and transfer matrix approach, stability analysis of MIMO LTI system, controllability, sterilizability, observability, Realization and Model Order Reduction. Multivariable Control System Design.

Unit 3

Motion Control: The manipulator control problem, Joint space control, computed torques techniques, Near Minimum Time control, feed forward control, Existing control algorithms used in controlling robots, PD control with gravity compensation, inverse dynamics control, Non-linear decoupled feedback control, resolved motion control, Adaptive Control, Robot control of trajectory using programming languages.

Text Books

M. W. Spong and M. Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, NY, USA, 2008.
K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision and Intelligence, Tata McGraw-Hill Edition, India, 3rd Re-Print, 2010.

Reference Books

M.D. Zivanovic, M. Vukobratovic, "Multi-Arm Cooperating Robots: Dynamics and Control: 30 (Intelligent Systems, Control and Automation: Science and Engineering), Springer, 2010.
SK Bhattacharya, "Control Systems Engineering", 3e, Pearson Education India, 2013.
Andrew J. Kurdila, Pinhas Ben-Tzvi, "Dynamics and Control of Robotic Systems", 1st Edition, Wiley, 2019.

23RAI303	MACHINE LEARNING	L-T-P-C: 3-0-3-4

Course Objectives

- To introduce students to the basic concepts and techniques of Machine Learning.
- To develop skills of using recent machine learning software for solving practical problems.
- To make students familiar with the application of machine learning in robotics

Course Outcomes

At the end of the course, the student will be able to

CO1: Apply pre-processing techniques to prepare the data for machine learning applications
CO2: Implement supervised machine learning algorithms for different datasets
CO3: Perform clustering tasks using unsupervised algorithms
CO4: Analyze the performance of various machine learning models for the given problem

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

Syllabus

Unit 1

Introduction to Machine Learning – Data and Features – Machine Learning Pipeline: Data Preprocessing: Standardization, Normalization, Missing data problem, Data imbalance problem – Data visualization - Setting up training, development and test sets – Cross validation – Problem of Overfitting, Bias vs Variance - Evaluation measures – Different types of machine learning: Supervised learning, Unsupervised learning, Reinforcement learning, Generative Learning and adversarial learning.

Unit 2

Supervised learning - Regression: Linear regression, logistic regression – Classification: K-Nearest Neighbor, Naïve Bayes, Decision Tree, Random Forest, Support Vector Machine, Perceptron, Error analysis.

Unit 3

Unsupervised learning – Clustering: K-means, Hierarchical, Spectral, subspace clustering, Gaussian Mixture Model, Hidden Markov Model, Parameter Estimation: MLE and Bayesian Estimate, Expectation Maximization, Dimensionality Reduction Techniques, Principal component analysis, Linear Discriminant Analysis.

Unit 4

Introduction to Neural Networks, Reinforcement learning and generative learning.

Lab Practice: Application of machine learning in robotics & AI – using data sets / case studies

Textbooks

Andrew Ng, Machine learning yearning, URL: http://www.mlyearning.org/(96) 139 (2017). Kevin P. Murphey. Machine Learning, a probabilistic perspective. The MIT Press Cambridge, Massachusetts, 2012.
Christopher M Bishop. Pattern Recognition and Machine Learning. Springer 2010

References

Richard O. Duda, Peter E. Hart, David G. Stork. Pattern Classification. Wiley, Second Edition; 2007 Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.

23RAI304	ROBOT OPERATING SYSTEM	L-T-P-C: 1-0-3-2

Course Objectives

- To familiarize the students with the basic understanding of robot operating system and their architecture.
- To visualize and simulate the robot environment with simulators.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Compare and examine the architectures of ROS.
CO2: Implement the ROS commands for interfacing, and establishing communication with the robot.
CO3: Simulate and analyze the robot in robot simulation software.
CO4: Implement hardware-software interfacing kernel to modify ROS.

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

Syllabus

Unit 1

Introduction –The ROS Equation - History - distributions -difference from other meta-operating systems– services - ROS framework – operating system – releases. UNIX commands - file system – redirection of input and output - File system security - Changing access rights– process commands – compiling, building and running commands – handling variables

Unit 2

File system - packages – stacks – messages – services – catkin workspace – working with catkin workspace – working with ROS navigation and listing commands. Navigation through file system -Understanding of Nodes – topics – services – messages – bags – master – parameter server.

Unit 3

Debugging of Nodes – topics – services – messages – bags – master – parameter – visualization using Gazebo– Rviz – URDF modeling – Xacro – launch files. Hardware Interface: Sensor Interfacing – Sensor Drivers for ROS – Actuator Interfacing – Motor Drivers for ROS.

Lab Components

- Experiment on Creating, building, modifying packages and Writing, building source code and nodes
- Creating and Running Publisher and Subscriber Nodes
- Creating and Running Service Servers and Client Nodes
- Writing and Running the Action Server and Client Node
- Programming experiment on nodes with setting, reading, building, running, displaying parameters list
- Experiment of ROS launch
- Experiment on 3D visualization tool (RViz)
- Design and development of graphical user interface in ROS environment
- Establish communication between robot client and server, and analysis of data packet loss
- Visualization of robot and their movements in Rviz ROS

Textbooks

Lentin Joseph, "Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018.
Aaron Martinez, Enrique Fernández, "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013.

Reference Books

Jason M O'Kane, "A Gentle Introduction to ROS", CreateSpace, 2013.
Anis Koubaa, "Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.
Kumar Bipin, "Robot Operating System Cookbook", Packt Publishing, 2018.
Wyatt Newman, "A Systematic Approach to learning Robot Programming with ROS", CRC Press, 2017.
Patrick Gabriel, "ROS by Example: A do it yourself guide to Robot Operating System", Lulu, 2012.

23RAI381	FLUID POWER SYSTEMS AND ROBOT DYNAMICS & CONTROL LAB	L-T-P-C: 0-0-3-1

A) FLUID POWER LAB

Course Outcomes

At the end of the course, the student will be able to:

CO1: Demonstrate the functioning of fluid power components.
CO2: Design and simulate the fluid power circuits for the given application.
CO3: Design and simulate the PLC program for the given application.
CO4: Design, develop and simulate closed loop systems for automation.

CO/PO Mapping

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

List of experiments

Students must be trained hands-on in designing, developing, simulating the industrial automation for various manufacturing processes (Eg. sequencing hydraulic press etc.,) using Automation Studio / Fluidsim software, Pneumatic and Electro-Pneumatic kits. The list of experiments to be followed but not limited to.

- Design and demonstrate the pneumatic circuits for a given application
- Design the industrial fluid power circuit
- Design of multiple cylinder sequence (cascade method) with timer
- Design of multiple cylinder sequence (cascade method) without timer
- Design of multiple cylinder sequence (cascade method) with pneumatic counter
- Design of electro pneumatic circuit
- Design of electro pneumatic circuit for multiple cylinders sequence
- Design of electro pneumatic circuit with various sensors
- Design of electro pneumatic circuit for multiple cylinders sequence using PLC
- Design the fluid power circuit for Industrial application
- Maintenance and troubleshooting of pneumatic components

B) ROBOT DYNAMICS & CONTROL LAB

Course Outcomes

At the end of the course the student will be able to:

CO1: Solve the dynamic problems of the robot manipulators
CO2: Implement various methods and algorithms for trajectory planning
CO3: Apply control algorithms and systems for robot motion control
CO4: Design the control schemes for robot manipulators
CO5: Design, develop, and simulate the forward and inverse dynamics followed by trajectory planning of robot manipulators

CO-PO Mapping

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

Lab Components

Students must be trained hands-on in designing, developing, simulating the forward and inverse dynamics problems, control algorithms and systems using MATLAB Simulink, and RoboAnalyzer / Gazebo. The list of experiments to be followed but not limited to:

- Dynamic modelling of an industrial robot manipulator
- Inverse and forward dynamics of robot manipulator
- Creating robot joint trajectories
- Trajectory Planning of 3R robot based on 3rd order polynomial trajectory
- Computation of geometric Jacobian for robot manipulator
- Trajectory tracking control of industrial robotic arm using robot manipulator blocks
- Rotational and transform Trajectory analysis of robot manipulator
- Trapezoidal velocity profile Trajectory analysis of robot manipulator
- Simulation of joint space Trajectory tracking of robotic arm
- Visualization of manipulator Trajectory tracking in 3D

Reference Books: *Lab manuals*

23RAI305	INTRODUCTION TO DRONES	L-T-P-C: 1-0-3-2

Course Objectives

- To familiarize the basics of Unmanned Arial Vehicles (Drones) and its broad applications in the age of artificial intelligence.
- To familiarize the basic dynamics of drone based flying system.
- To inculcate provide the knowledge of basic electronic components and their working principles in a drone/ Unmanned Aerial vehicle system.
- To impart the knowledge of how to fly a drone by considering the rules and regulations to the specific country.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Appraise the drone / UAV flying regulations and their applications in the age of AI.
CO2: Understand the working principles of different electronic components to build the drone.
CO3: Apply the concept of drone dynamics and different movements during flight.
CO4: Design and develop the UAV flying in the given environment.

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

Syllabus

Introductions to drones and its applications in the age of AI, Drone regulations specific to India, Basics of drone dynamics for flying - frame types, propellers, types of drones, dynamics specific to quadcopter, Understanding UAV movements (Quadcopter), fly a drone, Introduction to drone electronic components, working principle behind each electronic component. Lab: Drone frames and electronic assembly, flying experiments.

Text Books / Reference Books

Syed Omar Faruk Towaha, Building Smart Drones with ESP8266 and Arduino: Build exciting drones by leveraging the capabilities of Arduino and ESP8266, Packt Publishing, 2018.
Barnhart, R. Kurt, Douglas M. Marshall, and Eric Shappee, eds. Introduction to unmanned aircraft systems. Crc Press, 2021.
Garg, P. K. Unmanned Aerial Vehicles: An Introduction. Stylus Publishing, LLC, 2021.
Kimon P. Valavanis, Handbook of Unmanned Aerial Vehicles, Volume4, Springer Netherlands, 2014.

23RAI300	RESEARCH METHODOLOGY	L-T-P-C: P/F

Course Objectives

- To learn and practice the literature survey aspects of projects and prepare the scope and goals for the proposed project.
- To learn, practice and improve the research presentation skills and with latest tools
- To learn and understand the research publication ethics.
- To prepare plagiarism free quality reports and journal articles

Course Outcomes

At the end of this course, the students should be able to:

CO1: Identify appropriate research topics
CO2: Select and define appropriate research problem and parameters
CO3: Prepare a research proposal, organize and conduct research
CO4: Understand the importance of research ethics and IPR
CO5: Write research articles and technical reports

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

Syllabus

Unit 1

Problem definition, Objectives of Research, Approaches to Research, Importance of reasoning in research. Problem Formulation, Conducting Literature Review.

Unit 2

Development of Hypothesis, Measurement Systems Analysis, Statistical Design of Experiments, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results. Preparation of Dissertation and Research Papers. References, Citation and listing system of documents.

Unit 3

Intellectual property rights (IPR) – patents – copyrights – Trademarks - Industrial design geographical indication. Ethics of Research- Scientific Misconduct - Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science

Text Books/ Reference Books

Bordens, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011
Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rd Edition, Elsevier Inc.
Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age". Aspen Law & Business; 6 edition July 2012

23LIV390	LIVE-IN-LAB I	L-T-P-C: 0-0-0-3

Course Objectives

- To 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
- To design a solution by integrating Human Centered Design concepts
- To devise proposed intervention strategies for Sustainable Social Change Management

Course Outcome

At the end of the course, the student will be able to:

CO1: Learn ethnographic research and utilise the methodologies to enhance participatory engagement.
CO2: Prioritize challenges and derive constraints using Participatory Rural Appraisal.
CO3: Identify and formulate the research challenges in rural communities.
CO4: Design solutions using human centered approach.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		3		3		1	1		3	3		3			
CO2		3						3	3	3					
CO3		3			1		1		3	3		3			
CO4	3		3		1		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 chairpersonand a faculty assigned as the project guide.

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

SEMESTER 6

23MEE316	ADDITIVE MANUFACTURING	L-T-P-C: 1-0-3-2

Course objectives

- To provide comprehensive knowledge of the wide range of additive manufacturing processes, capabilities and materials
- To make the students understand the various software tools and techniques that enable advanced/additive manufacturing and personal fabrication.
- To make the students learn to create physical objects that satisfies product development/prototyping requirements, using /additive manufacturing processes.

Course Outcomes

At the end of the course, the students will be able to

CO1: Demonstrate various principles of additive manufacturing processes.
CO2: Evaluate the suitability of materials for different additive manufacturing processes and applications.
CO3: Investigate and demonstrate various CAD tools that can be interfaced with additive manufacturing systems.
CO4: Develop physical prototypes using suitable additive manufacturing 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	1	1				1	1		1	2	1	1
CO2	3	3	2	1	1				1	1		1	2	1	1
CO3	3	3	2	1	1				1	1		1	2	1	1
CO4	3	3	2	1	1				1	1		1	2	1	1

Syllabus

Unit1

INTRODUCTION: METHODS AND SYSTEMS

Introduction to layered manufacturing, Importance of Additive Manufacturing Additive Manufacturing in Product Development Classification of additive manufacturing processes, Common additive manufacturing technologies; Fused Deposition Modeling (FDM), Selective Laser Sintering(SLS), Stereo Lithography(SLA), Selection Laser Melting (SLM), Jetting, 3D Printing, Laser Engineering Net Shaping (LENS), Laminated Object Manufacturing (LOM), Electron Beam Melting (EBM), Wire Arc Additive Manufacturing(WAAM), Electro Chemical AM, 4D Printing.
Capabilities, materials, costs, advantages and limitations of different systems.

Unit 2

MATERIAL AND PROCESS EVALUATION

Material science for additive Manufacturing-Mechanisms of material consolidation-FDM, SLS, SLM, 3D printing and jetting technologies. Polymers coalescence and sintering, photo polymerization,

Unit 3

CAD in Additive Manufacturing

AM Software: data formats and standardization, slicing algorithms: -uniform flat layer slicing, adaptive slicing, and rasterization, part Orientation and support generation.

Laboratory

CAD Modeling: Introduction to CAD environment, Sketching, Modeling and Editing features, Different file formats, Export/Import geometries, Part orientation, Layer slicing, Process path selection, Printing,

References

Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.
Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

23RAI311	MOBILE ROBOTS	L-T-P-C: 3-0-0-3

Course Objectives

- Familiarize with essential elements of robotic locomotion.
- Comprehend challenges in realizing robotic locomotion.
- Familiarize with the concepts of path planning and navigation.
- Impart knowledge on the basics of robot learning and collective robotics.

Course Outcomes

At the end of the course, the student will be able to

CO1: Implement the concepts of mathematical models and motion control methods.
CO2: Apply various models of localization and navigation.
CO3: Analyze locomotion challenges and select motion-planning algorithms.
CO4: Design and develop autonomous mobile robots with obstacle avoidance.

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

Syllabus

Unit 1

Introduction to autonomous robotics, terrestrial and aerial locomotion, mobile robot kinematic models, maneuverability, workspace, and kinematic control. Perception – non-visual sensors and algorithms, computer vision, image processing, feature extraction – interest point detectors, range data.

Unit 2

Mobile robot localization, Noise and aliasing, belief representation, probabilistic map-based localization – Markoc and Kalman filter localization, Autonomous map building, SLAM paradigms - Extended Kalman filter, graph-based and particle filter. Sensorial, geometric and topological maps, robot collectives – Sensing, communication, formation control, localization and mapping.

Unit 3

Planning and Navigation: Path planning. Graph search – Voronoi diagram, deterministic graph search, Dijkstra's algorithm, A*, D* algorithm, Randomized graph search, Potential field path planning. Obstacle avoidance – Bug algorithm, Techniques viz. bubble band, curvature velocity, dynamic window approach, Schlegel approach, gradient method, etc., Mobile robots in practice, delivery robots, intelligent vehicles, mining automation, space robotics, underwater inspection, etc. .

Text Books

Roland Siegwart, Illah R. Nourbakhsh, and Davide Scaramuzza. (2011). Introduction to Autonomous Mobile Robots. 2nd edition, The MIT Press.
Gregory Dudek, and Michael Jenkin. (2010). Computational Principles of Mobile Robotics. Second edition, Cambridge University press

Reference Books

Ulrich Nehmzow, (2012). Mobile Robotics: A Practical Introduction Second Edition. Springer.
Peter Corke (2017). Robotics, Vision and Control Fundamental Algorithms in MATLAB®. Second Edition. Springer
Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun (2005) Principles of Robot Motion Theory, Algorithms, and Implementation, MIT press.
Sebastian Thrun, Wolfram Burgard, Dieter Fox. (2002) Probabilistic Robotics. The MIT press.
Steven M. LaValle. (2006). Planning Algorithms, Cambridge University Press.

23RAI312	DEEP LEARNING	L-T-P-C: 2-0-3-3

Course Objectives

- To explore the neural networks and deep learning architectures.
- To enable students to implement, train and debug deep feed forward neural networks.
- To familiarize the application of convolutional neural networks and RNN for images and image sequences.

Course Outcomes

At the end of the course, the student will be able to

CO1: Implement the architecture and parameters involved in deep neural nets.
CO2: Demonstrate the design and usage of convolutional neural networks.
CO3: Apply neural networks for sequential models.
CO4: Design and implement neural networks 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	2	2	2	2	3				2	2		2	1	3	3
CO2	2	2	2	2	3				2	2		2	1	3	3
CO3	2	2	2	2	3				2	2		2	1	3	3
CO4	2	2	2	3	3				2	2		2	1	3	3

Syllabus

Unit 1

Deep Feed forward Networks Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms Dataset Augmentation, Noise Robustness Semi-Supervised Learning, Multi-Task Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations, Bagging and Other Ensemble Methods, Dropout, Adversarial Training.

Unit 2

Convolutional Networks the Convolution Operation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features.

Unit 3

Sequence Modeling: Recurrent and Recursive Nets Recurrent Neural Networks, Bidirectional RNNs, Encoder Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory.

Lab Component: Specific exercises based on research articles / Case studies / data set for DL/ Robotic application

Text Books

Goodfellow I, Bengio Y, Courville A. Deep learning. MIT press; 2016.
Patterson J, Gibson A. Deep learning: A practitioner's approach. "O'Reilly Media, Inc."; 2017.

23RAI313	IOT AND AUTOMATION	L-T-P-C: 2-0-3-3

Course Objectives

- To provide the student with basic skills useful in identifying the concepts of automation using hydraulics, pneumatic and PLC.
- To familiarize with the frame works required in architecture for IoT based Automation.
- To introduce edge computing standards and protocols for IoT.
- To introduce Industry 4.0 its applications.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Design and simulate pneumatic and hydraulic circuits.
CO2: Develop a PLC program for a given application.
CO3: Demonstrate the architecture frameworks for IoT based automation.
CO4: Apply the edge computing standards and protocols for Industrial IoT.
CO5: Develop IoT based automated systems for different applications.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to Automation - Automated manufacturing systems. Sensors and Actuators in Automation - Digital and analog sensors; Fluid power actuators; Control valves; Electrical system elements; Motors drives; Mechanical devices. Pneumatic and Hydraulic Systems - Pneumatic fundamentals - control elements, position and pressure sensing – logic circuits - switching circuits - sequential circuits - cascade method. Control Using PLCs - Relay logic; Combinational and sequential control, Sequential flow chart, Minimization of logic equations; Ladder logic diagrams; Programmable logic controllers (PLCs); PLC components; Programming; I/O addresses; Timer and counters; A/D conversion and sampling; PLC applications. Introduction to SCADA

Experiments: Logical Circuits - Pneumatic and Electro-Pneumatic Circuits, Study of PLC and PLC based Electro-Pneumatic Sequencing Circuits.

Unit 2

Industry 4.0 &IoT. Genesis of IoT -IoT and Digitization- IoT Network Architecture and Design-A Simplified IoT Architecture -The Core IoT Functional Stack -IoT Data Management and Compute Stack- Smart Objects - The “Things” in IoT – Sensors –Actuators - Smart Objects - Sensor Networks - Connecting Smart Objects -IoT Devices – End, Edge, and Cloud Systems - IoT Challenges. Introduction to Industry 5.0.

Experiments: Familiarizing cloud tools and frameworks. Developing IoT devices (End and Edge nodes for various applications).

Unit 3

Application Protocols for IoT – MQTT, CoAP. Application Protocols for Industrial Automation – ModBus, ProfiBus. Communication Technologies – Wi-Fi, BLE, ZigBee, 6LoWPAN, Fiber Optic Applications: Smart cities & smart homes, connected vehicles, Healthcare, Machine condition monitoring, Process monitoring and control.

Experiments: Introduction to Arduino, and ESP8266 (Node MCU), Introduction to Raspberry Pi and Installation of OS, Measurement of temperature & pressure values of the process using Raspberry Pi/node MCU, Modules and Sensors Interfacing (LM35, DHT 11, POT, IR sensor, Ultrasonic sensors) using Raspberry Pi/Node MCU, Modules and Actuators Interfacing (Relay, Motor, Buzzer) using Raspberry Pi/Node MCU, Demonstration of MQTT communication, Demonstration of LoRa communication

Text Books

Antony Espossito, "Fluid power with Applications ", Pearson, Sixth Edition., 2003.

David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", First Edition, Cisco Press, 2017

Raj, Pethuru, and Anupama C. Raman.The Internet of things: Enabling technologies, platforms, and use cases. Auerbach Publications, 2017.

Reference Books

Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Third Edition, Pearson Education, 2009.

Nanua Singh, Tatla Dar Singh., "Systems Approach to Computer-Integrated Design and Manufacturing", John Wiley & Sons, 1995.

Bahga, Arshdeep, and Vijay Madisetti.Internet of Things: A hands-on approach. Vpt, 2014.

Buyya, Rajkumar, and Amir VahidDastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016.

23RAI382	MOBILE ROBOTS LAB	L-T-P-C: 0-0-3-1

Course objectives

1. Familiarize with mathematical models used in mobile robotics.
2. Comprehend challenges in realizing localization and navigation.
3. Explore various path planning algorithms essential for autonomous mobile robot navigation.
4. Impart knowledge of mobile robot navigation schemes in real-world robotic applications.

Course Outcomes

At the end of the course, the student will be able to

CO1: Formulate mathematical models and motion control methods for mobile robots.
CO2: Apply various models for mapping, localization and navigation for mobile robots.
CO3: Analyze locomotion challenges and select motion-planning algorithms.
CO4: Design and develop autonomous mobile robots with obstacle avoidance.

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

Lab Practice

Students must be trained hands-on in designing, developing, simulating the robot path planning for mobile robots using ROS or similar tools

The list of experiments to be followed but not limited to.

1. Design and simulation of mobile robot.
2. Robot programming using suitable tools for kinematic control of differential drive vehicles.
3. Line fitting, and range data feature extraction using LiDAR/SONAR/Camera sensors.
4. Line-based Kalman filtering for mobile robot localization
5. Simultaneous localization and mapping based on Extended Kalman Filtering.
6. Simulate a system of collective robots for arbitrary inputs and constraints.
7. Mobile robot path planning with global and local dynamic window approaches.
8. Noise rejection navigation simulation for mobile robot.

Reference Book: *Lab Manuals*

23RAI398	MINI PROJECT	L-T-P-C: 0-0-6-2

Course Objectives

The Mini Project is a part of the coursework to demonstrate the abilities and specialization of the students. It provides the opportunity for the students to put into practice and develop a prototype/hardware/software solution for a real-world problem in an integrated manner by implementing some of the techniques that have been learned in the previous semesters.

- The mini project should be on Hardware Design integrated software and/or Fabrication in any of the areas in Robotics & AI
- Mini project work can be carried out individually or by a group of a maximum of five students.
- The course progress will be monitored at regular intervals.
- There will be not any specific guide for a student or project group. The students must identify the project based on their interest and students can approach any faculty member of the department with a prior appointment if they need any guidance or suggestion.
- There will be a faculty coordinator for this course. Every week, the faculty coordinator will review the progress of the course and evaluate the Continuous Internal Examination (CIE) Components with the help of an additional faculty member.
- The end semester evaluation is based on design, working model, report, presentation, and viva-voce. A panel appointed by the department will review the Semester End Examination (SEE) Components.

Course Outcomes

At the end of the course, the student will be able to

CO1: Design a hardware solution to a real-life problem/application.
CO2: Implement the hardware solution by developing a working model /prototype
CO3: Use software tools required for the design and implementation of hardware solutions.
CO4: Communicate the designs and work procedure through presentations and reports.

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

* Note: Evaluations to be done based on the rubrics (wherever possible) by considering COs defined for the course.

23LIV490	LIVE-IN-LAB II	L-T-P-C: 0-0-0-3

Course Objectives

- To illustrate proposal writing in order to bring in a detailed project planning, enlist the materials required and propose budget requirement.
- To familiarize the concept of CoDesign to ensure user participation in the design process in order to rightly capture user needs/requirements.
- To build and test a prototype to ensure that the final design implementation is satisfies the user needs, feasible, affordable, sustainable and efficient.
- To implement real time project in the village followed by awareness generation and skill training of the users (villagers).

Course Outcomes

At the end of the course, the student will be able to:

CO1: Learn co-design methodologies and engage anticipatorily 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: Apply 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	PSO1	PSO2	PSO3
CO1	1	1	3	3	1		1	3	3	3		1			
CO2					1				3	3		1			
CO3					1				3	3	3	1			
CO4	3		3		1	3	1	3	3	3	3	1			
CO5			1		1				3	3	3	1			

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

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

SEMESTER 7

23RAI401	COMUTER INTEGATED MANUFACTURING	L-T-P-C: 3-0-0-3

Course Objectives

- To provide fundamental knowledge of CAD/CAM and CIM in manufacturing system.
- To familiarize the application of computer in process planning, cellular manufacturing and flexible manufacturing systems.
- To provide exposure to different types of automatic material handling and storage systems for CIMS.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand various elements of CIM in developing various level of automations for manufacturing.
CO2: Apply computer aided process planning in CIM environment.
CO3: Analyze the material handling systems for implementing automated materials handling systems.
CO4: Understand various techniques needed to build a data warehouse
CO5: Design machine cell layout based on Group Technology and FMS.

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

Syllabus

Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Manufacturing Control– Basic Elements of an automated system – Levels of Automation – Lean Production and Just-In-Time Production.

Computerised process and resource planning: Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP)

Automated material handling and storage: Material functions, types of material handling equipment, analysis of material handling systems, design of system, conveyor system, automated guided vehicle systems, automated storage/retrieval systems, caroused storage systems, work in process storage, interfacing handling & storage with manufacturing, ASRS and Industry 4.0, case studies

Data Warehousing: Data warehouse concepts and architecture, multidimensional representation of a data warehouse, Data warehouse design principles & Methodologies, Data integration concepts, processes & techniques, Data integration tools, case studies.

Textbook

Groover, Mikell P. Automation, production systems, and computer-integrated manufacturing. Pearson Education India, 2016.

Reference Books

Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India, 2003.
Joe Reus, 'Fundamentals of Data Engineering', Matt Housley Released June 2022 Publisher(s): O'Reilly Media, Inc.
Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, 1995.
Rao. P, N Tewari &T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2000.
Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

23RAI402	REINFORCEMENT LEARNING	L-T-P-C: 2-0-3-3

Pre-requisite: Deep Learning (Knowledge level)

Course Objectives

- To provide a solid introduction to the field of reinforcement learning.
- To make the students learn about the core challenges and approaches, including exploration and exploitation.
- To make the students well versed in the key ideas and techniques for reinforcement learning

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning.

CO2: Formulate the robotic applications as a RL problem using suitable state space, action space, dynamics and reward model.

CO3: Implement RL algorithm using suitable software tools and programming languages.

CO4: Analyze the RL algorithms using well-defined evaluation criteria.

CO5: Apply RL based solution for real-time robotic 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	2		3	1	2	2
CO2	3	2	2	1	3				2	2		3	1	2	2
CO3	3	2	2	1	3				2	2		3	1	2	2
CO4	3	2	2	1	3				2	2		3	1	2	2
CO5	3	2	2	1	3				2	2		3	1	2	2

Syllabus

Introduction to Reinforcement Learning – Elements of Reinforcement Learning – Multi-armed Bandits – Finite Markov Decision Processes – Dynamic Programming – Monte Carlo Methods – Temporal-Difference Learning – n-step Bootstrapping - Planning and Learning with Tabular Methods.

Lab Exercise: Reinforcement learning applications to Robotics & AI.

Reference / Text Books

Ian Goodfellow, Yoshua Bengio and Aeron Courville, Deep Learning, MIT Press, First Edition, 2016.

Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Edition, The MIT Press, 2018

Hao Dong, Zihan Ding, and Shanghang Zhang, Deep Reinforcement Learning: Fundamentals, Research and Applications, Springer, 2020

Laura Graesser and Wah Loon Keng, Foundations of Deep Reinforcement Learning: Theory and Practice in Python, Addison-Wesley, 2020

Sudharsan Ravichandiran, Hands-On Reinforcement Learning with Python: Master reinforcement and deep reinforcement learning using OpenAI Gym and TensorFlow ,2nd Edition

23RAI481	CNC and SYSTEM SIMULATION LABORATORY	L-T-P-C: 0-0-3-1

Course Objectives

- To familiarize the working principles of a CNC machine tool.
- To inculcate CNC part programming skills through CAM software.
- To provide practices in discrete event simulation modelling of a manufacturing systems
- To analyze the performance of a manufacturing system using work study and lean techniques

Course Outcomes

At the end of the course, the student will be able to:

CO1: Describe the working principles and various subsystems functions of a CNC Machining center
CO2: Simulate and generate simple G and M code of CNC part programing using CAM software
CO3: Modelling of manufacturing and service systems using discrete event simulation package
CO4: Interpret and analyze the results obtained by the simulation model for performance improvement
CO5: Apply work study principles and lean techniques to improve the performance of a manufacturing system

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

CNC LAB EXERCISES

- A study on the working principle, construction, and tooling requirement CNC Machine tool
- Generate G and M Code for manual part programming for a simple part geometry
- Modelling of part geometries and CNC code generation using CAM software for generating
- Simulation of machining process using CAM software.
- Machining of a given component using CNC machine tool using CAM software

SIMULATION OF MANUFACTURING SYSTEMS LAB EXERCISES

- Modelling and analysis of manufacturing and service systems using discrete event simulation package.
- Analysis of simulation output data and fit the data into a suitable distribution.
- Modelling of Flow-shops, Job shops, Assembly shops, FMS, and Kanban Controlled Manufacturing Systems using simulation software
- Simulation and Optimization of a manufacturing system model for productivity improvement
- Time and motion study experiments using simulation software for calculating standard time.
- Study and design of lean assembly lines using LEGO kits.

S7

23RAI497	SUMMER INTERNSHIP	1 Cr

Course objectives

- To impart the social, economic and administrative considerations that influence the working environment of Industrial / Research organizations.
- To familiarize with various materials, processes, products and their applications along with relevant aspects of quality control and recent technical developments.
- To expose students to the engineer's responsibilities and ethics.
- To upskill students to implement the technical knowledge in the real industrial situations.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Apply theoretical knowledge and skill sets acquired from the course and workplace in the assigned job function (s).

CO2: Articulate career options by considering opportunities in industry, research and educational advancement.

CO3: Communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means.

CO-PO Mapping

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

Guidelines

Internships are educational and career development opportunities, providing practical experience in a field or discipline. They are structured, short-term, supervised placements often focused around particular tasks or projects with defined timescales. The internship is to be taken in a phased manner during the summer vacation starting from the end of sixth semester. The students are recommended to pursue the internship at Public Sector Undertaking (PSU) and private companies including MNC's, Small and Medium scale industries or Research labs/institutes or Academic Institutions. After the completion of the internship, the students are instructed to submit the industry supervisors report according to the prescribed format for the external evaluation. Apart from these, the internal evaluation includes a presentation and report submission.

S7

23RAI498	PROJECT PHASE I	4 Cr

Course Objectives

- Identify suitable and relevant topics, which can be, developed either through development or research activities and match the level expected of an undergraduate student.
- Collate relevant information pertaining to the project's requirements from various resources.
- Design and propose a feasible solution based on the given timeline.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Identify and define a problem based on the community/industry/research.
CO2: Collect the literature related to the problem, and analysis the literature and identify research gaps.
CO3: Plan project activities, considering their underlying requirements, constraints and deliverables.
CO4: Design and develop the solution using experimental/simulation tools.
CO5: Communicate and document the project work through technical reports and presentations.

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

Guidelines

The aim of the final year project is to give students opportunity to apply the knowledge they have gained to solve practical engineering problems. By doing so, students will gain knowledge and experience in solving problems systematically thus when they graduate, they will be ready to work as reliable and productive engineers. The project problem may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, etc. or a combination of these.

In project phase 1, students are recommended to conduct an exhaustive literature survey to identify the real-life problems. Based on the literature survey they should formulate the problem statement and identify the methodology utilized to solve the problem. At the end of phase 1 of the project, students will have to document their work in the form of project report in the prescribed form. The final evaluation and viva-voce will be conducted after submission of the final project report. Students have to make a presentation on the work carried out, before the departmental committee, as part of project evaluation.

SEMESTER 8

23RAI499	PROJECT PHASE II	8 Cr

Prerequisite: Project Phase I

Course Objectives

- Develop the project identified in project phase 1 according to the proposed plan and design.
- Verify and validate the developed projects against the proposed objectives and goals.
- Propose future improvement based on project outcomes.
- Communicate project ideas and final product through technical report and presentation.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Plan project activities, considering the project objectives, constraints and deliverables.
CO2: Formulate the solution methodology for the project objectives.
CO3: Design and develop the solution using simulation/ experimental approaches.
CO4: Analyse the solution and obtain the optimal solutions.
CO5: Validate the design/solution in real-world robotic applications.
CO6: Communicate and document the project work through technical reports and presentations.

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	1	3	3	1	2	3	3	3
CO2	3	3	3	3	1	1	1	1	3	3	2	2	3	3	3
CO3	3	3	3	3	2	1	1	1	3	3	1	2	3	3	3
CO4	3	3	3	3	2	1		11	3	3	1	2	3	3	3
CO5	3	3	3	3	2	1	1	1	3	3	1	2	3	3	3
CO6	3	2	2	2	1	1	1	1	3	3	1	1	3	3	3

Guidelines

The aim of the final year project is to give students opportunity to apply the knowledge they have gained to solve practical engineering problems. By doing so, students will gain knowledge and experience in solving problems systematically thus, when they graduate, they will be ready to work as reliable and productive engineers. The project problem may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, etc. or a combination of these.

In phase 2 of the project work, students are recommended to prove the solution to the identified problem statement and methodology in phase 1. The solution should be in the form of fabrication/coding/modeling/product design/process design/relevant scientific methodology. The consolidated report along with the developed model to be submitted for the assessment. Project outcome to be evaluated in terms of technical, economic, social, environmental, political and demographic feasibility. The final evaluation and viva-voce will be conducted after submission of the final project report in the prescribed form. Students have to make a presentation on the work carried out, before the departmental committee, as part of project evaluation.

PROFESSIONAL ELECTIVES

23RAI331	**BIO-INSPIRED ROBOTS**	**L-T-P-C: 3-0-0-3**

Course Objectives

- To familiarize the knowledge of the biological systems with reference to robotic systems.
- To inculcate the development of biologically inspired robotic applications.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Interpret the bio-inspired sensing and formulate the bioinspired motion.
CO2: Differentiate the requirements of soft and hard robotics.
CO3: Analyze the control architecture and behavior with reference to kinematics.
CO4: Evaluate collective and bio-hybrid robotics/create electromechanical robotic system.

CO-PO Mapping

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

Syllabus

Unit 1

Fundamentals of Traditional Robots, Biologically-inspired Robots, Introduction, Bio-inspired morphologies, Bio-inspired sensors, Vision, Audition, Touch, Smell, taste, Idiothetic sensors. Fundamentals of Biologically Inspired Robots, Bio-inspired actuators, locomotion, crawling, walking, wall climbing, jumping, swimming, flying, grasping, drilling

Unit 2

Soft Robotics, Structural Difference between Hard and Soft Robots, Bio-inspiration in Soft Robotics, Hydrostatic Skeletons, Muscular Hydrostats, Soft Active Plant Structure, Soft Robots, Actuators, Pneumatic Artificial Muscles, Electroactive Polymers, Shape Memory Alloys

Unit 3

Bio-inspired control architectures, Behavior-based robotics, learning robots, evolving robots, developing robots, Bio-inspired Robot Design Considering Load-bearing and Kinematic Ontogeny of Sea Turtles. Energetic anatomy, Collective robotics, Bio-hybrid robots. Case studies and mini projects in Design and Fabrication of Biologically Inspired Robots.

Text Books /References

Thomas R. Consi and Barbara Webb, Biorobotics - Methods and Applications, MIT Press, 2001.
Yunhui Liu and Dong Sun, Biologically Inspired Robotics, CRC Press, 2012.
Ralf Simon King, BiLBIQ: A Biologically Inspired Robot with Walking and Rolling Locomotion, Springer, 2013.
Karl Williams, Amphibionics - Build Your Own Biologically Inspired Robot, McGraw-Hill Education, 2003.

23RAI332	HUMANOID ROBOTS	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the knowledge of the kinematics and dynamics of Humanoid Robots.
- To familiarize the generation of biped walking patterns and control.
- To impart the design of different methods for generation of Whole-Body Motion Patterns.
- To inculcate the methods for simulating humanoid robot dynamics.

Course Outcomes

At the end of the course, the student will be able to:
CO1: Understand the kinematics and dynamics of Humanoid Robots.
CO2: Apply the knowledge of design in generating biped walking patterns and control.
CO3: Analyze whole-body motion patterns for humanoid robots.
CO4: Evaluat**e** different methods for simulating humanoid robot dynamics.

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

Syllabus

Unit 1

Introduction, Kinematics: Coordinate Transformations, Characteristics of Rotational Motion, Velocity in Three-Dimensional Space, Robot Data Structure and Programming, Kinematics of a Humanoid Robot. Zero Moment Point (ZMP) and Dynamics: ZMP and Ground Reaction Forces, Measurement of ZMP, Dynamics of Humanoid Robots, Calculation of ZMP from Robot's Motion

Unit 2

Biped Walking: How to Realize Biped Walking? Two-Dimensional Walking Pattern Generation, 3D Walking Pattern Generation, ZMP Based Walking Pattern Generation, Stabilizer, Pioneers of Dynamic Biped Walking Technology, Additional Methods for Biped Control

Unit 3

Generation of Whole-Body Motion Patterns: How to Generate Whole Body Motion, Converting Whole Body Motion Patterns to Dynamically Stable Motion, Remote Operation of Humanoid Robots with Whole Body Motion Generation, Reducing the Impact of a Humanoid Robot Falling Backwards

Dynamic Simulation: Dynamics of Rotating Rigid Body, Spatial Velocity, Dynamics of Rigid Body, Dynamics of Link System: Forward and Inverse Dynamics, Featherstone's Method.

Text/Reference Books

Shuuji Kajita, Hirohisa Hirukawa, Kensuke Harada and Kazuhito Yokoi, Introduction to Humanoid Robotics, Springer, 2014.
Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, Humanoid Robots: Modelling and Control, Butterworth-Heinemann, 2019
Matthias Hackel, Humanoid Robots: Human-like Machines, I-Tech Education and Publishing, 2007.
Ben Choi, Humanoid Robots, In-Tech, 2019.

23RAI333	MEDICAL ROBOTS	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the knowledge of medical robots in computer integrated minimally invasive surgery.
- To inculcate the diverse applications of robotics in surgery.
- To familiarize the importance of robotics in Rehabilitation and medical care.
- To familiarize the methodologies for design of medical robots.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Classify the robots and its components for different medical applications.
CO2: Understand different methods of surgical robots and their applications.
CO3: Design robots in rehabilitation and medical care.
CO4: Analyse the methodologies for implementing medical robots using case study.

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

Syllabus

Unit 1

Types of medical robots: Navigation, Motion Replication, Imaging, Rehabilitation and Prosthetics, State of art of robotics in the field of healthcare; Localization and Tracking: Position sensors requirements, Tracking, Mechanical linkages, Optical, Sound-based, Electromagnetic, Impedance-based, In-bore MRI tracking, Video matching, Fiber optic tracking systems, Hybrid systems.

Unit 2

Applications of Surgical Robotics: Radiosurgery, Orthopedic Surgery, Urologic Surgery and Robotic Imaging, Cardiac Surgery, Neurosurgery, ENT surgery; Robots in rehabilitation: Rehabilitation for Limbs, Brain-Machine Interfaces, Steerable Needles.

Unit 3

Robots in Medical Care: Assistive robots – types of assistive robots – case studies; Design of Medical Robots: Characterization of gestures to the design of robots, Design methodologies- Technological choices – Security

Text/Reference Books

Paula Gomes, Medical robotics: Minimally invasive surgery, Woodhead Publishing Limited, 2012.
Achim Schweikard and Floris Ernst, Medical Robotics, Springer, 2015
Jocelyne Troccaz, Medical Robotics, John Wiley & Sons, 2012.
Pedro Encarnação and Albert M. Cook, Robotic Assistive Technologies: Principles and Practice, CRC Press, 2017.
Roberto Colombo and Vittorio Sanguineti, Rehabilitation Robotics: Technology and Application, Academic Press, 2018.

23RAI334	UNDERWATER ROBOTS	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the building blocks and principles of marine robotics.
- To impart the knowledge in designing the marine robots.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the basics elements of marine robots.
CO2: Design thruster system and develop trajectory methods for marine robot navigation.
CO3: Apply different methods to predict the motion and control of the marine robot.
CO4: Design marine robot replicas from bio-mimetics and bio-inspired 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		1								1	2	1	1
CO2	3	3	1	2								1	2	1	1
CO3	3	3	2	3	2							1	2	1	1
CO4	3	3	3	3	3							1	2	1	1

Syllabus

Unit 1

Introduction to marine robotics and robotics configurations, autonomous underwater glider (AUGs), autonomous underwater vehicles (AUVs), and remotely operated underwater vehicles. Actuation and sensing systems; communication; manipulation; interaction; guidance, navigation and control; and mission control systems.

Unit 2

Algorithms for SLAM, fault detection/tolerance systems; multiple coordinated vehicle; and networked vehicle. Signature detection, analysis, and optimization; sensor networks for radars, sonar and navigation; design of propulsion system; and trajectory measurements and simulations. Design and analysis of thrusters for AUGs/AUVs.

Unit 3

Motion prediction and control system, and co-operative adaptive sampling techniques. Design of variable buoyancy systems for UVs. Design of DCDM based controllers for UVs. Remote sensing and environmental monitoring with AUGs/AUVs, underwater vehicle-manipulator system, bio-mimetic underwater robotics, and bio-inspired robotics systems. Case studies from India, Republic of Korea, Japan and USA.

Text Books

T. Fossen, "Guidance and control of ocean vehicles", Chichester New York, USA, 1994
N. Newman, "Marine Hydrodynamics", MIT Press, USA, 1997
T. Fossen, "Marine Control Systems: Guidance, Navigation, and Control of Ships, Rigs, and Underwater Vehicles", Marine Cybernetics, Trondheim, Norway

Reference Books

K. D. Do, and J. Pan, "Control of ships and underwater vehicles: Design for underactuated and Non-linear Marine Systems", Advances in Industrial Control, 1e, Springer, 2009.
G. Griffiths, "Technology and applications of autonomous underwater vehicles", Ocean science and technology, vol. 2, CRC Press, USA, 2002.
R. Suttons, G Roberts, "Advances in unmanned marine vehicles", IEEE Control Series, Institution of Engineering and Technology, USA, 2006.

23RAI335	COGNITIVE ROBOTS	L-T-P-C: 3-0-0-3

Course Objectives

- To impart the basic knowledge of robot cognition, human brain and neuro transmissions.
- To familiarize the concepts of robot cognitive models, robot perceptions and 3D digital reconstruction.
- To inculcate the cognitive and intelligent robotic models.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the fundamentals of human psychology, neuroscience for cognitive robots.
CO2: Apply cognitive intelligence and soft computing tools in the robot models.
CO3: Apply the 3D digital reconstruction for the robot perception and map building.
CO4: Integrate the path planning and navigation tools with robot models.

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

Syllabus

Unit 1

Introduction to human robot interaction, smart materials. Brain physiology and neural signal transmission, architecture of the brain and nerve cells. Neural modeling: Introduction to synchronization modeling, electroencephalography. Intelligent architecture: Theories of intelligence, Kuramoto model, Child-Robot interaction.

Unit 2

Introduction to the model of cognition, visual perception and recognition, Machine learning, soft computing tools, and robot cognition. Necessity for 3D Reconstruction – Building Perception – Imaging Geometry – Global Representation – Transformation to Global Co-ordinate System. Map building: 2D world map, data structure for map building, Procedure map building, procedure traverse boundary, robot simulation and robot map building programming.

Unit 3

Robot Parameter Display, Program for BotSpeak, Program for Sonar Reading Display, Program for Wandering Within the Workspace, Program for Tele-operation, A Complete Program for Autonomous Navigation.

Text Books

Patnaik, Srikanta, "Robot Cognition and Navigation - An Experiment with Mobile Robots", SpringerVerlag Berlin and Heidelberg, 2007.
Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.

Reference Books

Sebastian Tharun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics", MIT Press, 2005.
Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg 2008.
HoomanSomani," Cognitive Robotics", CRC Press, 2015.
Jared Kroff,"Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016.
Lidia Ogiela, Marek Ogiela, "Advances in Cognitive Information Systems", Springer, 2012.

23RAI336	ADVANCED DRONES TECHNOLOGY	L-T-P-C: 2-0-3-3

Pre-requisite: Introduction to Drones (Knowledge level)

Course Objectives

- To familiarize with the basic concepts of drones, propellers, and controls of drones.
- To impart the state estimations and path planning of drones.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the kinematics and dynamics of drones.

CO2: Analyze the kinematics and dynamics of fixed wing drones and multi rotor micro drones.

CO3: Design the flight controllers of drones.

CO4: Design and implement path planning algorithms for drones.

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

Syllabus

Unit 1

Fixed Wing and Multirotor Micro Drones: Introduction – Drones – Kinematic and dynamics modelling formulation of drones - Transformation and representations – Dynamics of a fixed-wing drones, Propeller theory – Thrust and drag moment – Dynamics of a multi rotor micro drones (MMD) – Mathematical modelling of MMD

Unit 2

State Estimation: Physics and working of Navigational sensors – Inertial Sensors – Magnetometer – Pressure sensors, GPS – Camera based navigation – Kalman filter – Position and velocity analysis, Inertial navigation systems – Attitude estimation

Unit 3

Flight Controls and Motion Planning: PIC control – Lateral control of MMD, LQR – Design of servo LQR control, Linear model predictive control – Design and implementation. Holonomic vehicle boundary value solver, Dubins airplane model boundary value solver – collision free navigation, Structural inspection path planning

Text Books

R. Beard, and T. W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, 2012

R. C. Nelson, "Flight Stability and Automatic Control", McGraw Hill, New York, 1998.

Reference Books

L.R. Newcome, Unmanned Aviation, a Brief History of Unmanned Aerial Vehicles, American Institute of Aeronautics and Astronautics, Reston, 2004.

Kuo, B. C., "Automatic Control Systems", Prentice Hall, 1991

23RAI341 INTELLIGENT CONTROL SYSTEMS FOR ROBOTS L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the student with knowledge of various soft computing tools.
- To impart knowledge regarding the theory and application of fuzzy logic controller design.
- To impart understanding of various Non-linear controller strategies.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the principles of soft computing tools like neural networks and fuzzy logic.
CO2: Apply neural networks and fuzzy logic for system identification.
CO3: Design non-linear control for robot applications
CO4: Design fuzzy logic controllers for robot 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										1	3	3	3
CO2	3	3	2	2	1							1	3	3	3
CO3	3	3	1									1	3	3	3
CO4	3	3	2	2	1							1	3	3	3

Syllabus

Unit 1

Basic Concepts for Intelligent Systems - Artificial Neural Networks - Perceptral Networks - Radial Basis Function Networks - Back-propagation Networks and Recurrent Networks - System Identification Using Neural Networks - Fuzzy logic - Knowledge Representation - Fuzzy Sets - Fuzzy Rules and Reasoning - Fuzzy Logic Control - Mamdani Model - Takagi-Sugeno Model - System Identification using T-S Fuzzy Models. ANFIS.

Unit 2

Nonlinear Control - Nonlinear State-space Model - Lyapunov Stability Theory - Lyapunov's Indirect Method - Nonlinear Control Strategies Direct Adaptive Control Using Neural Networks - Direct Adaptive Control - SISO and MIMO Systems - Back-stepping Control.

Unit 3

Fuzzy Model Based Control - T-S Fuzzy model - Linear Matrix Inequality (LMI) Technique - Fixed Gain state Feedback Controller Design Technique - Variable Gain Controller Design using Single Linear Nominal Plant and each Linear Subsystem as Nominal Plant - Controller Design using Discrete T-S Fuzzy System.

Text Book:

Behera L., Kar I., "Intelligent Systems and Control: Principles and Applications", Oxford University Press, 2009.

Reference Books:

Gopal M., "Digital Control and State Variable Methods", Tata McGraw Hill, third Edition, 2008.
Zi-Xing C., "Intelligent Control: Principles, Techniques and Applications", World Scientific Publishing Co. Pvt. Ltd., 1997.
Jang J. S. R., Sun C. T., Mizutzni E., "Neuro-Fuzzy and Soft Computing", Prentice Hall India Private Limited, 2002.

23RAI342	OPTIMIZATION FOR ROBOT MODELLING	L-T-P-C: 2-0-3-3

Course Objectives

- To impart the basic knowledge in optimizing the design and performance of robots in kinematics, dynamics and trajectory modelling.
- To impart the concepts of meta-heuristic algorithms in the optimization of robot manipulators.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Formulate Homogeneous Transformation Matrix (HTM) of rigid body and compute optimal values of Roll, Yaw and Pitch.

CO2: Develop solutions using optimization procedure for the forward kinematics and inverse kinematics of the robot manipulator.

CO3: Compute optimum path and trajectory of the robot using optimization methods.

CO4: Optimize the dimensions of the physical components of the robot using meta-heuristic approaches.

CO5: Identify an appropriate robot type with minimum dimensionality for a given specific task using optimization procedure.

CO-PO Mapping

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

Syllabus

Unit I

Introduction –traditional gradient based Optimization algorithms – Optimality criterion for unconstrained and constrained optimization problems –Heuristic, Meta-heuristics, and Evolutionary algorithms: selective algorithms specific to robotic applications.

Unit 2

Spatial representation of a rigid body: Position - Rotational Matrix - Euler angles: problem formulation to find best Euler angles - Roll, Pitch and Yaw angles - Homogeneous transformation matrix – Finding optimal values of Roll, Pitch and Yaw. Kinematic Synthesis: Introduction – Type synthesis – Dimensional Synthesis - Evolutionary method – Graph theory approach. Structural Optimization: Topology optimization - Dimensional synthesis using optimization algorithms – Stiffness analysis and optimization.

Unit 3

Manipulator Kinematics: Introduction – Manipulator – Formulating objective function of the forward and inverse kinematics, identify optimum joint angle for the given position vector - Manipulator Jacobian: Finding optimum Jacobian of a manipulator. Path and Trajectory Planning: Introduction – Path Planning algorithms: Identifying optimal path using heuristic approach, Collision detection algorithms – Trajectory Planning: Algorithms, identifying optimum velocity and acceleration along the path.

Note: MATLAB will be used for teaching and learning; Computational exercises – Lab practice

Text/Reference Books

Ghafil, Hazim Nasir, and Károly Jármai. Optimization for Robot Modelling with MATLAB. Springer International Publishing, 2020.

Koubâa, Anis, Hachemi Bennaceur, Imen Chaari, Sahar Trigui, Adel Ammar, Mohamed-Foued Sriti, Maram Alajlan, Omar Cheikhrouhou, and Yasir Javed. Robot Path Planning and Cooperation. Vol. 772. Springer International Publishing, 2018.

Jha, Panchanand, and Bibhuti Bhusan Biswal. "Optimization Approach for Inverse Kinematic Solution." In Kinematics. IntechOpen, 2017.

Rao, Singiresu S. Engineering optimization: theory and practice. John Wiley & Sons, 2019.

Arora, Rajesh Kumar. Optimization: algorithms and applications. Chapman and Hall/CRC, 2019.

23RAI343	COMPUTER VISION AND IMAGE PROCESSING	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize with the principles of nonlinear systems.
- To impart the nonlinear system theory to design control systems.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand various methods for digital image processing and analysis.
CO2: Select and apply suitable algorithms for vision related tasks.
CO3: Analyse the digital image data with different image data models, pattern recognition algorithms and learning theory.
CO4: Apply machine learning algorithms for image processing.

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

Syllabus

Unit 1

Introduction to Computer Vision and Basic Concepts of Image Formation: Introduction and Goals of Computer Vision and Image Processing, Image Formation Concepts; Fundamental Concepts of Image Formation: Radiometry, Geometric Transformations, Geometric Camera Models, Camera Calibration, Image Formation in a Stereo Vision Setup, Image Reconstruction from a Series of Projections.

Unit 2

Image Processing Concepts: Image Transforms, Image Enhancement, Image Filtering, Color Image Processing, Image Segmentation; Image Descriptors and Features: Texture Descriptors, Color Features, Edges/Boundaries, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Histogram of Oriented Gradients, Scale Invariant Feature Transform, Saliency

Unit 3

Fundamentals of Machine Learning: Linear Regression, Basic Concepts of Decision Functions, Elementary Statistical Decision Theory, Parameter Estimation, Clustering for Knowledge Representation, Dimensionality Reduction, Linear Discriminant Analysis. Applications of Computer Vision: Artificial Neural Network for Pattern Classification, Convolutional Neural Networks, Auto encoder, Machine Learning Algorithms and their Applications in Image Segmentation, Gesture Recognition, Object recognition, template matching, classification; Object detection and tracking: background modeling, kernel-based tracking, particle filters.

Text Books / References

David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, 2nd Edition, Pearson Education India, 2015.
Manas Kamal Bhuyan, Computer Vision and Image Processing - Fundamentals and Applications, CRC Press, 2020.
Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.
Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson, 2018

23RAI344	ADVANCED MATERIALS FOR ROBOTICS	L-T-P-C: 3-0-0-3

Course Objectives

- To impart the basic concepts of cell biology, evolutionary systems, neuroscience and immune systems in relation to robotics.
- To familiarize the connection between biology and robotics and how biology inspires robotics.
- To familiarize the different types of robots developed based on biology.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the thermodynamics of nucleation and strengthening mechanisms.
CO2: Analyze metallic, functional, polymer materials, and its processing.
CO3: Select suitable high performance materials and processing methods for robot components.
CO4: Analyze structure properties, and performance using advanced material characterization technique.

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

Syllabus

Unit 1

Advanced metallic materials- Fundamental principles of advanced materials and application of advanced materials to robotics using a multidisciplinary science-based approach. Liquid-solid transformation-Nucleation and kinetics of growth, interface morphologies, non-equilibrium freezing, segregation. Nucleation in the solid state- transformations, diffusion in solid state, diffusion equations for steady state and transient conditions, Strengthening methods and mechanisms.

Structural Materials for Robots – Aluminium, copper, magnesium, steel, nickel and titanium alloys. Recent advances in materials development- Hi-Entropy alloys, functionally gradient materials, shape memory alloys, metallic composite for soft robotics, computational metamaterials.

Unit 2

Composites in robotics- Types of matrices and reinforcements, principles, properties and applications, stretchable elastomeric sensor and ionic polymer for robotics, Kevlar, biodegradable smart materials, macroscopic composites, three-dimensional, periodic cellular architecture. Special processing techniques of material for robotics.

Unit 3

Introduction to thin film sand sensor material, energy material and refractory materials and characterization. Materials characterization techniques for advanced and robotic material – Recap of mechanical, metallurgical, chemical and thermal methods. Instrumentational methods – Scanning electron microscopy, transmission electron microscopy and energy dispersive analyses, X-ray diffraction, atomic force microscopy, Field array NDT techniques for futuristic materials, surface patterning techniques.

Text Books / References

Bhushan Bharat, "Springer Handbook of Nanotechnology", Springer, 2017.
Sohel Rana and Raul Fangueiro, "Advanced Composite Materials for Aerospace Engineering: Processing, Properties and Applications", Woodhead Publishing, 2016.
Rowe Jason, "Advanced Materials in Automotive Engineering", Woodhead Publishing, 2016.
Cantor Brian, Hazel Assender and Patrick Grant, "Aerospace Materials", CRC Press, 2015.
Park Joon and Roderic S. Lakes, "Biomaterials: An Introduction", Springer Science & Business Media, 2007.
Cao Guozhong, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications", Imperial College Press, 2004.
Michio Inagaki Feiyu Kang Masahiro Toyoda Hidetaka Konno, "Advanced Materials Science and Engineering of Carbon", 1st Edition, Butterworth-Heinemann, 2013, ISBN: 9780124077898.
W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, 2007.
C. Kittel, "Introduction to Solid State Physics" Wiley Eastern Ltd, 2005.
Charles P Poole Jr., and Frank J. Ownes, "Introduction to Nanotechnology", John Wiley Sons, Inc., 2003.
Sam Zhang, Lin Li and Ashok Kumar, "Materials Characterization Techniques", CRC Press, (2008).

23RAI345	ADVANCED ROBOTICS AND ANALYSIS	L-T-P-C: 3-0-0-3

Course Objectives

- To impart the knowledge of advanced topics of the robot manipulators.
- To inculcate mathematical modelling, numerical analysis and problem-solving techniques of robot manipulators.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Compute DH parameters of serial and parallel robot manipulators.
CO2: Formulation and analysis of robot dynamic equations
CO3: Apply motion planning algorithms for robot manipulators.
CO4: Apply advanced control algorithms for robot manipulators

CO-PO Mapping

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

Syllabus

Unit 1

Review of robot manipulator (Serial and Parallel), D-H convention, Forward and Inverse kinematics, Workspace, Analytical and numerical solutions, vibration isolation.

Unit 2

Redundancy and resolution of redundancy in robots, minimizing joint rotations and cartesian motion, Tractrix based approach (resolution, planar and spatial). Experimental 8-link hyper-redundant manipulator, Dynamic equations of motion, derivation & simulation, Recursive inverse dynamics: Newton-Euler formulation, Articulated body algorithm, Pseudo-inverse approach, modal approach for straight and circular trajectory.

Unit 3

Simulation on linear control, motion planning, nonlinear position and force control of 6 DOF robot manipulator, partitioning of tasks. Numerical and analytical solutions, Over-constrained and deployable structures – modelling and analysis, Cable driven & pneumatically actuated flexible robots.

Text Book

Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.

Reference Books

R.K. Mittal and I.J. Nagrath, "Robotics and Control", Tata McGraw Hill.
John J Craig, "Introduction to Robotics: Mechanics and control", Printice Hall of India.
S. K. Saha, "Introduction to Robotics", Tata McGraw Hill.
K.S.Fu, R.C.Gonzalez and C.S.G.Lee, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill.
M.W.Spong and M. Vidyasagar, "Robot Dynamics and Control", Wiley India.

23RAI346	SIMULATION MODELLING OF ENGINEERING SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives:

- Provide a generalized framework for modeling engineering systems through lumped parameter elements.
- Introduce and apply different mathematical tools to analyze models of engineering systems.
- Familiarize the use of software tools for solving engineering problems.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Develop mathematical models for engineering systems in different domains and derive analogies.
CO2: Analyze first and second-order linear and nonlinear systems in the time and frequency domain.
CO3: Perform system identification for linear time-invariant systems.
CO4: Simulate mathematical models of engineering systems using simulation software.

CO-PO Mapping

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

Syllabus

Unit 1

Fundamental concepts in mathematical modeling: Abstraction-linearity and superposition-balance and conservation laws and the system boundary approach. Lumped element modeling: Mechanical systems- Translational, rotational. Hydraulic systems. Thermal systems. RLC electrical systems. Modeling analogies.

Unit 2

Modeling of the first order and second order systems: Governing equations for free and forced responses – transient response specifications - experimental determination of time constant and damping coefficient. Laplace Transforms. State space formulation. Frequency response of Linear Time-Invariant (LTI) systems: Frequency response of first-order and second-order systems - Transfer function - mathematical features - Bode Plots-Relating time domain, frequency domain, and state space. Introduction to modeling and analysis of nonlinear engineering systems.

Unit 3

Introduction to linear system identification – time and frequency domain identification – discrete-time input-output models for LTI systems – linear least square parameter estimation.

References

Cha P.D, Rosenberg J.J, and Dym C.L, Fundamentals of Modeling and Analyzing Engineering Systems, Cambridge University 2000

Keesman, Karel J. System identification: an introduction. Springer Science & Business Media, 2011

Katsuhiko Ogata, System Dynamics, 4th Edition, Pearson Prentice Hall, 2004.

Karnopp D C, Margolis D L and Rosenberg R C, Modeling and Analysis of Mechatronic Systems, Wiley Interscience, 3rd Ed, 1999.

Doebelin E O, System Dynamics: Modeling, Analysis, Simulation and Design, Marcel Dekker 1998

23RAI351	**BIG DATA ANALYTICS**	**L-T-P-C: 3-0-0-3**

Course Objectives

- To familiarize big data frameworks and APIs.
- To conceptualize data analysis, various data processing and pipelining strategies.
- To visualize map-reduce computing paradigm.
- To train and impart the skills required for managing and balancing large data clusters.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the basic data abstraction and imbibe the map-reduce skillset.
CO2: Apply general data pipelining, design and data analytics solutions.
CO3: Apply scaling up machine learning techniques and associated computing techniques and technologies.
CO4: Identify the characteristics of datasets and compare the trivial data and big data 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	3	3	3	3				2	2		2	1	2	2
CO2	3	3	3	3	3				3	3		2	1	2	2
CO3	3	3	3	3	3				2	3		2	1	2	2
CO4	2	2	3	2	3				2	2		2	1	2	2

Syllabus

Hadoop ecosystem in Brief –Basic Paradigm and system architecture, MapRed and HDFS, Making a small Hadoop cluster –Iterative and non-Iterative batch processing, Data stores, HBASE, HIVE, PIG-New generation Big data using Functional Programming in Scala: Basic Syntax-type inference and static types-function types and value types, closures.

Immutability and immutable types-generic type Parameters-Recursive arbitrary collections –ConsList -Iterative arbitrary collections-Arrays-Tail recursion-factorial example-functional abstractions with examples-square root, fixed point, sequence summations. Higher order functions-MapReduce Template-Pattern Matching syntax. Similar higher order (Cons) List operations on arbitrary Collections-filter, fold, partition, span. Basic entity classes and objects in Scala.

Apache Spark: -Resilient Distributed Datasets -Creating RDDs, Lineage and Fault tolerance, DAGs, Immutability, task division and partitions, transformations and actions, lazy evolutions and optimization -Formatting and housing data from spark RDDs--Persistence. Data frames, datasets, Setting up a standalone Spark cluster-: spark-shell, basic API, Modules-Core, Key/Value pairs and other RDD features, MLlib-examples for bi-class SVM and logistic regression.

Lab Practice: Bigdata Analytics using data sets/ case problems – Python/ MATLAB

Text Books

Learning Spark: Lightning-Fast Big Data Analysis', Holden Karau, Andy Konwinski, Patrick Wendell and MateiZaharia, 1st Edition
'Programming in Scala: A Comprehensive Step-by-Step Guide', Martin Odersky, Lex Spoon andBillVenners, Third Edition
'High Performance Spark: Best Practices for Scaling and Optimizing Apache Spark', Holden Karau, Rachel Warren, 1st Edition
'Scala for the Impatient', Cay S. Horstmann, 2nd Edition
'Spark: The Definitive Guide: Big Data Processing Made Simple', Bill Chambers and MateiZaharia, 1st Edition
Hadoop: The Definitive Guide

23RAI352	BIG DATA AND DATABASE MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- To impart the concepts of normalization and indexing in RDBMS as why they were required.
- To understand how NoSQL data bases works and various ACID and Graph data base structures.
- To introduce SQL for query writing and database management.
- To convert query processing to function calls using SparkSQL API and understand their equivalence.
- To familiarize topic based streaming and multi-source data acquisition.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand RDBMS and basic entity relations, normalization and Functional Dependencies as well as time series and sequence data.

CO2: Select a data model that suits the characteristics of the data.

CO3: Differentiate between a traditional Database Management System and a Big Data Management System.

CO4: Recognize different data elements in everyday life problems.

CO-PO Mapping

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

Syllabus

Overview of Speech Processing Systems, Speech Production, Speech Perception, Speech Signal Characteristics, Properties of speech sounds. Short time processing of speech- Time Domain parameters, Frequency domain parameters, Spectrograms, Cepstral Analysis, MFCC, Linear Prediction Analysis - Speech Recognition- Basic speech models- GMM, HMM, Deep neural network models (DBN, TDNN, LSTM) used for speech modeling, Speech synthesis, End to-End Deep neural network Models (DeepSpeech, WaveNet).

Data Frames and Datasets revisited. NoSQL data bases and ACID concept. Data Frames and Datasets. Creating data frames from RDDs. Introduction to Spark SQL to query data frames. Streaming data and Spark Streaming Big Time series data representations- Traditional Database systems and Indexing issues: The NoSQL advantage, Index vs Computation. Dealing with timeseries data: Skewing techniques, creating overlapping and non-overlap windows using joins and group by, creating Henkel matrices from univariate time series. Streaming data and Stream API, Dealing with Topic data using Apache Kafka. Distributed Matrix operations – Row Matrix and its APIs.

Introduction to Apache Flink – Graph processing- Introduction to GraphX library. Graph problem examples, PageRank and other graph-based examples. Process methods on multivariate time series using map reduce. Interfacing Spark with sensor devices for data accusations (PMU, Arduino, Raspberry PI). Pushing data to DataFrames and NoSQL/ ACID databases (Cassandra/MongoDB), Some popular file formats for large data sets, Some real case study projects on large scale multi source data warehousing.

Lab Practice: Computational Exercises pertaining to Big Data & DBMS.

Text Books

Learning Spark: Lightning-Fast Big Data Analysis 1st Edition by Holden Karau, Andy Konwinski, Patrick Wendell, MateiZaharia

'Programming in Scala: A Comprehensive Step-by-Step Guide Third Edition by Martin Odersky, Lex Spoon, Bill Venners.

Reference Books

'High Performance Spark: Best Practices for Scaling and Optimizing Apache Spark 1st Edition, by Holden Karau, Rachel Warren.

'Scala for the Impatient 2nd Edition, by Cay S. Horstmann.

'Spark: The Definitive Guide: Big Data Processing Made Simple 1st Edition, Kindle Edition by Bill Chambers, MateiZaharia.

23RAI353	AI IN NATURAL LANGUAGE PROCESSING	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the leading trends and systems in Natural Language Processing.
- To understand the basic representations used in syntax, the semantics of Natural Language Processing.
- To explore the models used for word/sentence representations for various NLP applications.
- To understand how machine learning and deep learning algorithms are used for Natural Language Processing applications.
- To implement deep learning algorithms in Python and learn how to train deep networks for NLP applications

Course Outcomes

At the end of the course, the student will be able to:

CO1: Generate word representation to solve NLP problems.
CO2: Implement machine-learning models for NLP.
CO3: Implement sequence-to-sequence models for NLP.
CO4: Assess NLP models using various evaluation metrics.

CO-PO Mapping

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

Syllabus

Computational linguistics- Introduction, syntax, semantics, morphology, collocation and other NLP problems. Word representation: One-hot encoding, Bag-of-Words (BoW) Dictionary: Term Frequency – Inverse Document Frequency (TF-IDF), Embedding: Word2vec, Glove and Fasttext. Language Model-n-gram, Sequences and sequential data: Part-of-Speech tagging-HMM and CRF, Named Entity recognition, Dependency parsing.

Evaluation metrics for NLP models and Visualization Machine learning and deep learning for NLP, Sequence to sequence modelling (Encoder decoder), Attention mechanism, Transformer Networks – BERT.

A brief introduction to Reinforcement learning for NLP. NLP application introduction- Sentiment Analysis, Machine translation, Question answering, Text summarization.

Text Books / References Books

'Foundations of Statistical Natural Language Processing', Christopher Manning and Hinrich Schütze, MIT press, 1999
'Natural Language Processing with Python', Steven Bird, Ewan Klein and Edward Loper, O'Reilly Media, Inc.", 2009.
'Deep Learning for Natural Language Processing: Develop Deep Learning Models for your Natural Language Problems (Ebook)', Jason Browlee, Machine Learning Mastery, 2017.
'Speech & language processing', Daniel Jurafsky, James H Martin, preparation [cited 2020 June 1] Available from: https://web. stanford. edu/~ jurafsky/slp3 (2018).

23RAI354	AI IN SPEECH PROCESSING	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce acoustic theory behind the human speech production and speech perception systems.
- To equip the students to analyze and estimate the acoustic features from a speech signal.
- To provide the basics for the AI based algorithms used for speech modeling enable the students to develop various speech systems.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the acoustics of speech production and perception.
CO2: Differentiate the characteristics of different speech sounds.
CO3: Analyse the time-domain and frequency domain features of the speech signal.
CO4: Realize various algorithms on AI based speech modelling.

CO-PO Mapping

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

Syllabus

Overview of Speech Processing Systems, Speech Production, Speech Perception, Speech Signal Characteristics, Properties of speech sounds. Short time processing of speech- Time Domain parameters, Frequency domain parameters, Spectrograms, Cepstral Analysis, MFCC, Linear Prediction Analysis - Speech Recognition- Basic speech models- GMM, HMM, Deep neural network models (DBN, TDNN, LSTM) used for speech modeling, Speech synthesis, End to-End Deep neural network Models (DeepSpeech, WaveNet).

Text Books / Reference Books

'Fundamentals of Speech Recognition', L. Rabiner, Biing-Hwang Juang and B. Yegnanarayana, Pearson Education Inc.2009.
'Speech Communication', Douglas O'Shaughnessy, University Press, 2001.
'Discrete Time Speech Signal Processing', Thomas F Quatieri, Pearson Education Inc., 2004.
Hannun, Awni, et al. "Deep speech: Scaling up end-to-end speech recognition." arXiv preprint arXiv:1412.5567 (2014).
Collobert, Ronan, Christian Puhrsch, and Gabriel Synnaeve. "Wav2letter: an end-to-end convnet-based speech recognition system." arXiv preprint arXiv:1609.03193 (2016).

23RAI355 MACHINE LEARNING BASED CONDITION MONITORING L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize with the concept of condition-based maintenance for effective utilization of machines.
- To impart knowledge of artificial intelligence for machinery fault diagnosis.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Select the proper maintenance strategies and condition monitoring techniques for identification of failure in amachine.
CO2: Acquire and process sound and vibration signals in a dynamic mechanical system.
CO3: Predict the faulty component in a machine by analyzing the acquired vibration signals.
CO4: Build a classifier model for machine learning based fault diagnosis of rotating machines.

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

Syllabus

Unit 1

Basic Concepts: Machinery failures, basic maintenance strategies, factors influencing maintenance strategies, machine condition monitoring, transducer selection and location, PC interfacing and virtual instrumentation. Vibrationsignatures of faults in rotating machines; detection and diagnosis of faults.

Unit 2

Instrumentation and Signal Processing: Types of sensors in condition monitoring: vibration, sound, acoustic emission, temperature, ultrasonic and infrared sensors - Signal processing: basic signal and systems concepts, time domain analysis, frequency domain analysis, time-frequency analysis and wavelets.

Unit 3

Machine Learning: Feature extraction and feature selection methods, feature reduction using PCA - discriminate functions and decision boundaries, decision trees, maximum likelihood and nearest neighbor classification - Bayesiantheory, neural networks and support vector machines in classification

Application and case studies of condition monitoring: Bearings, gearboxes, centrifugal pumps, turbines and tool wear monitoring.

Text Books

Clarence W.de Silva "Vibration Monitoring, Testing and Instrumentation (Mechanical and Aerospace Engineering Series)", CRC Press, Taylor & Francis, 2007.
A. R. Mohanty, "Machinery Condition Monitoring: Principles and Practices", CRC Press, Taylor & Francis, 2015

Reference Books

Collacot, "Mechanical Fault Diagnosis and Condition Monitoring", Chapman- Hall, 1987. Davies, "Handbook of Condition Monitoring - Techniques and Methodology", Springer, 1998.
Cornelius Scheffer and PareshGirdhar, "Practical Machinery Vibration Analysis and Predictive Maintenance",Elsevier, 2004.
K.P.Soman, ShyamDiwakar and V.Ajay, "Data Mining: Theory and Practice" PHI Learning Pvt. Ltd., 2006.Duda, R.O., Peter, Hart, E., and Stork, D.E., "Pattern Classification", 2e, Wiley India, 2007.

23RAI356	DIGITAL TWINS	L-T-P-C: 2-0-3-3

Course Objectives

- To introduce digital twins concepts and their applications in industry.
- To familiarize with trends in discrete industry
- To be acquainted with digital twins in the process industry.
- To elaborate on the advantages and applications of digital twins.

Course Outcomes

CO1: Understand the concept of Digital Twins
CO2: Select suitable technologies/tools for enabling Digital Twins for industrial applications
CO3: Develop Digital Twins for discrete and process industries.
CO4: Analyze the performance of Digital Twins.
CO5: Realize the advantages and applications of Digital Twins.

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

Syllabus

UNIT 1

DIGITAL TWINS: Industrial Revolutions. Digital Twins: Definition, Types of Industry & its Requirements, Characteristics of Digital Twins, Importance, benefits, Impact, and Challenges. Conceptual design methodology of digital twins, Five-dimensional digital twins for the product, Application of Digital Twins in process, product, service industries, History of Digital Twins, Digital Transformation role in industry innovation, Technologies/tools enabling Digital Twins.

UNIT 2

DESIGN OF DIGITAL TWINS: Design of Digital Twins: Technological needs. Physics-based approach: Model identification, Model creation. Data-driven approach: Model development using ML/DL models. Digital twins for Prototype, Product, and Performance. Digital Twins validation.

UNIT 3

DIGITAL TWINS IN THE DISCRETE INDUSTRY: Discrete Industry: Trends in the Discrete Industry, control system requirements in a Discrete Industry, Digital Twins of a Product, Digital Thread in Discrete Industry, Data Collection & Analysis for Product & production improvements, Automation Simulation, and Digital Enterprise.

UNIT 4

DIGITAL TWINS IN THE PROCESS INDUSTRY: Process Industry: Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twins of a plant, Digital Thread in process Industry, Data collection & Analysis for process improvements, process safety, Automation simulation, and Digital Enterprise.

UNIT 5

APPLICATIONS OF DIGITAL TWINS: Improvement in product quality, production process, process Safety, identifying bottlenecks and Improve efficiency, achieve flexibility in production, continuous prediction, and tuning of the production process through Simulation, reducing the time to market.

List of Experiments

1. Exercise on Model development using MATLAB Simulink, Simscape
2. Exercise on Model identification using MATLAB – System Identification
3. Model development using Simscape
4. Fault Diagnosis of rotating elements using Digital Twins
5. Parameter tuning of Digital Twins
6. Digital Twins modeling of the Drilling system
7. Validation and performance optimization of the Digital Twins model of the Drilling system

8. Digital Twins for fan speed control system
9. Develop Predictive Models using Digital Twins
10. Estimate the remaining useful life using Digital Twins

Textbooks:

Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017.

Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019

Shyam Varan Nath, Pieter van Schalkwyk, Dan Isaacs, "Building Industrial Digital Twins Design, Develop, and Deploy Digital Twin Solutions for Real-world Industries Using Azure Digital Twins", Packt Publishing, 2021

Reference Books:

Enis Karaarslan, Moharram Challenger, Ömer Aydin, Ümit Cali, "Digital Twin Driven Intelligent Systems and Emerging Metaverse", Springer Nature Singapore, 2023

Christoph Jan Bartodziej, "The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler., Germany, 2017.

23RAI357	CLOUD COMPUTING	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the basic principles of cloud computing, cloud native application development anddeployment, containerization principles, micro-services and application scaling.
- To equip the students to understand major industry players in the public cloud domain for applicationdevelopment and deployment.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the basic principles of cloud computing.

CO2: Apply cloud native application development for containerization and container orchestration.

CO3: Analyze different types of cloud services – Delivery models, Deployment models.

CO4: Implement different solution approaches in Cloud – containers in public cloud, setting up private cloud andconvert monolithic applications to containers.

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

Syllabus

Unit 1

Distributed Computing Taxonomy – Cluster, Grid, P2P, Utility, Cloud, Edge, Fog computing paradigms; Introductionto Cloud Computing – Cloud delivery models (XaaS), Cloud deployment models (Private, Public, Hybrid); Characteristics of Cloud, Major use cases of Cloud; disadvantages and best practices; Major public cloud players in the market; Security Issues and Challenges; Cloud Native application development – Introduction to JavaScript Cloud native application development.

Unit 2

Public Cloud – Using public cloud for infrastructure management (compute and storage services), Web application deployment using public cloud services, and Deploying container images in public cloud, Overview of cognitive services, Case study on architecting cloud-based solutions for a chosen scenario.

Unit 3

Virtualization – Basics, Cloud vs Virtualization, Types of virtualization, Hypervisor types; Containers – Introductionto dockers and containers, containerization vs virtualization, docker architecture, Use cases, Learn how to build container images, Operations on container images; Kubernetes – Need for orchestration, container orchestration methods, Introduction to Kubernetes, Kubernetes architecture, using YAML file, Running Kubernetes via minikub.

Text Books

Rajkumar Buyya et.al. Mastering cloud computing, McGraw Hill Education; 2013.

Matthias K, Kane SP. Docker: Up & Running: Shipping Reliable Containers in Production. "O'Reilly Media, Inc.";2018.

Reference Books

Kocher PS. Microservices and Containers. Addison-Wesley Professional; 2018.

Sarkar A, Shah A. Learning AWS: Design, build, and deploy responsive applications using AWS Cloud components.Packt Publishing Ltd; 2018.

Menga J. Docker on Amazon Web Services: Build, deploy, and manage your container applications at scale. Packt Publishing Ltd; 2018.

Bentley W. OpenStack Administration with Ansible 2. Packt Publishing Ltd; 2016.

23RAI358	MOBILE APPLICATION DEVELOPMENT	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce basics of application development in smart phone operating systems such as Android.
- To learn techniques for Android application development.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the mobile application development platform and programming
CO2: Develop Android programs for mobile applications
CO3: Develop mobile applications with cloud services
CO4: Analyse various services of mobile applications development and its usage

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to mobile application development platforms, Application development - Layouts, Views, Resources, Activities, Intents, Background tasks, Connecting to the Internet, Fragments, Preferences.

Unit 2

User Interaction – input, menu items, custom views, User Experience – themes and styles, lists and adapters, material design, adaptive layouts, accessibility, localization, debugging the UI Storing Data, SQLite database, Sharing Data, content resolvers and providers, loaders to load data.

Unit 3

Services, background work, alarms, broadcast receivers, Notification, widgets, location-based services and Google maps. Transferring data efficiently, publishing app, Multiple form factors, sensors, Google cloud messaging, monetizingmobile app.

Text / Reference Books

Tejinder Randhawa, "Mobile Applications Design, Development and Optimization" Springer International Publishing,2021.
Phillips, Stewart, Hardy and Marsicano "Android Programming (Big Nerd Ranch Guide)", Fourth Edition, Big NerdRanch Guides, 2019.
Hellman, "Android Programming – Pushing the limits", First Edition, Wiley, 2013.
Joseph Annuzzi Jr., Lauren Darcey, and Shane Conder, "Advanced Android Application Development",Fourth Edition, Addison-Wesley Professional, 2014.

23RAI359	VIRTUAL AND AUGMENTED REALITY	L-T-P-C: 3-0-0-3

Course Objectives

To facilitate the complete understanding of VR and AR.
To familiarize the motion tracking in real and virtual cases with suitable devices and components.
To enable students to analyze the applications of VR and AR in different domains.

Course Outcomes

At the end of the course, the student will be able to:
CO1: Understand the basics of VR and AR.
CO2: Determine the motions in real and virtual cases with suitable orientation methods.
CO3: Comprehend the suitable components and devices required for AR.
CO4: Apply AR and VR technology in health care and manufacturing system

CO-PO Mapping

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

Syllabus

Introduction - History of VR and AR- Difference between VR and AR – Commercial VR – Motion tracking- human behind the lenses – Motion in real and virtual – Vestibular system – Tracking 2D and 3D orientation – Tracking position- Tracking attached bodies – Audio interaction with virtual – Ambisonics- HRTF – Augmented Reality – AR components and devices - Displays for AR – Audio, Haptic and Visual displays – Tracking with sensors –Computer vision for AR- AR & VR applications in health care- Robotics- Manufacturing. Introduction to GHOST (General Haptics Open Software Toolkit).

Text Books

Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002

Reference Book

Smith, Craig. The car hacker's handbook: a guide for the penetration tester. No Starch Press, 2016.

23RAI360	CYBER SECURITY	L-T-P-C: 2-0-3-3

Course Objectives

The course is to give students an extensive overview of cyber security issues, tools and techniques that are critical in solving problems in cyber security domains. The course aims at providing students with concepts of computer security, cryptography, digital money, secure protocols, detection and other security techniques. The course will help students to gauge understanding in essential techniques in protecting Information Systems, IT infrastructure, analyzing and monitoring potential threats and attacks, devising security architecture, and implementing security solutions. The students will also have a wider perspective to information security from national security perspective from both technology and legal perspective.

Course Outcomes

At the end of the course, the student will be able to:

CO1: *Design* and implement appropriate security technologies and policies to protect computers and digital information.

CO2: Identify & Evaluate Information Security threats and vulnerabilities in Information Systems and apply security measures to real time scenarios

CO3: Identify common trade-offs and compromises that are made in the design and development process of Information Systems

CO4: Demonstrate the use of standards and cyber laws to enhance information security in the development process and infrastructure protection

CO-PO Mapping

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

Cyber Security Concepts: Essential Terminologies: CIA, Risks, Breaches, Threats, Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning). Open Source/ Free/ Trial Tools: nmap, zenmap, Port Scanners, Network scanners. [2 Hrs]

Cryptography and Cryptanalysis: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management, VPN Security, Security Protocols: - security at the Application Layer- PGP and S/MIME, Security at Transport Layer- SSL and TLS, Security at Network Layer-IPSec. Open Source/ Free/ Trial Tools: Implementation of Cryptographic techniques, OpenSSL, Hash Values Calculations MD5, SHA1, SHA256, SHA 512, Steganography (Stools) [4 Hrs]

Infrastructure and Network Security: Introduction to System Security, Server Security, OS Security, Physical Security, Introduction to Networks, Network packet Sniffing, Network Design Simulation. DOS/ DDOS attacks. Asset Management and Audits, Vulnerabilities and Attacks. Intrusion detection and Prevention Techniques, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation. Open Source/ Free/ Trial Tools: DOS Attacks, DDOS attacks, Wireshark, Cain & abel, iptables/ Windows Firewall, snort, suricata, fail2ban [6 Hrs]

Cyber Security Vulnerabilities& Safe Guards: Internet Security, Cloud Computing &Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, IT Audit, Authentication. Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities assessment. [8 hrs] Open Source/ Free/ Trial Tools: WinAudit, Zap proxy (OWASP), burp suite, DVWA kit.

Malware: Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis. Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System tuning tools, Anti Phishing. [8 Hrs]

Security in Evolving Technology: Biometrics, Mobile Computing and Hardening on android and ios, IOT Security, Web server configuration and Security. Introduction, Basic security for HTTP Applications and Services, Basic Security for Web

Services like SOAP, REST etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges. Open Source/ Free/ Trial Tools: adb for android, xcode for ios, Implementation of REST/ SOAP web services and Security implementations. [8 Hrs]

Cyber Laws and Forensics: Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013. Introduction to Cyber Forensics, Need of Cyber Forensics, Cyber Evidence, Documentation and Management of Crime Sense, Image Capturing and its importance, Partial Volume Image, Web Attack Investigations, Denial of Service Investigations, Internet Crime Investigations, Internet Forensics, Steps for Investigating Internet Crime, Email Crime Investigations. Open Source/ Free/ Trial Tools: Case Studies related to Cyber Law, Common Forensic Tools like dd, md5sum, sha1sum, Ram dump analysis, USB device [9 Hrs]

LIST OF PRACTICALS

1. Implementation to gather information from any PC's connected to the LAN using whois, port scanners, network scanning, Angry IP scanners etc.
2. Implementation of Symmetric and Asymmetric cryptography.
3. Implementation of Steganography.
4. Implementation of MITM- attack using wireshark/ network sniffers
5. Implementation of Windows security using firewall and other tools
6. Implementation to identify web vulnerabilities, using OWASP project
7. Implementation of IT Audit, malware analysis and Vulnerability assessment and generate the report.
8. Implementation of OS hardening and RAM dump analysis to collect the Artifacts and other information's.
9. Implementation of Mobile Audit and generate the report of the existing Artiacts.
10. Implementation of Cyber Forensics tools for Disk Imaging, Data acquisition, Data extraction and Data Analysis and recovery.

LIST OF SUGGESTED BOOKS

William Stallings, "Cryptography and Network Security", Pearson Education/PHI, 2006.
V.K. Jain, "Cryptography and Network Security", Khanna Publishing House.
Gupta Sarika, "Information and Cyber Security", Khanna Publishing House, Delhi.
Atul Kahate, "Cryptography and Network Security", McGraw Hill.
V.K. Pachghare, "Cryptography and Information Security", PHI Learning
Nina Godbole, "Information System Security", Wiley
Bothra Harsh, "Hacking", Khanna Publishing House, Delhi.

BASKET 4: ADVANCED SENSORS AND COMMUNICATION SYSTEMS

23RAI371	SMART SENSORS	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the available physical phenomena behind the operation of different types of sensors and micro systems.
- To design sensors with appropriate electronic interface as a complete system.
- To inculcate the applications of sensors in robotics and automation.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the available physical phenomena behind the operation of different types of sensors and micro systems.
CO2: Design the sensors with appropriate electronic interface as a complete system.
CO3: Analyze and apply sensors in robotics and automation.
CO4: Design and fabricate the process of MEMS fabrication.

CO-PO Mapping

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

Syllabus

Unit I

Sensor Characteristics and Physical Principles of Sensing - Example of Smart Sensors in nature (Vision –Hearing –touch - and smell) - Classification and Terminology of sensors – Measurands - Physical principles of sensing - electric charges – fields - and potentials Capacitance - magnetism - Induction – resistance - Piezoelectric effect - pyroelectric effect - Hall effect - Seebeck and Peltier effects.

Unit 2

Acoustic Sensors - Magnetic Sensors and Mechanical Sensors - Acoustic waves, piezoelectric materials - Acoustic sensing, -saw sensor - Sensor applications and future trends - Magnetic sensors - effects and materials -Integrated Hall sensors – Magneto-transistors - other magnetics transistor and future trends, Mechanical sensors - piezoresistivity - Piezoresistive sensors - Capacitive sensors.

Radiation Sensors Thermal Sensors and Chemical Sensors - Radiation basics - HgCdTe infrared sensors - Visible-light color sensors - high-energy photodiodes - Heat transfer - thermal structures – Thermal sensing elements - Thermal and temperature sensors - Interaction of gaseous species at semiconductor Surfaces - Catalysis - the acceleration of chemical reactions - Thin-film sensors - FET devices for gas and ion sensing.

Unit 3

Micro-and Nanotechnologies or Sensors - Fundamentals of MEMS fabrication - introduction and description of basic processes - MEMS fabrication technologies - bulk micromachining - Surface micromachining - High-aspect-ratio (LIGA and LIGA-Like) technology microfluidics microsystem components.

Microfluidics microsystem components Nanotechnology - product prospects - application trends Procedures and techniques - the making of ultrathin films Creation of lateral nanostructures - clusters and Nano crystalline materials and principles of self-organization and Future trends.

Text Books

Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Springer; 4th ed. 2010.
S. M. Sze, "Semiconductor Sensors", Wiley-Interscience, 1994.

Reference Books

Gerard Meijer, "Smart sensor systems", Wiley, 2008.
W Gopel, J. Hesse, J. N. Zemel, "Sensors A Comprehensive Survey", Vol. 9, Wiley-VCH, 1995.

23RAI372	E NOSE FOR ROBOTS	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the importance of electronic noses for robots through its anatomy.
- To discuss about different chemo sensors and their signaling conditions.
- To illustrate the pattern analysis for olfaction in electronic noses.
- To enable students to analyze different case studies of electronic nose applications in environment modeling.

Course Outcomes

At the end of the course the student will be able to:

CO1: Understand the basics of electronic noses for robotics olfaction.
CO2: Demonstrate the working principles of different chemo sensors and their signaling conditions.
CO3: Analyze the patterns of electronic noses to predict the odors in robots.
CO4: Apply electronic nose in environment modeling for robotic 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							1	1		1
CO2	3	2	2		1							1	1		1
CO3	3	2	2		1							1	1		1
CO4	3	2	2	3	1							1	1		1

Syllabus

Unit 1

Introduction- Olfaction, anatomy, Physiology, and Molecular biology- Chemical sensing in humans and machines- Chemosensory perception and detection – Linear salvation model – Static and Dynamic olfactomatery – Environmental chambers- Charm analysis – AEDA – Osme.

Unit 2

Introduction to Chemosensors –chemoresistors – MOS – Organic CP- Chemo capacitors- Potentiometric odor sensors – MOSFET- Gravimetric odor sensors – QCM – SAW – optical odor sensors – SPR – Fluroscent odor sensors- calorimetric and amperiometric sensors. Signal conditioning in chemoresistors and capacitors, voltage dividers- wheatstone bridge - AC impedance spectroscopy - Acoustic wave sensors – buffering- amplification- filtering and compensation- local and global methods for normalization – Noise in sensor circuits.

Unit 3

Pattern analysis for electronic noses – Statistical pattern – LCM, LDA, PCA & CA- Intelligent pattern analysis – multilayer feed forward networks – competitive and feature mapping networks – Fuzzy based pattern analysis – Neuro fuzzy systems – Intelligent sensor systems. Applications and case studies in Environment modeling.

Text Books / References

Handbook of Machine Olfaction, Electronic Nose Technology Wiley, 2006
Andrew R Russell , Odour Detection By Mobile Robots, World Scientific Publishing Company, 1999
A.S. Barwich, Smellosophy, What the Nose Tells the Mind, Harvard University Press, 2020.
Electronic Noses and Tongues in Food Science, Elsevier Science, 2016

23RAI373	HUMAN COMPUTER INTERACTION	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the basic of human computer interaction (HCI).
- To impart the basic concepts of models and theories of HCI.
- To enable the students to acquire knowledge to develop the HCI for solving real world problems.

Course Outcomes

At the end of the course the student will be able to:
CO1: Understand the basics of concepts of HCI process.
CO2: Realize the importance of HCI models and theories.
CO3: Analyse the different concepts in existing HCI systems.
CO4: Design and develop HCI using user interface systems.

CO-PO Mapping

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

Syllabus

Introduction of HCI- HCI Guidelines- HCI Design Process- Human Factors of HCI Design - Models and Theories- Users Interface Layers, HCI concepts of: Cognitive models- Brain-Computer Interaction- Human Behaviors Analysis- Motion Based learning- Object Based Modeling- Human-Robot Interactions- Interactive System developments- HCI Tools and Visualization- Camera and Sensors- Case studies of HCI Applications.

Text Books

Dix, Alan, et al. "Human-computer interaction." Harlow ua, 2000.
Kim, Gerard Jounghyun. Human-computer interaction: fundamentals and practice. CRC press, 2015.
Shneiderman, Ben, et al. Designing the user interface: strategies for effective human-computer interaction. Pearson, 2016.
Johnson, Jeff. Designing with the mind in mind: simple guide to understanding user interface design guidelines. Morgan Kaufmann, 2020.

Reference Books

Tan, Desney S., and Anton Nijholt, eds. Brain-computer interfaces. Springer-Verlag London Limited, 2010.
Magnenat-Thalmann, Nadia, et al., eds. Context aware human-robot and human-agent interaction. Springer International Publishing, 2016.
Jacko, Julie A., ed. Human computer interaction handbook: Fundamentals, evolving technologies, and emerging applications. CRC press, 2012.

23RAI374	UAV NETWORKS	L-T-P-C: 3-0-0-3

Pre-requisite: Machine-to-Machine Communications (Knowledge Level)

Course Objectives

- To illustrate the UAV types and their missions for swarm communication.
- To familiarize the basics of data link communication for UAV.
- To explore the network platforms for UAV based systems.
- To enable students to analyze the security issues and challenges in UAV Networks.

Course Outcomes

At the end of the course the student will be able to:

CO1: Understand the types of UAV and their missions for swarm communication.
CO2: Design data link communication for different interfacing of UAV.
CO3: Analyze the types of network platforms for UAV based systems.
CO4: Apply security and privacy issues in UAV Networks.

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

Syllabus

Unit 1

Introduction – UAV Types and Missions – Swarming and Miniaturization- Air to Ground and Air to air data link communication – Air to ground communication for manned aviation – Practical and UAV and MUAV links – Terrestrial wideband solutions.

Unit 2

Aerial Wifi Networks – Characteristics- Communication demands –requirements – Airborne Networks and protocols – Aeronautical protocol architecture – UAV platform systems and UAV Networked systems.

Unit 3

UAV detection and identification – Cellular connected UAVs – Safety security and privacy in UAV.

Text Books / References

Jae H. Kim , UAV Networks and Communications, Cambridge University Press, 2018.
UAV Communications for 5G and Beyond, Wiley, 2020.
Unmanned Aerial Vehicles for Internet of Things (IoT) Concepts, Techniques, and Applications, Wiley, 2021.
Hailong Huang, Andrey V. Savkin, Chao Huang, Wireless Communication Networks Supported by Autonomous UAVs and Mobile Ground Robots, Elsevier Science, 2022.

23RAI375	INTRODUCTION OF CYBER VEHICLE SYSTEM	L-T-P-C: 3-0-0-3

Course Objectives

- To impart the basic understanding of cyber vehicle system.
- To familiarize the issues of cyber-attacks in vehicle networks using different portal.
- To enable students to acquire knowledge to diagnose the cyber vehicle system from different threats.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the basic terminologies of cyber vehicle systems.
CO2: Identify the cyber vehicle attacks with different constraints.
CO3: Apply the security mechanisms for cyber vehicle attacks.

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

Syllabus

Introduction of Automotive Cyber Vehicle System- Cyber-attack of Vehicle-Vehicular Ransomware Attack-Intelligent Autonomous Vehicle Security and Privacy in Intelligent Autonomous Vehicles- In-Vehicle Communication and Cyber Security- AUTOSAR Embedded security vehicles-Inter Vehicles Communication and Cyber Security- IOT of Vehicles-VCN and Cyber security-Automotive Cyber security- Car sharing and Cybers attacks-Case studies of Car hackers.

Text Books

Kim, Shiho, and Rakesh Shrestha. Automotive Cyber Security. Springer, 2020.
Möller, Dietmar PF, and Roland E. Haas. Guide to automotive connectivity and cybersecurity. Springer International Publishing, 2019.

Reference Book

Smith, Craig. The car hacker's handbook: a guide for the penetration tester. No Starch Press, 2016.

23RAI376	V2X CONNECTED CARS	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the evolution of intelligent transport systems.
- To familiarize with communication technologies and business models for connected vehicles.
- To inculcate the beam forming and signal design strategies for connected vehicles.
- To enable the students to analyze the security issues and challenges in connected vehicles.
- To explore the regulations of connected vehicles.

Course Outcomes

At the end of the course, the students will be able to:

CO1: Understand the evolution of intelligent transport systems for automated driving.
CO2: Apply the communication technologies and business models for connected vehicles.
CO3: Analyze the beam forming and signal design strategies for connected vehicles.
CO4: Identify the security issues and challenges in connected vehicles.
CO5: Familiarize with the regulations of connected vehicles.

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

Syllabus

Introduction- Intelligent transport system- Connected and automatic driving- Communication technologies for V2x- Business models – standards and regulations for V2x -3GPP- IEE and SAE- 5GPP – EATA- V2x in 5G.

Spectrum and Channel modeling – V2x Radio Interface – Beam forming for V2x in mm wave- Beam formed multicasting- Broadcasting- Network slicing – Radio and Video based positioning – Signal design –Measurement.

Localization, mapping and tracking – multi camera calibration- Vehicle tracking and localization with video – Security and Privacy – Security Challenges- Isolation challenges – V2V/ V2I security.

Future prospects of V2x – Network sharing alternatives – Vehicle processing platforms supported by networks – Automotive standardization – Regulators –Deployment, coverage and road infrastructure –Spectrum aspects.

Text Books / References

Cellular V2X for Connected Automated Driving, Wiley, 2021

Connected Vehicles in the Internet of Things Concepts, Technologies and Frameworks for the IoV, Springer International Publishing, 2020

Self-Driving Vehicles and Enabling Technologies, IntechOpen, 2021

Networking Vehicles to Everything Evolving Automotive Solutions, Markus Mueck, IngolfKarls, De Gruyter, Incorporated, 2018.

Introduction to Self-Driving Vehicle Technology, Hanky Sjafrie, CRC Press, 2019

23RAI377	INTRODUCTION TO COMPUTER NETWORKS	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the telecommunication and computer network technologies.
- To illustrate the communication process through OSI layer architecture and its functionalities.

Course Outcomes

At the end of the course the student will be able to:

CO1: Understand the elements of networks and their entities.
CO2: Identify the error and its correction mechanisms for different medium.
CO3: Implement the routing protocols and identify the shortest path in network communication.
CO4: Understand the principles of connectionless and connection-oriented protocols.
CO5: Apply the socket programming concepts for end user 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							1	1		1
CO2	3	2	2		1							1	1		1
CO3	3	2	2		1							1	1		1
CO4	3	2	2		1							1	1		1
CO5	3	2	2		1							1	1		1

Syllabus

Introduction to Computer Networking Concepts: Layered Network Protocol Architectures; Personal, Local, Metropolitan and Wide Area Networks; Telecommunications and Cellular Networks overview.
Physical Layer: Basics of communications; Physical media types and their important bandwidth and bit-error-rate characteristics; Wired and Wireless media including copper cables, optical fiber and wireless.

Data Link Layer and Logical Link Control (LLC) sub-layer: Framing; Error control including Bit-parity, CRC and Hamming Codes; Reliable transmission and Automatic Repeat Request (ARQ) protocols including Stop-and-Wait, Go-back-N, Selective Repeat. Performance analysis of ARQ protocols. Example protocols such as HDLC and PPP. Medium Access Control (MAC) sub-layer: Shared media systems; Bus, Star and Ring topologies; TDMA, FDMA, CSMA, CSMA/CD, Ethernet and IEEE 802.3; IEEE 802.11 including CSMA/CA protocols; Performance analysis; Shared and Switched Ethernet; Related protocols such as ICMP, NAT, ARP and RARP.

Network Layer: Internet Protocol (IP) suite; Hierarchical network architectures; IPv4 and IPv6 addressing and headers; Routing protocols including distance-vector and link-state approaches; Interior and Exterior Gateway Protocol concepts; Routing Algorithms including Dijkstra's algorithm and distributed Bellman-Ford algorithm; Example protocols: OSPF, RIP, BGP.
Transport Layer: Reliable end-to-end transmission protocols; UDP header; Details of TCP header and operation including options headers and congestion control; TCP variants such as Reno, Tahoe, Vegas, Compound and CUBIC**.**
Application Layer: Socket Interface and Socket programming; Example protocols such as DNS, SMTP, FTP, and HTTP.

Text Books

Kurose and Ross, "Computer Networking - A top-down approach", Seventh Edition, Pearson, 2017.
Andrew S. Tanenbaum, "Computer Networks", Fifth Edition, Pearson Education India, 2013.
Peterson and Davie, "Computer Networks, A Systems Approach", 5th ed., Elsevier, 2011.
Berhouz A Forouzan, "Data Communication and Networking ", 3rd Edition, Tata McGraw Hill, 2004.
Ying-Dar Liu, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw-Hill, 2011.
W. Richard Stevens, Bill Fenner and Andrew Rudoff, "Unix Network Programming", Volumes 1 and 2, Third Edition, Addison-Wesley Professional, 2003.

BASKET 5: ADVANCED MANUFACTURING TECHNOLOGIES

23MEE356	ADVANCED MANUFACTURING PROCESSES	L-T-P-C: 3-0-0-3

Course Objectives

- To impart the fundamental concepts in powder metallurgy.
- To familiarize various nontraditional machining processes and advanced inspection systems.
- To introduce the advanced machining and finishing processes like CNC, mico and nanomachining processes, abrasive finishing processes etc.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the concepts of powder metallurgy and its manufacturing process

CO2: Apply the knowledge on various energy based non-traditional machining processes and suggest a suitableprocess based on the situations.

CO3: Develop programming skills to generate CNC program

CO4: Identify and estimate measurement errors and suggest suitable techniques to minimize them.

CO5: Select a specific Material addition, Micro and Nano and super finish process.

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

Syllabus

Powder metallurgy: Stages in powder metallurgy -production of metal powders - characteristics of metal powders- Mixing of metallic powders -compaction - Mechanism of sintering - applications. Impregnation and Infiltration Advantages, disadvantages and specific applications of P/M.

Non-conventional machining processes: Comparison between traditional and non-traditional machining process. Abrasive Jet Machining, Electrical Discharge Machining, Electrochemical Machining, Ultrasonic Machining, Laser Beam Machining, Electron Beam machining. Introduction to Rapid Prototyping & Rapid Tooling, Green manufacturing.

CNC machines: Overview, types, construction, tool and work holding devices, feedback devices, part programming - examples. Data exchange between CAD/CAM - Concepts of native and neutral file formats for data exchange, Interfacing with manufacturing systems. Computer aided process planning

Computer Aided Inspection: High precision measurements – interfacing - software metrology - Automated visual inspection in manufacturing, contact and non - contact type inspection methods, Electrical field techniques, radiation techniques, ultrasonic - Atomic Force Microscopes (AFM), Talysurf instruments. Coordinate Measuring Machine: CMM Types, Applications - Non-contact CMM using Electro optical sensors for dimensional metrology - Non-contactsensors for surface finish measurements – Measurements / programming with CNC CMM – Performance evaluations –Measurement integration. Machine Vision: Image Acquisition and Processing - Binary and gray level images, image segmentation and labelling, representation and interpretation of colours.

Advanced finishing processes: Abrasive Flow Machining, Magnetic Abrasive Finishing. Magnetorheological AbrasiveFlow Finishing, Magnetic Float Polishing, Elastic Emission Machining.

Material addition process: Rapid prototyping, stereo-lithography, selective laser sintering, 3D Printing, fused deposition modelling, laminated object manufacturing, laser engineered net-shaping, laser welding, LIGA process.

Micro & Nano machining process: Diamond turn mechanism, material removal mechanism, applications. Concepts of reverse engineering.

References

Serope Kalpakjian and Steven Schmid, Manufacturing Engineering and Technology, 8th Edition, Pearson, 2020.
Ibrahim Zeid and R Sivasubramanian, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
Benedict. G.F. Nontraditional Manufacturing Processes, Marcel Dekker Inc., New York,1987.
Jagadeesha T, Non-Traditional Machining Processes, I K International Publishing House 2016.
V. K. Jain, Introduction to Micromachining, Second Edition, Narosa Publishing House 2019.

23MEE320	ADVANCED METROLOGY AND SENSING SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- To impart knowledge on the fundamentals of high precision measurements, laser metrology and Coordinate Measuring Machine (CMM).
- To facilitate an understanding on functioning and applications of machine vision system for quality control.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the various methods of high precision measurements and Ultrasonic techniques.

CO2: Apply the methods of laser interferometry, Atomic Force techniques to measure surface topography andinterpret the results.

CO3: Apply suitable programming commands to measure the critical features of a component usingCMM.

CO4: Select suitable Machine Vision system for image acquisition, processing and interpret the results for on-linequality 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							1	1	2	
CO2	3	1			2							1	1	2	
CO3	3	1	2	2	2							1	1	2	
CO4	3	1	2	2	2							1	1	2	

Syllabus

Unit 1

Computer Aided Inspection: High precision measurements – interfacing - software metrology - Automated visual inspection in manufacturing, contact and non-contact type inspection methods, Electrical field techniques, radiation techniques, ultrasonic - Atomic Force Microscopes (AFM), Talysurf instruments. Laser Metrology: Laser Interferometer, Alignment Telescope, laser scanners. On-line and in-process measurements - diameter, surface roughness, Micro holes, surface topography measurements, straightness and flatness measurement, speckle measurements

Unit 2

Coordinate Measuring Machine: CMM Types, Applications - Non-contact CMM using Electro optical sensors for dimensional metrology - Non-contact sensors for surface finish measurements – Measurements / programming withCNC CMM – Performance evaluations – Measurement integration. Machine Vision: Image Acquisition andProcessing - Binary and gray level images, image segmentation and labelling, representation and interpretation of colours.

Unit 3

Edge detection techniques, Normalization, Grey scale correlation – Reflectance map concepts; surface roughness and texture characterization - photogrammetry. Application of Machine Vision in inspection - Measurement of length, diameters, and Surface roughness - automated visual inspection - 3D and dynamic feature extraction. On-line Quality control: On-line feedback quality control variable characteristics - control with measurement interval, one unit, and multiple units control systems for lot and batch production.

Text Books

Bechwith-Marangoni-Lienhard, "Mechanical Measurements", Pearson Education Asia, Sixth Edition, 2009.
Marshall A. D. and Martin R. R. - 'Computer Vision, Models and Inspection' - World Scientific – 1998.

Reference Books

NelloZuech - 'Understanding and Applying Machine Vision' - Marcel Dekker - 2000 - 2nd Edition.
John A. Bosch, Giddings, and Lewis Dayton - 'Coordinate Measuring Machines and Systems' - Marcel Dekker –1999.
ASTE - 'Handbook on Industrial Metrology' - Prentice Hall – 1992.

23MEE326	SMART MANUFACTURING	L-T-P-C: 3-0-0-3

Course Objectives

- To provide the concept of smart manufacturing systems.
- To familiarize various methods by which the smart manufacturing implemented.
- To provide case studies on implementation of Smart manufacturing in various industries.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the concept of smart manufacturing.
CO2: Inculcate the various elements of Smart Manufacturing and its role in the system.
CO3: Apply different model driven approach for sustainable and smart manufacturing.
CO4: Evaluate the trends and issues in implementing smart manufacturing through case studies.

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

Syllabus

Unit 1

Introduction to Smart Manufacturing, Smart Sensors and Smart Tooling, Smart machines and intelligent machining, digital and smart factories, implementing smart manufacturing across an industrial organization, cyberinfrastructure for the democratization of smart manufacturing, the role of hardware and software in smart manufacturing Infrastructure changes, Reinvigorating the manufacturing workforce, benefits of smart manufacturing to value chain.

Unit 2

Measuring, managing, and transforming data for operational insights, the role of advanced process modelling in smart manufacturing, Industrial AI and predictive analytics for smart manufacturing systems, A systems engineering-driven decomposition approach for large-scale industrial decision-making processes, Model-predictive safety: A new evolution in functional safety, Inferential modelling and soft sensors, A decision support framework for sustainable and smart manufacturing.

Unit 3

Case studies: Smart Manufacturing in the Food Industry, Advancing Smart Manufacturing in the Pharmaceutical Industry, Smart Reservoir Management in the Oil and Gas Industry Smart Manufacturing in the Paints and Coatings Industry, Smart Manufacturing in Additive Manufacturing, Smart Manufacturing in Industrial Gas Production: A Digital Transformation, Smart Manufacturing: Machine Learning-Based Economic MPC and Preventive Maintenance.

Text Books / Reference Books

Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing -Concept and Methods, Elsevier Publications Ist Edition, August 4, 2020.
Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing: Applications and Case Studies, Elsevier Publications, 1st Edition, August 4, 2020.
Jim Davis, Denise Swink, Julie Tran, white paper, CMTC's Guide to Smart Manufacturing, 2015.

23MEE328	MICRO AND NANO ELECTROMECHANICAL SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the concepts of micro and nano electromechanical devices.
- To familiarize the fabrication process of Microsystem.
- To provide information on various nanofabrication techniques currently in practices.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Interpret the basics of micro/nano electromechanical systems including their applications and advantages**.**

CO2: Identify and describe micro fabrication technique based on the materials and applications.

CO3: Apply the knowledge of micro/nano sensors and actuators in development of MEMS/NEMS**.**

CO4: Identify appropriate nano fabrication process based on various principles like various etching, lithography, template and other advanced 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	
CO2	3	2										1		2	
CO3	3	2	1									1		2	
CO4	3	2	1									1		2	

Syllabus

Unit 1

Introduction, overview and applications of Micro Electro Mechanical Systems (MEMS) and Nano Electro Mechanical Systems (NEMS). Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals. Mechanical components in MEMS. Design concepts of mechanical components. Working Principles of Microsystems. Engineering Science for Microsystems design and Fabrication. Scaling laws – Scaling in geometry, rigid body dynamics.

Unit 2

Fabrication technologies – Photolithography – Ion implantation – diffusion – oxidation – CVD – Physical Vapor Deposition – Etching. Micro manufacturing – Bulk and surface micro machining – LIGA. Applications of Microsensors and Microactuators for MEMS, Microsystems Design – Design considerations – Process design – Mechanical Design – CAD – Micro system packaging – Levels – Bonding – Interfaces – Assembly.

Unit 3

Nano Electro Mechanical Systems (NEMS) Introduction- Nano machining of NEMS based lithography techniques, Nano electromechanical systems fabrication, nano imprint lithography, polymeric nano fibre templates, focused ion beam doping and wet chemical etching, stencil lithography and sacrificial etching.

Scanning-probe techniques, Scanning-probe techniques, Self-assembly for NEMS, nanometrology and applications of nano sensors for NEMS- ZnO nanorods based NEMS device: Gas sensor, future challenges.

Text Books / Reference Books

Tai–Ran Hsu,'Mems & Microsystems Design and Manufacturing', John Wiley & Sons, 2008, 2nd Edition.

Sergey Edward Lyshevski, MEMS and NEMS: Systems, Devices, and Structures‖ CRC Press, 2002.

S.A. Campbell: The Science and Engineering of Microelectronic, Fabrication, Oxford Univ. Press, New York 2001.

Marc J Madou, 'Fundamentals of Microfabrication', CRC Press, 2002, 2nd Edition.

Mohamed Gad-el-Hak – 'The MEMS Handbook', CRC Press, 2002.

Muameer Koç "Micro Manufacturing: Design and Manufacturing of Micro-Products", John Wiley & Sons.

Karl Goser, Peter Glosekotter, Jan Dienstuhl, Nanoelectronics and Nanosystems, From Transistors to Molecular and Quantum Devices, Springer, 2004.

Kourosh Kalantar-zadeh, Benjamin Fry, Nanotechnology, Enabled Sensors, springer, 2008.

23MEE329	INTELLIGENT MANUFACTURING SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- To provide fundamental concepts on intelligent manufacturing system (IMS) to achieve flexible, smart, and reconfigurable manufacturing processes.
- To familiarize various supporting technologies required to implement IMS.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the various concepts of intelligent manufacturing systems (IMS).
CO2: Integrate various elements of manufacturing for developing IMS.
CO3: Select suitable supporting technologies to enable IMS implementation.
CO4: Identify the real time issues in implementations of IMS with suitable case studies.

CO-PO Mapping

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

Syllabus

Introduction to Manufacturing systems, various subsystems in manufacturing systems, procurement, design, manufacturing, inspections, assembly, prototyping, material handling, storage systems, concept of Intelligent manufacturing: Internet of Things enabled manufacturing, cloud manufacturing. Characteristics of Intelligent manufacturing systems: Intelligent decision-making, Application of Artificial Intelligence and Machine learning in developing intelligent manufacturing systems.

Component of Intelligent Manufacturing Technologies, Development of Intelligent systems for Design, Process planning, Controls, Scheduling, Quality Management, Maintenance and Diagnostics.
Supporting technologies for IMS: Industry Internet of Things, Cyber Physical Systems, Cloud computing, RFID Technologies, Data Analytics, other Information and Communications Technology.

Framework for intelligent manufacturing: Smart design, Smart machines, Smart control, Smart scheduling, Human-Machine collaboration, collaborative robots and other enabling technologies such as AR and VR, Data-driven intelligent manufacturing models, Autonomous intelligent manufacturing units.

Applications and case studies in intelligent manufacturing systems implementation, limitation of technologies and other real time issues in implementations of IMS.

Text Books / Reference Books

Andrew Kusiak, Intelligent Manufacturing Systems, Prentice Hall international series- industrial & systems engineering, 1990.
Intelligent Manufacturing in the Context of Industry 4.0: A Review, Engineering, Elsevier Publications, Volume 3, Issue 5, October 2017, Pages 616-630.
Peigen Li, Special Issue: Intelligent Manufacturing, Engineering, Elsevier Publications, 3, 2017, 575.
Yubao Chen, Integrated and Intelligent Manufacturing: Perspectives and Enablers, Engineering, Engineering 3, 2017, Pages 588–595.
Hamid R. Parsaei and Mohammad, Jamshidi, Design and Implementation of Intelligent Manufacturing Systems: From Expert Systems, Neural Networks, to Fuzzy Logic, Prentice Hall Series Publication, 1995.
Jongwon Kim, Manufacturing Systems 1997 - IFAC Proceedings Volumes, Elsevier publications, 1997.

23MEE357	ADVANCED MATERIALS AND PROCESSES	L-T-P-C: 3-0-0-3

Pre-requisite: Materials Science and Engineering (Knowledge Level)

Course Objectives

- To introduce composites and advanced materials and their applications.
- To familiarize manufacturing, characterization of composite and aerospace alloys.
- To provide knowledge about behaviour and applications of smart and nano-materials.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Interpret the properties and structure of composite and advanced material.
CO2: Identify the appropriate fabrication technique for a composite and aerospace alloys.
CO3: Analyze the different behaviour of materials for aerospace applications.
CO4: Characterize the properties and applications of smart and nano-materials.

CO-PO Mapping

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

Syllabus

Unit 1

Composite Materials: Types of metal matrices and reinforcements and their properties, bonding mechanisms, structure-property relationships, preforms, design of composites. Physical and Mechanical properties. Characterization of microstructures and macrostructures. Fabrication techniques - metal infiltration, pressure and vacuum casting methods. Case studies.

Unit 2

Aerospace Alloys: High strength Aluminium and Magnesium alloys, Nickel and Cobalt based Superalloys, Titanium alloys, their structures, structure-property relationships, heat treatment. Directional solidification and single crystal turbine blades. Case studies.

Unit 3

Smart Materials: Concept of shape memory, crystal structure, phase transformation mechanism and characteristics, properties, classification, applications. Nanomaterials: properties, classification, characterization, materials behaviour, fabrication and applications.

Text Books

Clyne T. W. and Withers P. J. - 'An Introduction to Metal Matrix Composites' - Cambridge University Press – 2003. Duerig T. W, Melton K. N., Stöckel D. and Wayman C. M. - 'Engineering Aspects of Shape Memory Alloys' Butterworth Heinemann – 1990.

Reference Books

'Handbook of Nanostructured Materials and Nanotechnology' - Academic Press – 2000.
Wang Z. I., Liu Y. and Zhang Z. - 'Handbook of Nanophase and Nanostructured Materials: Vol 1. Synthesis' - Kluwer Academic/Plenum Publishers – 2002.
Sinha A. K. - 'Physical Metallurgy Handbook' - McGraw Hill – 2002.

23MEE325 SIMULATION MODELING OF MANUFACTURING SYSTEMS L-T-P-C: 3-0-0-3

Course Objectives

- To impart knowledge in the field of modern methods for simulation and modelling of production systems for industrial needs.
- To focus on technological processes and manufacturing systems and applies the principles of discrete simulation for their modeling using software tool.
- To familiarize with discrete event simulation for modelling & simulation of manufacturing systems.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the basic concepts and applications of discrete event simulation
CO2: Analyze the simulation input data
CO3: Verify and validate simulation models using statistical techniques
CO4: Analyze and interpret the simulation output results
CO5: Build credible simulation models 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		2	2							1		2	
CO2	1	1	1	1	2							1		2	
CO3	1	1	1	3	2							1		2	
CO4	1	1	1	3	2							1		2	
CO5	1	1	1	3	2							1		2	

Syllabus

Unit 1

Introduction: Introduction to manufacturing systems – Introduction to simulation – applications – System and System Environment – Types of Simulation - Simulation procedure – Examples of simulation. Probability distributions: Review of basic probability and statistics – Probability distributions – Random number generators – Testing of Random numbers.

Unit 2

Analysis of Simulation input data: Data Collection – Statistical analysis of numerical data – Tests for Independence and Identically distributed data - Distribution fitting – selecting a distribution in the absence of data – Modelling discrete probabilities – Demonstration of input modelling using Arena Simulation package. Model Building of Discrete systems: Modelling Paradigms - Modelling of Structural elements and Operational elements – Modelling issues – Model Verification and Validation.

Unit 3

Applications of Simulation in Manufacturing – Manufacturing Modelling Techniques – Modelling Material Handling system – Model building exercises using Arena - Case study. Simulation output analysis: Design of Simulation Experiments: Determination of warm up period, Run length, Number of replications - Statistical analysis of simulation output – Terminating and Non-Terminating Simulations – Comparing alternative system designs – Variance reduction Techniques – Simulation Optimization.

Text Books

Law A. W. and Kelton D. W. - 'Simulation Modeling and Analysis' - McGraw Hill - 2010 - 5th Edition.
Kelton D. W., Sadowski R. P. and Sasowski D. A. - 'Simulation with ARENA' - McGraw Hill – 2009.

Reference Books

Banks J., Carson J. S., Nelson B. L. and Nicol D. M. - 'Discrete Event System Simulation' - Pearson Education - 2001 - 3rd Edition.
Viswanathan N. and Narahari Y. - 'Performance Modeling of Automated Manufacturing Systems' - Prentice Hall 1998.

23MEE327	SUSTAINABLE MANUFACTURING	L-T-P-C: 3-0-0-3

Course Objectives

- To familiarize the concept of sustainability manufacturing with tools and techniques.
- To inculcate knowledge on performing life cycle analysis.

Course Outcomes

At the end of the course, the student will be able to:

CO1: Understand the concepts of sustainable manufacturing.
CO2: Identify the tools and techniques of sustainable manufacturing.
CO3: Conduct life cycle assessment and environmental impacts of manufacturing processes.
CO4: Perform sustainability analysis using software packages.

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

Syllabus

Unit 1

Concept of sustainability, manufacturing operations, resources in manufacturing. Concept of triple bottom line, environmental, economic and social dimensions of sustainability. Relation between green, lean and sustainable manufacturing.

Unit 2

Environmental conscious- quality function deployment-R3 and R6 cycles-Environmental impact assessment methods CML, EI 95 and 99, ISO 14001, EMS and PAS 2050 standards, environmental impact parameters. Sustainability assessment-concept models and various approaches, product sustainability and risk assessment-corporate social responsibility.

Unit 3

Life cycle analysis-Remanufacture and disposal, tools for LCA, optimization for achieving sustainability in manufacturing, value analysis, analysis for carbon footprint-software packages for sustainability analysis.

Text Books

Atkinson G, Dietz S, Neumayer E, "Handbook of sustainable manufacturing" Edward Elgar Publishing limited, 2007.
Rodick, D, "Industrial Development for the 21 st century: Sustainable development perspectives" UN New York, 2007.

Reference Books

Lawn.P, "Sustainable development indicators in ecological economics", Edward Elgar Publishing limited, 2006.
Asefa, "The economics of sustainable development", WE Upjohn institute for employment research, 2005.
Dornfeld, David (Ed), "Green manufacturing: fundamentals and applications", Springer Science & Business Media, 2012.
Klemes J, "Sustainability in the process industry", McGraw Hill, 2011.

23MEE330	FUNCTIONAL AND CONCEPTUAL DESIGN	L-T-P-C: 3-0-0-3

Course Objectives:

- Learn the importance of systematic design process in product design
- Identify various steps involved in the design process
- Learn the importance of "function" and "form" in the design process
- Apply the systematic design process for product development

Course Outcomes

At the end of the course, the student will be able to:

CO1: Demonstrate the diverse methods employed in design process
CO2: Establish a workable design-thinking framework to solve critical problems
CO3: Analyze and map the user to whom the design solution is being offered
CO4: Interact with user to identify the customer needs
CO5: Effectively communicate with high emotional and intellectual impact
CO6: Implement projects in interdisciplinary domain

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	1	1					1	1	1	1	1
CO2	2	2	2	2	1	1			2		1	1	1	1	1
CO3	2	2	2	2	1	1			2		1	1	1	1	1
CO4	2	2	2	2	1	1			2		1	1	1	1	1
CO5	3	2	3	2	1	1	1	1	2	3	2	1	1	1	1
CO6	3	2	3	3	1	1	2	1	2		2	1	1	1	1

Syllabus

Overview of the Design Process – Philosophy of Traditional Design, Stages in product development, Reverse Engineering Project mission statement, Stakeholder identification, Customer need identification process, Need analysis, Critical needs, Need metric matrix, Target Specifications.
Functional Design – Functional decomposition, Functional diagram, Product architecture, Identification of product modules, Product Concept – Various methods of concept generation, Concept selection, TRIZ.

Text Books

Kevin Otto & Krisitn Wood, Product Design, Pearson Education
D.G. Ullman, The Mechanical Design Process, McGraw- Hill, 2015
G. Pahl and W.Beitz, Engineering Design- A systematic Approach, Springer, 2007.
Ulrich & Eppinger, Product Design and Development, 3rd Edition, McGraw Hill, 2004

Courses offered under the framework of
Amrita Values Programmes I and II

22AVP201 Message from Amma's Life for the Modern World
Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

22ADM211 Leadership from the Ramayana
Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

22ADM201 Strategic Lessons from the Mahabharata
Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

22AVP204 Lessons from the Upanishads
Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, SatyakamaJabala, Aruni, Shvetaketu.

22AVP205 Message of the Bhagavad Gita
Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

22AVP206 Life and Message of Swami Vivekananda
Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

22AVP207 Life and Teachings of Spiritual Masters India
Sri Rama, Sri Krishna, Sri Buddha, AdiShankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri RamanaMaharshi, Mata Amritanandamayi Devi.

22AVP208 Insights into Indian Arts and Literature
The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

22AVP209 Yoga and Meditation
The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

22AVP210 Kerala Mural Art and Painting
Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

22AVP213 Traditional Fine Arts of India
India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

22AVP214 Principles of Worship in India
Indian mode of worship is unique among the world civilizations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realization of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

22AVP215 Temple Mural Arts in Kerala
The traditional percussion ensembles in the Temples of Kerala have enthralled millions over the years. The splendor of our temples makes art enthusiast spellbound, warmth and grandeur of color combination sumptuousness of the outline, crowding of space by divine or heroic figures often with in vigorous movement are the characteristics of murals.
The mural painting specially area visual counterpart of myth, legend, gods, dirties, and demons of the theatrical world, Identical myths are popular the birth of Rama, the story of Bhīma and Hanuman, Shiva, as Kirata, and the Jealousy of Uma and ganga the mural painting in Kerala appear to be closely related to, and influenced by this theatrical activity the art historians on temple planes, wood carving and painting the architectural plane of the Kerala temples are built largely on the pan-Indians almost universal model of the Vasthupurusha.

22AVP218 Insights into Indian Classical Music
The course introduces the students into the various terminologies used in Indian musicology and their explanations, like Nadam, Sruti, Svaram – svara nomenclature, Stayi, Graha, Nyasa, Amsa, Thala,- Saptatalas and their angas, Shadangas, Vadi, Samavadi, Anuvadi. The course takes the students through Carnatic as well as Hindustani classical styles.

22AVP219 Insights into Traditional Indian Painting
The course introduces traditional Indian paintings in the light of ancient Indian wisdom in the fields of aesthetics, the Shadanga (Sixs limbs of Indian paintings) and the contextual stories from ancient texts from where the paintings originated. The course introduces the painting styles such as Madhubani, Kerala Mural, Pahari, Cheriyal, Rajput, Tanjore etc.

22AVP220 Insights into Indian Classical Dance
The course takes the students through the ancient Indian text on aesthetics the Natyasastra and its commentary the AbhinavaBharati. The course introduces various styles of Indian classical dance such as Bharatanatyan, Mohiniyatton, Kuchipudi, Odissy, Katak etc. The course takes the students through both contextual theory as well as practice time.

22AVP221 Indian Martial Arts and Self Defense
The course introduces the students to the ancient Indian system of self-defense and the combat through various martial art forms and focuses more on traditional Kerala's traditional KalariPayattu. The course introduces the various exercise technique to make the body supple and flexible before going into the steps and techniques of the martial art. The advanced level of this course introduces the technique of weaponry

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY

23CHY240	COMPUTATIONAL CHEMISTRY AND MOLECULAR MODELLING	L-T-P-C: 3-0-0-3

Course Outcomes:
CO1: Get to understand the structure of molecules using symmetry.
CO2: Understanding Quantum mechanical approach to calculate the energy of a system.
CO3: Applying mathematical knowledge and quantum mechanical approach in finding out the characteristics-reactivity, stability, etc., of the molecule.
CO4: To get a brief idea about molecular mechanics based chemical calculations.
CO5: To get an idea about general methodology of molecular modeling.

Syllabus
Unit 1
Introduction: Stability, symmetry, homogeneity and quantization as the requirements of natural changes - Born – Haber cycle – Energetic – kinetics - Principles of spectra.
Computational techniques: Introduction to molecular descriptors, computational chemistry problems involvingiterative methods, matrix algebra, Curve fitting.
Molecular mechanics: Basic theory - Harmonic oscillator – Parameterization - Energy equations - Principle ofcoupling - Matrix formalism for two masses - Hessian matrix - enthalpy of formation - enthalpy of reactions.
Introduction to Quantum mechanics - Schrodinger equation - Position and momentumMO formation - Operators and the Hamiltonian operator - The quantum oscillator Oscillator Eigen value problems - Quantum numbers - labeling of atomic electrons.

Unit 2
Molecular Symmetry: Elements of symmetry - Point groups - Determination of point groups of molecules.
Huckel's MO theory: Approximate and exact solution of Schrodinger equation - Expectation value of energy - Huckel's theory and the LCAO approximation - Homogeneous simultaneous equations - Secular matrix - Jacobi method - Eigen vectors: Matrix as operator - Huckel's coefficient matrix - Wheeland's method - Hoffmann's EHTmethod - 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 to molecular simulation - M.D. simulation.

TEXTBOOKS:
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.
Donald W Rogers, "Computational Chemistry Using PC", Wiley, (2003).
Alan Hinchliffe, "Chemical Modeling from atoms to liquids", Wiley, (2005).

REFERENCES:
James B Forseman and Aeleen Frisch-Gaussian, "Exploring Chemistry with Electronic Structure Method", Inc., Pittsburgh, PA, 2nd edition, (2006).
A C Philips, "Introduction to Quantum mechanics", Wiley, (2003).
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

Syllabus

Unit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicatorand ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler- Volmer equation -Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafelplots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air, zinc-silver oxide batteries; lithium primary cells - liquid cathode, solid cathode and polymer electrolyte types and lithium-ferrous sulphide cells (comparative account).
Secondary batteries: ARM (alkaline rechargeable manganese) cells, Lead acid and VRLA (valve regulated (sealed)lead acid), nickel-cadmium, nickel-zinc, nickel- metal hydride batteries, lithium ion batteries, ultra thin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Reserve batteries and Fuel cells: Reserve batteries - water activated, electrolyte activated and thermally activated batteries - remote activation - pyrotechnic materials. Fuel Cells: Principle, chemistry and functioning - carbon, hydrogen- oxygen, proton exchange membrane (PEM), direct methanol(DMFC), molten carbonate electrolyte (MCFC) fuel cells and outline of biochemical fuel cells.
Electrochemical Processes: Principle, process description, operating conditions, process sequence and applications of Electroforming – production of waveguide and plated through hole (PTH) printed circuit boards by electrodeposition; Electroless plating of nickel, copper and gold; Electropolishing of metals; Anodizing of aluminium; Electrochemical machining of metals and alloys.

TEXTBOOKS:

Derek Pletcher and Frank C. Walsh, "Industrial Electrochemistry", Blackie Academic and Professional, (1993).
Dell, Ronald M Rand, David A J, "Understanding Batteries", Royal Society of Chemistry, (2001).

REFERENCES:

Christopher M A, Brett, "Electrochemistry – Principles, Methods and Applications", Oxford University, (2004).
Watanabe T, "Nano-plating: microstructure control theory of plated film and data base of plated film microstructure", Elsevier, Oxford, UK (2004).
Kanani N, "Electroplating and electroless plating of copper and its alloy", ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).
Lindon David, "Handbook of Batteries", McGraw Hill, (2002).
Curtis, "Electroforming", London, (2004).
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

Syllabus

Unit 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:

Fuels and Combustion, Samir Sarkar, Orient Longman Pvt. Ltd, 3rd edition, 2009.

REFERENCES:

Fuels - Solids, liquids and gases - Their analysis and valuation, H. Joshua Philips, Biobliolife Publisher,2008.
An introduction to combustion: Concept and applications - Stephen R Turns, Tata Mc. Graw Hill, 3rd edition,2012.
Fundamentals of Combustion, D P Mishra, 1st edition, University Press, 2010
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:

- Understand the principles of green chemistry and its contribution to the development of sustainable products
- Possess knowledge of the migration from a hydrocarbon-based economy to carbohydrate-based economy
- Evaluate the deficiencies of traditional process and acknowledge the invent of new processes
- 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:

Hand Book of Green Chemistry and Technology; by James Clarke and Duncan Macquarrie; Blakwell Publishing.
Anastas, P. T., Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press Inc., New York, 1998.
Matlack, A. S. Introduction to Green Chemistry Marcel Dekker: New York, NY, 2001.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY244	INSTRUMENTAL METHODS OF ANALYSIS	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: To develop an understanding of principle and working of the range of instrumental methods in analyticalchemistry

CO2: To provide an understanding and skills in contemporary methods of separation and appropriate selection of instruments for the successful analysis of chemical compounds

CO3: To impart skills in the scientific method of planning, conducting, reviewing, reporting experiments andproblem solving in chemical analysis.

Syllabus

Unit 1

Error Analysis and Sampling: Accuracy - Precision - Classification of Errors -Minimization of errors – Standard deviation - Coefficient of variance - F-test - t-test - Significant figures. Sampling - Basis of sampling, Sampling andphysical state - Safety measures of sampling.

Separation Techniques: Brief out line of column, paper and thin layer chromatography - Ion exchange methods - principle and application – HPLC.

Unit 2

Gas chromatography - principle and applications – gel chromatography.

Electroanalytical techniques: Potentiometry - Potentiometric titration - determination of equivalence point - acidbase, complexometric, redox and precipitation titrations - merits and demerits. Voltammetry - Cyclic voltammetry - basic principle and application - Polarography - introduction - theoretical principles - migration current - residual current - half wave potential - instrumentation - analytical applications.

Unit 3

Spectro-chemical techniques: UV-VIS spetrophotometry - principle - Beer's Law application - photometric titration - single and double beam spectrophotometer - instrumentation of IR - sample handling - IR applications - H - NMR - Instrumentation and applications – principle - instrumentation - applications of atomic absorption spectroscopy.

Thermal and Diffraction techniques: Principles and applications of DTG - DTA DSC - X-ray - Electron DiffractionStudies - SEM, TEM.

TEXTBOOKS:

Willard H W, Merritt J R, "Instrumental Methods of Analysis", 6th edition, Prentice Hall, (1986).

Skoog Douglas A, West Donald, "Fundamentals of Analytical Chemistry", 7th edition, New York Addison,Wesley, (2001).

REFERENCES:

"Vogel's Textbook of Quantitative Chemical Analysis", 5th edition, ELBS, (1989).

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.

Syllabus

Unit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicatorand ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler- Volmer equation -Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafelplots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air batteries; Lithium primary cells - liquid cathode, solid cathode and lithium-ferrous sulphide cells (comparative account).
Secondary batteries: Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultrathin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Fuel Cells: Description, working principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspects of the following types of fuel cells:Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells. Membranes for fuel cells: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments. Fuels for Fuel Cells: Hydrogen, methane, methanol - Sources and preparation, reformation processes for hydrogen –clean up and storage of the fuels – use in cells, advantages and disadvantages of using hydrogen as fuel.

TEXTBOOKS:

Dell, Ronald M Rand, David A J, 'Understanding Batteries', Royal Society of Chemistry, (2001).
M. Aulice Scibioh and B. Viswanathan 'Fuel Cells – principles and applications', University Press, India(2006).

REFERENCES:

Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).
Curtis, 'Electroforming', London, (2004).
F. Barbir, 'PEM fuel cells: theory and practice', Elsevier, Burlington, MA, (2005).
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

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

Fontana and Mars G, "Corrosion Engineering", 3rd edition, McGraw Hill, (1987).
Uhlig H H and Reviees R W, "Corrosion and its Control", Wiley, (1985).

REFERENCES:

ASM Metals Handbook, "Surface Engineering", Vol. 5, ASM Metals Park, Ohio, USA, (1994).
ASM Metals Handbook, "Corrosion", Vol. 13, ASM Metals Park, Ohio, USA, (1994).
Brain Ralph, "Material Science and Technology", CRC Series, Boston, New York.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

PHYSICS

23PHY240	ADVANCED CLASSICAL DYNAMICS	L-T-P-C: 3-0-0-3

Course Outcomes:
CO1: Able to use the Lagrangian formalism to solve simple dynamical system
CO2: Able to understand Hamiltonian formalism and apply this in solving dynamical systems
CO3: Able to apply Lagrangian formalism in bound and scattered states with specific reference to Kepler's lawsand Scattering states
CO4: Able to solve problems in the Centre of Mass frame and connect it to Laboratory Frame of Reference**CO5:** Understand and solve problems in rigid body rotations applying of Euler's equations.

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

Syllabus
Unit 1
Introduction to Lagrangian dynamics.
Survey of principles, mechanics of particles, mechanics of system of particles, constraints, D'Alembert's principle and Lagrange's equation, simple applications of the Lagrangian formulation, variational principles and Lagrange's equations, Hamilton's principles, derivation of Lagrange's equations from Hamilton's principle, conservation theorems and symmetry properties.

Unit 2
Central field problem.
Two body central force problem, reduction to the equivalent one body problem, Kepler problem, inverse square lawof force, motion in time in Kepler's problem, scattering in central force field, transformation of the scattering to laboratory system, Rutherford scattering, the three body problem. Rotational kinematics and dynamics; Kinematics of rigid body motion, orthogonal transformation, Euler's theorem on the motion of a rigid body.

Unit 3
Angular momentum and kinetic energy of motion about a point, Euler equations of motion, force free motion of rigid body. Practical rigid body problems; Heavy symmetrical spinning top, satellite dynamics, torque-free motion, stability of torque-free motion - dual-spin spacecraft, satellite maneouvering and attitude control - coning maneuver - Yo-yo despin mechanism - gyroscopicattitude control, gravity- gradient stabilization.

TEXTBOOKS:
H. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, 1980, (Second Edition)
H. Goldstein, Charles Poole, John Safko, Classical Mechanics, Pearson education, 2002 (Third Edition)
Howard D. Curtis, Orbital Mechanics for Engineering Students, Elsevier, pp.475 - 543
Anderson John D, Modern Compressible flow, McGraw Hill.

REFERENCE BOOKS:
D. A. Walls, Lagrangian Mechanics, Schaum Series, McGraw Hill, 1967.
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

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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, collision time, 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 inmatter, 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:
A J Decker, "Electrical Engineering materials", PHI, New Delhi, 1957.

REFERENCES:
A J Decker, "Solid State Physics", Prentice Hall, Englewood Cliffs, N J 1957.
C Kittel, "Introduction to solid state Physics", Wieley, New York, 1956 (2nd edition).
Allison, Electronic Engineering materials and Devices, Tata Mc Graw Hill
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

Syllabus

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:

William T Silfvast, "Laser Fundamentals", Cambridge University Press, UK (2003).
B B Laud, "Lasers and Non linear Optics", New Age International (P) Ltd., New Delhi.
Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India (Distributors).
K R Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.
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

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

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:

Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, Nanoscale Science and Technology, John Wileyand Sons Ltd 2004.

W. R. Fahrner (Ed.), Nanotechnology and Nanoelectronics, Springer 2006.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY244	PHYSICS OF SEMICONDUCTOR DEVICES	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: Understand, comprehend and acquaint with the basics working principles and governing equations ofelectronic devices like diodes, Bipolar junction transistors, Mosfet and heterojunction transistors

CO2: Analyze and Solve physics problems pertaining to various process like charge conduction acrosssemiconductor device.

CO3: Apply the knowledge for the development and design of new methods to determine semiconductorparameters and devices

Syllabus

Unit 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:

C Kittel, "Introduction to Solid State Physics", Wiley, 7th Edn. 1995.
D A Neamen, "Semiconductor Physics and Devices", TMH, 3rd Edn. 2007.

REFERENCES:

S M Sze, "Physics of Semiconductor Devices", Wiley, 1996.
P Bhattacharya, "Semiconductor Opto- Electronic Devices", Prentice Hall, 1996.
M K Achuthan & K N Bhat, "Fundamentals of Semiconductor Devices", TMH, 2007.
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:
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:

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

Syllabus

Unit 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 - planklength and time, different cosmic models - inflationary, steady state. Variation of G. anthropic principle.

REFERENCES:

"Textbook of Astronomy and Astrophysics with elements of Cosmology", V. B. Bhatia, Narosa publishing2001.
William Marshall Smart, Robin Michael Green "On Spherical Astronomy", (Editor) Carroll, Bradley WCambridge University Press ,1977
Bradley W. Carroll and Dale A. Ostlie. "Introduction to modern Astrophysics" Addison-Wesley, 1996.
Bradley W. Carroll and Dale A. Ostlie, "An Introduction to Modern Astrophysics" Addison-Wesley Publishing Company,1996
'Stellar Astronomy' by K. D Abhayankar.
'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:

Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, ElsevierAcademic Press.

REFERENCES:

Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons Inc., 2005

Ravichandran, J. Probability and Statistics for engineers, First Reprint Edition, Wiley India, 2012.

Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics forEngineers and Scientists, 8th Edition, Pearson Education Asia, 2007.

Hogg, R.V., Tanis, E.A. and Rao J.M., Probability and Statistical Inference, Seventh Ed, PearsonEducation, 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:
Martin Osborne, An Introduction to Game Theory, Oxford University Press.

REFERENCES:
Thomas Ferguson, Game Theory, World Scientific, 2018.
Stef Tijs. Introduction to Game Theory, Hindustan Book Agency.
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:
Edwin K.P. Chong, Stanislaw H. Zak, "An introduction to Optimization", 2nd edition, Wiley, 2013.
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:
Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples,Prentice Hall, 2002.
S.S. Rao, "Optimization Theory and Applications", Second Edition, New AgeInternational (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 STREAM
COMMON 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

PO/PSO CO	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			

Syllabus

Unit 1

Introduction: Financial Management an overview – Financial Decisions in a firm – Goal of FM – Function of the financial system.

Unit 2

Fundamental Valuation Concepts:Time value of money – Risk and Return. Capital Budgeting: Techniques of capital budgeting investment criteria– NPV – Benefit Cost Ratio – IRR – Payback Period – ARR – Investment appraisal inPractice – Estimation of Project cost flows.

Unit 3

Working Capital Management: Current Assets – Financing Ruling – Profit Criterion. Cash and Liquidity Management. Working Capital Financing.

Financial Analysis and Planning**:** financial instruments, sources of long-term, intermediate term and short term finance. Analyzing Financial Performance – Break – even analysis and Leverages – Financial Planning and Budgeting.
Mergers and Takeovers-International trade.

TEXT BOOKS

Chandra, P., 'Financial Management: Theory and Practice', 9e, TMH, 2017.
Denzil Watson & Antony Head, 'Corporate Finance- Principles and Practice', 2e, Pearson Education Asia,2016.
R L Varshney& K L. Maheshwari, 'Managerial Economics', S Chand & Sons, 22e, 2014.

REFERENCE BOOKS

Stephen Blyth, 'An Introduction to Corporate Finance', McGraw Hill Book Company, 2014.
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

PO/PSO / CO	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		

Syllabus

Unit 1

Introduction: Introduction to SCM-the complexity and key issues in SCM – Location strategy – facility locationdecisions – single facility and multiple location models. Logistics: Logistics Network Configuration – data collection-model and data validation- solution techniques-network configuration DSS – Transport strategy – Service choices: single service and inter modal services – vehicle routingand scheduling models – traveling salesman problems – exact and heuristic methods.

Unit 2

Inventory: Inventory Management and risk pooling-managing inventory in the SC. Value of Information-bullwhipeffect-lead time reduction.

Supply Chain Integration: Supply chain integration-distributed strategies-push versus pull systems. Distribution Requirements Planning – DRP and demand forecasting, DRP and master production scheduling. DRP techniques –time-phased order point – managing variations in DRP – safety stock determination-Strategic alliances-third partylogistics-distribution integration.

Unit 3

Issues in SCM**:** Procurement and outsourcing strategies – framework of e-procurement. International issues in SCM-regional differences in logistics. Coordinated product and supply chain design-customer value and SCM.

TEXT BOOK

Simchi-Levi,D.,Kaminsky,P.,Simchi-Levi,E., Shankar,R., 'Designing and Managing the Supply Chain: Concepts, Strategies, and Cases', Tata McGraw Hill, 2008.

REFERENCE BOOKS

Christopher, M., 'Logistics and Supply Chain Management: Strtegies for reducing Cost and ImprovingService', PH, 1999.

Ballou, M., 'Business logistics / Supply chain management', Pearson Education, 2003.

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

CO1: Illustrate key marketing concepts, theories and techniques for analysing a variety of marketing situations
CO2: Identify and demonstrate the dynamic nature of the environment in which marketing decisions are taken and appreciate the implication for marketing strategy determination and implementation
CO3: Develop the ability to carry out a research project that explores marketing planning and strategies for aspecific marketing situation
CO4: Understand the need and importance of sales promotions and make use of advertising
CO5: Manage a new product development process from concept to commercialization.
CO6: Illustrate the importance of modern trends in retailing and marketing logistics

CO/PO Mapping

PO/PSO / CO	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 purchase-unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing.

TEXT BOOKS

Kolter, P.,'Marketing Management', Pearson Education 2001.
Ramasamy and Namakumari, 'Marketing Environment: Planning, implementation and control the Indiancontext', 1990.

REFERENCE BOOKS

Paul, G.E. and Tull, D., 'Research for marketing decisions', Prentice Hall of India, 1975.
Tull, D.S. and Hawkins, 'Marketing Research', Prentice Hall of Inida-1997.
Kotler, P. and Armstrong, G., 'Principles of Marketing' Prentice Hall of India, 2000.
Skinner, S.J., 'Marketing', All India Publishers and Distributes Ltd. 1998.
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

PO/PSO CO	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

Syllabus

Unit 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 crashing Resource 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

Jack R. Meredith and Samuel J. Mantel, Jr. - 'Project Management- A Managerial Approach' EighthEdition - John Wiley & Sons Inc - 2012.

Arun Kanda – 'Project Management-A Life Cycle Approach' PHI Learning Private Limited - 2011

REFERENCE BOOKS

'A Guide to Project Management Body of Knowledge' PMBOK GUIDE, Sixth edition, Project management Institute – 2017

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

PO/PSO CO	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 implementationissues. Introduction to Six Sigma. Plant Location – globalization, factors affecting location decisions, facility location- Break-even method, rectilinear, factor-rating and centre of gravity – problems. Plant Layout – types, process layout,product layout, Systematic layout planning (SLP), Line Balancing problems. Capacity Planning – Aggregate Planning - importance, planning process, methods – problems.

Unit 3

Role of IT in business performance improvement – e-commerce – e-purchasing –Master Production Schedule, inventory lot sizing strategies, MRP basics – MRP explosion, Available to Promise(ATP) inventory – MRP calculations – MRP II – Scheduling – Gantt chart – Introduction to ERP – ERP software – ERP modules – ERP implementation.

TEXT BOOKS

L J Krajewski, L.P.RitzmanMalhotra.M and Samir K. Srivastava, 'Operations Management: Processes andValue chains, 11e, Pearson, 2015.
R L Varshney& K L. Maheshwari, 'Managerial Economics', S Chand & Sons, 22e, 2014.

REFERENCE BOOKS

Richard B. Chase, Ravi Shankar, F. Robert Jacobs, 'Operations and Supply Chain Management' McGrawHill Education (India) Private Limited.14e, 2017.
E S Buffa and R K Sariss, 'Modern Production/Operations Management', Wiley India Private Limited, 8e,2007.
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

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

Syllabus

Unit1

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

Taha,H.A., 'Operations Research: an Introduction', 8e, Prentice HalI, New Delhi, 2008.
Ravindran, A., Phillips, D.J., and Solberg, J.J., 'Operations Research- Principles and Practice', John Wiley& Sons, 2005.
Wagner, H.M., 'Principles of Operations Research', Prentice Hall, New Delhi, 1998.
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
- To Impart skills to design, develop, implement, and improve manufacturing/service systems

Course Outcomes

CO1: Create value to organizations through the analysis, evaluation, and improvement of work systems using work study and method study

CO2: Develop work systems through motion economy principles

CO3: Apply work measurement techniques to improve productivity, fix wages and incentives

CO4: Apply systematic layout planning techniques and work station design principles based on ergonomics andmaterial handling.

CO/PO Mapping

PO/PSO CO	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		

Syllabus

Unit 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 andincentives, 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

Barnes, R, "Motion and Time Study" - Design and Measurement of Work . NY: John Wiley and Sons, 8thEdition, 1985.
"Introduction to Work Study", 4ed, International Labor Office, Geneva, 2006.

REFERENCE BOOKS

Martand T. Telsang, 'Industrial Engineering and Production Management' S Chand; 2nd Rev Edn 2006.
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

23MEE322	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 quantitative data 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

PO/PSO / CO	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 irregularvariation. Decision theory**:** Decision tree analysis

TEXT BOOKS

Levin R. I. and Rubin D. S. - 'Statistics for management' - Pearson Education – 2007 - 5th Edition
Montgomery D. C. and Runger G. C. - 'Applied Statistics and Probability for Engineers' - John Wiley &Sons - 2002 - 3rd Edition

REFERENCE BOOKS

Bain.L. J. and Engelhardt M. - 'Introduction to Probability and Mathematical Statistics' - Duxbury Press -March 2000 - 2nd Edition
Hinkelmann K. and Kempthorne O. - 'Design and Analysis of Experiments : Volume I' - John Wiley & Sons,Inc. - December 2007 - 2nd Edition
Johnson R.A. and Wichern D.W. –'Applied Multivariate Statistical Analysis'-Prentice-Hall,Inc.-Dec 2001-5th Edition
Myers R. H. - 'Classical and Modern Regression with Applications' - PWS-Kent Publishing Company -March 2000 - 2nd Edition
Devore.J.L.- 'Probability and Statistics for Engineering and the Sciences' - Brooks/Cole PublishingCompany - December 1999 - 5th Edition
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 life applications

Course Outcomes

CO1: Evaluate the principles of quality management and to explain how these principles can be applied withinquality management systems.
CO2: Evaluate the performance measures using various quality and management tools
CO3: Apply the Quality Function Deployment, Taguchi principles, Total Productive Maintenance and FailureMode and Effect Analysis concepts to solve industrial problems.
CO4: Practice the various quality system in industry.

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	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

Evans J. R, and Lidsay W. M. - 'The Management and Control of Quality' - Southwestern (ThomsonLearning) - 2002 - 5th Edition
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

PO/PSO / CO	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

Syllabus

Unit 1

Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods - The 7 Wastes, their causes and the effects - An overview of Lean Principles / concepts / tools - Stockless Production.
The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow –5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems.
Ford production systems – FPS gear model

Unit 2

Value Stream Mapping – Current state: Preparation for building a Current State Value Stream Map – Building a Current State Map (principles, concepts, loops, and methodology) – Application to the factory Simulation scenario.

Unit 3

Value Stream Mapping – Future State: Key issues in building the Future State Map – Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop – Example of completedFuture State Maps – Application to factory simulation
Implementation of lean practices - Best Practices in Lean Manufacturing.

TEXT BOOKS

Womack, J.P., Jones, D.T., and Roos, D., 'The Machine that Changed the World', Simon & Schuster, NewYork, 2007.
Liker, J.K., 'Becoming Lean', Industrial Engineering and Management Press, 1997.

REFERENCES BOOKS

Womack, J.P. and Jones, D.T., 'Lean thinking', Simon & Schuster, USA, 2003.
Rother, M. and Shook, J., 'Learning to see', The Lean Enterprise Institute, Brookline, USA, 2003.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23CSE321	SOFTWARE PROJECT MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- This course describes the key aspects of a software project.
- It introduces the basic principles of Engineering Software Projects. Most, if not all, students' complete projects as part of assignments in various courses undertaken. These projects range in size, subject and complexity but there are basic project essentials that need to be understood and practiced for successful team project outcomes.
- The course provides an understanding of the purpose, methods and benefits of process management by exposing the student to the concepts, practices, processes, tools and techniques used in process managementfor software development.

Course Outcomes

CO1: To understand the basic concepts, terminologies and issues of software project management.
CO2: To apply appropriate methods and models for the development of solutions.
CO3: To analyze the cost-benefits of calculations so as to optimize the selection strategy
CO4: To evaluate methods, models and technologies towards achieving project success
CO5: 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	PSO3
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	

Syllabus

Unit 1

Introduction to Software Project Management- Software Projects - ways of categorizing software projects – problems with software projects - Project Life Cycle– Management -Setting objectives –Stakeholders - Project Team- Step-wise : An overview of project planning -project Evaluation –Selection Of Appropriate Project Objectives- Software Effort Estimation Techniques, Function Point Analysis-Object Point-COCOMO.

Unit 2

Activity planning-- project schedules - sequencing and scheduling projects - Network planning model – AON andAOA-identifying critical activities-Crashing And Fast Tracking-,Risk management—Categories , Risk planning, Management and Control - Evaluating risks to the schedule. PERT- Resource Allocation, Monitoring and Tracking -Monitoring and control - allocation - identifying resource requirements - scheduling resources - creating critical paths - publishing schedule - cost schedules- sequence schedule.

Unit 3

Monitoring and control – Visualizing Progress, Earned value analysis, managing people and organizing teams-organizational structures- Planning for small projects. Case Study: PMBOK, Agile Development

TEXT BOOK(S)

Mike Cotterell, Bob Hughes. Software Project Management, Fifth Edition, Tata McGraw-Hill; 2012.

REFERENCE(S)

Roger S. Pressman. Software Engineering – A Practioner's Approach, Eighth Edition, Tata McGraw-Hill publishers; 2014.

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	PSO3
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 valuesof streams - IRR. Fixed income securities - Market value for future cash - Bond value - Bond details – Yields – Convexity – Duration - Immunization. Bond portfolio management - Level of market interest rates, Term structureof interest-rate theories.

Unit 2

Stocks and Derivatives: Common stock valuation - Present value of cash dividends - Earnings approach - Value versus price - Efficient markets theory - Technical analysis. Analysis of financial statements. Derivatives - futures and options - Black Scholes formula - Utility functions - Applications in financial decision making.

Unit 3

Portfolio analysis and capital market theory: Covariance of returns – Correlation - Portfolio return - Portfolio standard deviation - Two asset case - Efficient frontier - Optimum portfolio. Capital market theory - Capital market line - Sample diversifications to reduce risk - Characteristic line - Capital asset pricing model. Arbitrage price theory - Stock performance evaluation.

TEXT BOOK(S)

David Luenberger, Investment Science. Second Edition, Oxford University Press; 2013
Jack Clark Francis, Richard W. Taylor. Investments, Schaum's Outlines, Tata McGraw Hill; 2006.

REFERENCE(S)

Lyuu YD. Financial Engineering and Computation. Cambridge University Press; 2004.
Perry H. Beaumont. Financial Engineering Principles. John Wiley and Sons Inc, New Jersey; 2004.

Evaluation Pattern

Assessment	Internal	External
3Periodical 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 forthe 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 anddecision making

CO-PO Mapping

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

Syllabus

Unit 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)

Panneerselvam, R. Engineering Economics, Second Edition, PHI; 2013.
R L Varshney,K L. Maheshwari. Managerial Economics, S Chand & Sons;2014.
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	PSO3
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, valuechain ,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)

O'Brien JA, Marakas GM. Management information systems. McGraw-Hill Irwin; 2006.
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 STREAMS
COMMON 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.

Syllabus

Unit 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:

Awaken Children (Dialogues with Sri Mata Amritanandamayi) Volumes 1 to 9
Complete works of Swami Vivekananda (Volumes 1 to 9)
Mahabharata by M. N Dutt published by Parimal publications – New Delhi (Volumes 1 to 9)
Universal message of Bhagavad-Gita (An exposition of Gita in the light of modern thought and Modernneeds) by Swami Ranganathananda. (Vols.1 to 3)
Message of Upanishads, by Swami Ranaganathananda published by Bharatiya Vidya Bhavan, Bombay.
Personality Development – Swami Vivekananda published by Advaitha Ashram, Kolkatta.
Art of Man Making - Swami Chinmayananda published by Chinmaya Mission, Bombay
Will Power and its Development- Swami Budhananda published by Advaitha Ashram, Kolkatta
Ultimate Success - Swami Ramakrishnananada Puri published by Mata Amritanandamayi Math, Kollam
Yoga In Daily Life - Swami Sivananda – published by Divine Life Society
Hindu Dharma - H. H. Sri Chandrasekharandra Saraswati published by Bharatiya Vidya Bhavan, Bombay
All about Hinduism – Swami Sivananda - Published by Divine Life Society
The Mind and its Control by Swami Budhananda published by Advaitha Ashram, Kolkatta
Krida Yoga - Vivekananda Kendra, Publication.
Valmiki Ramayana – Four volumes- published by Parimal Publications, Delhi
New perspectives in Stress Management - Dr H R Nagendra & Dr R Nagaratna published by SwamiVivekananda Yoga Prakashana, Bangalore.
Mind Sound Resonance Technique (MSRT) Published by Swami Vivekananda Yoga Prakashana,Bangalore.
Yoga & Memory - Dr H R Nagendra & Dr. Shirley Telles, published by Swami Vivekananda YogaPrakashana, Bangalore.SSS

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CUL231	EXCELLENCE IN DAILY LIFE	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

1. The anatomy of 'Excellence'. What is 'excellence'? Is it judged by external factors like wealth?
2. The Great Flaw. The subject-object relationship between individual and world. Promote subject enhanceexcellence.
3. To work towards excellence, one must know where he is. Our present state... An introspective analysis.Our faculties within.

Unit 2

4. The play of the mind. Emotions – convert weakness into strength.
5. The indispensible role of the intellect. How to achieve and apply clear thinking?
6. The quagmire of thought.The doctrine of Karma – Law of Deservance.
7. Increase Productivity, reduce stress.. work patterning.

Unit 3

8. The art of right contact with the world. assessment, expectations.
9. Myths and Realities on key issues like richness, wisdom, spirituality.
10. Collect yourself, there is no time to waste. The blue-print of perfect action.

REFERENCES:

The Bhaja Govindam and the Bhagavad Gita.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CUL232	EXPLORING SCIENCE AND TECHNOLOGY IN ANCIENT INDIA	L-T-P-C: 2-0-0-2

OBJECTIVES:

- This course offers a journey of exploration through the early developments in India of astronomy, mathematics, technologies and perspectives of the physical world. With the help of many case studies, the students will be equipped to understand concepts as well as well as actual techniques.

Syllabus

Unit 1

1. General introduction: principles followed and sources;
2. Astronomy & mathematics from the Neolithic to the Indus civilization;
3. Astronomy & mathematics in Vedic literature;
4. Vedanga Jyotisha and the first Indian calendars;
5. Shulba Sutras and the foundations of Indian geometry;

Unit 2

1. Astronomy & mathematics in Jain and Buddhist literature;
2. The transition to the Siddhantic period; Aryabhata and his time;
3. The Aryabhatiya: concepts, content, commentaries;
4. Brahmagupta and his advances;
5. Other great Siddhantic savants;
6. Bhaskara II and his advances;

Unit 3

1. The Kerala school of mathematics;
2. The Kerala school of astronomy;
3. Did Indian science die out?;
4. Overview of recent Indian scientists, from S. Ramanujan onward;
5. Conclusion: assessment and discussion;

TEXTBOOK:

Indian Mathematics and Astronomy: Some Landmarks, by S. Balachandra Rao

REFERENCE:

IFIH's interactive multimedia DVD on Science & Technology in Ancient India.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CUL233	YOGA PSYCHOLOGY	L-T-P-C: 2-0-0-2

OBJECTIVES:

- This course offers the foundation necessary to understand Eastern approaches to psychology and spirituality. The course includes experiential components centering on meditation and spiritual practice.

Syllabus

Unit 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:

The course book will be "The four chapters of Freedom" written by Swami Satyananda Saraswati of BiharSchool of Yoga, Munger, India.

"The message of Upanishads" written by Swami Ranganathananda. Published by Bharathiya VidyaBhavan.

Eight Upanishads with the commentary of Sankaracharya, Translated by Swami Gambhirananda,Published by Advaita Ashram, Uttaranjal.

'Hatha Yoga Pradipika' Swami Muktibodhananda, Yoga Publications Trust, Munger, Bihar, India

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG230	BUSINESS COMMUNICATION	L-T-P-C: 1-0-3-2

OBJECTIVES:

- To introduce business vocabulary; to introduce business style in writing and speaking; to expose students to thecross-cultural aspects in a globalised world; to introduce the students to the art of persuasion and negotiation inbusiness contexts.

Course Outcomes

CO1: Familiarize and use appropriate business vocabulary and etiquettes in verbal communication in 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 thebusiness 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	PSO1	PSO2	PSO3
CO1										3		2			
CO2									1		1				
CO3										3					
CO4						2									
CO5									2						

Syllabus

Unit 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:

Jones, Leo & Richard Alexander. New International Business English. CUP. 2003.

Horner, David & Peter Strutt. Words at Work. CUP. 1996.

Levi, Daniel. Group Dynamics for Teams. 3 ed. Sage Publications India Pvt. Ltd. New Delhi, 2011.

Owen, Roger. BBC Business English. BBC. 1996.

Henderson, Greta Lafollette & Price R Voiles. Business English Essentials. 7th Edition. Glencoe / McGrawHill.

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.

Syllabus

Unit 1

Poems

Rabindranath Tagore's Gitanjali (1-10); Nizzim Ezekiel's Enterprise; A.K. Ramanujam's Small-Scale Reflections on a Great House.

Unit 2

Prose

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:

Lahiri, Jhumpa. Interpreter of Maladies, Harper Collins Publications, 2000.
Ramanujan A. K. ed. K. M. George, Modern Indian Literature: An Anthology, Vol. I, Sahitya Akademi,1992.
Singh, Khushwant. The Portrait of a Lady: Collected Stories, Penguin, 2009.
Tagore, Rabindranath. Gitanjali, Penguin Books India Pvt. Ltd, 2011.
Tendulkar, Vijay. Five Plays, Oxford University Press, 1996.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG232	INSIGHTS INTO LIFE THROUGH ENGLISH LITERATURE	L-T-P-C: 2-0-0-2

OBJECTIVES:

- To expose the students to different genres of Literature; to hone reading skills; to provide deeper critical and literary insights; to enhance creative thinking; to promote aesthetic sense.

Syllabus

Unit 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 3

Prose

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, Book reviews, 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

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					
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:

Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and TechnologyProfessionals". II Edition. New York: IEEE press, 2002

Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt BraceCollege Publication, 2003

Strunk, William Jr. and White. E B. "The Elements of Style" New York. Alliyan & Bacon, 1999.

Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (IndianAdaptation). 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 help them 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.

Syllabus

Unit 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

Syllabus

Unit 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

Syllabus

Unit 1

The first room of a student

A party to celebrate the 1st room; Description of a room; furniture; Locate objects: prepositions (devant, derrière, dans…), Read advertisement; Appreciation (I like, I prefer,).

Grammar - Perfect past tense with avoir; Possessive adjectives (mon, ton, son…); Demonstrative adjectives (ce, cet, cette); Yes (oui, si).

Unit 2 Small jobs

Conversation on the phone; Give Time indications; Answer a job offer; Describe a job; Suggest a meeting time. Grammar - Perfect past tense with être and avoir (continuation); Possessive adjectives (notre, votre, leur); Prepositions (à, pour, avec …); Pronoun as direct object (le, la, l', les).

Unit 3

University Restaurant

Inquiry; Express an opinion; Ask questions (continuation); Food, meals, taste, preferences; Nutrition, diet, choosea menu or diet, Expression of quantities (beaucoup, peu).

Grammar - Partitif (expressing quantity) (du, de la, pas de….); Comparison (plus...que, moins….que, autant …que); Interrogation (continuation), inversion, Est-ce que, qu'est-ce que?.

TEXTBOOK:

Metro St Michel - Publisher: CLE International

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER230	GERMAN FOR BEGINNERS I	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Greetings; Introducing one-self (formal and informal context), saying their name, origin, living place, occupation. Numbers 1-100; Saying the telephone number. Countries and Languages.

Grammar: Structure – W - Questions and Yes/No questions and statements, personal pronouns, verb conjugations. Articles. Vocabulary: Professions.

Unit 2

Giving the personal details. Name, age, marital status, year of birth, place of birth, etc.Numbers till 1000. Saying a year. Alphabets – spelling a word.

Filling up an application form; In the restaurant – making an order.

Grammar: Definite, indefinite and negative article in nominative. Accusative: indefinite and negative Article Vocabulary: Food items

Unit 3

Numbers above 1000. Orientation in Shopping plazas: asking the price, where do I find what, saying the opinion.Grammar: Accusative – definite article. Adjectives and plural forms. Vocabulary: Furniture and currencies.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER231	GERMAN FOR BEGINNERS II	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Shopping and orientation in supermarket; Conversation between the customer and salesman; Where one finds what in supermarket; Asking for requests and suggestions.

Grammar: Dative of personal pronouns. Imperative form. Vocabulary: Consumables and measurements;

Unit 2
Appointments; Work and leisure time activities; Time, weekdays, months and seasons; saying the date; fixing upan appointment.

Grammar: Model verbs; Prepositions with time and place; Ordinal numbers. Vocabulary: Leisure activities,weekdays, months and seasons.

Unit 3
Family and household; Family and relations; household and daily routine. Grammar: Possessive articles; Divisibleand indivisible verbs.
Vocabulary: Family circle; Household articles.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER232	PROFICIENCY IN GERMANLANGUAGE (LOWER)	L-T-P-C: 2-0-0-2

Syllabus

To have an elementary exposure to German language; specifically

1. to have some ability to understand simple spoken German, and to be able to speak it so as to be able tocarry on life in Germany without much difficulty (to be able to do shopping, etc.);
2. to be able to understand simple texts, and simple forms of written communication;
3. to have a basic knowledge of German grammar;
4. to acquire a basic vocabulary of 500 words;
5. to be able to translate simple letters with the use of a dictionary; and
6. to have some familiarity with the German life and culture.

(This will not be covered as part of the regular classroom teaching; this is to be acquired by self-study.)Some useful websites will be given.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER233	PROFICIENCY IN GERMAN LANGUAGE (HIGHER)	L-T-P-C: 2-0-0-2

Syllabus

The basic vocabulary and grammar learned in the earlier course is mostly still passive knowledge. The endeavourof this course is to activate this knowledge and develop the skill of communication.

Topics are: Airport, railway station, travelling; shopping; invitations, meals, meeting people; around the house; the human body; colours; professions.

Past and future tenses will be introduced. Applying genitive, dative and accusative. Some German culture. Films.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HIN230	HINDI I	L-T-P-C: 2-0-0-2

OBJECTIVES:

- To teach Hindi for effective communication in different spheres of life - Social context, Education, governance, Media, Business, Profession and Mass communication.

Course Outcomes:

After the completion of the course the student will be able to:

CO1: Gain knowledge about the nature and culture of Hindi 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	PSO3
CO1									2	3					
CO2									2	3					
CO3									2	3					
CO4										3					
CO5									2						

Syllabus

Unit 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 indifferent 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:

Prem Chand Ki Srvashrestha Kahaniyam: Prem Chand; Diamond Pub Ltd. New Delhi
Vyavaharik Hindi Vyakaran, Anuvad thaha Rachana: Dr.H.Parameswaran, Radhakrishna publishingHouse, NewDelhi
Kamtha Prasad Guru : Hindi Vyakaran, Best Book pub House, New Delhi
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	PSO3
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:

Kavay Tarang: Dr. Niranjan, Jawahar Pusthakalay, Mathura.
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:

Daniel Goleman (1996). Emotional Intelligence- Why it can Matter More than IQ. Bantam Doubleday Dell Publishing Group

Daniel Goleman (2000). Working with Emotional Intelligence. Bantam Doubleday Dell Publishing Group

Liz Wilson, Stephen Neale & Lisa Spencer-Arnell (2012). Emotional Intelligence Coaching. Kogan PageIndia 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 INDIAN 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:

Tilak, Bal Gangadhar. The Orion / Arctic Home in the Vedas.

Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.

Vivekananda, Swami. "Address at the Parliament of Religions"/"The Future of India"/"In Defence ofHinduism" from Selections from the Complete Works of Swami Vivekananda.

Aurobindo, Sri. The Renaissance in India / On Nationalism.

Coomaraswamy, Ananda K. Essays in Indian Idealism (any one essay) / Dance of Shiva.

Nivedita, Sister. "Noblesse Oblige: A Study of Indian Caste" / "The Eastern Mother" from The Web ofIndian Life.

Gandhi, Mahatma. Hind Swaraj.

Nehru, Jawaharlal. "The Quest" from Discovery of India.

Ambedkar, B. R. "Buddha and His Dhamma" from Collected Works.

Saraswati, Chandrasekharendra. "The Sastras and Modern Life" from The Hindu Dharma.

Dharampal. Bharatiya Chitta, Manas and Kala / Understanding Gandhi.

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 – classicalsanskrit literature – Harsavardhana; Trade and commerce in classical and medieval India and the story of Indiansupremacy in the Indian ocean region; The coming of Islam – dismantling of the traditional Indian polity – the Mughal empire – Vijayanagara samrajya and days of Maratha supremacy.

Unit 2

India's contribution to the world: spirituality, philosophy and sciences

Indian Philosophy – the orthodox (Vaidika) and the heterodox (atheistic) schools; Ramayana and Mahabharata;Bhagavad Gita; Saints and sages of India; Ancient Indian medicine: towards an unbiased perspective; Ancient Indian mathematics; Ancient Indian astronomy; Ancient Indian science and technology.

The arrival of Europeans, British paramountcy and colonization

What attracted the rest of the world to India?; India on the eve of the arrival of European merchants; The story of colonization and the havoc it wrecked on Indian culture and civilization; Macaulay and the start of the distortion ofIndian education and history; Indian economy – before and after colonization: a brief survey; The emergence ofmodern India.

Unit 3

Women in Indian society

The role and position of women in Hindu civilization; Gleanings from the Vedas, Brihadarnyaka Upanishad, Saptasati Devi Mahatmyam, Ramayana, Mahabharata, Manusmriti, Kautilya's Arthasastra and Mrichchhakatikamof Sudraka; The role and position of Indian women vis-a-vis Islam and European cultures; The great women of India.

Modern India

The national movement for freedom and social emancipation; Swami Vivekananda, Sri Aurobindo, RabindranathTagore; Understanding Mahatma Gandhi; A new nation is born as a republic – the pangs of birth and growth; India since Independence – the saga of socio-political movements; Problems facing the nation today; Globalization and Indian Economy; Bharatavarsha today and the way ahead: Regeneration of Indian National Resources.

Conclusion

The Wonder that was India; The 'politics' and 'purpose' of studying India.

REFERENCES:

Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.

Somayaji, D. A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.

Sen, S. N. & K. V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.

Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.

Bose, D. M. et. al. A Concise History of Science in India. New Delhi: 1971.

Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.

Bajaj, Jitendra & M. D. Srinivas.Timeless India, Resurgent India. Chennai: Centre for Policy Studies.

Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre forPolicy Studies, 2008.

The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture

Vivekananda, Swami. Selections from the Complete Works of Swami Vivekananda. Kolkata: AdvaitaAshrama.

Mahadevan, T. M. P. Invitations to Indian Philosophy. Madras: University of Madras.

Hiriyanna, M. Outlines of Indian Philosophy. Motilal Banarsidass.

Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.

Majumdar, R. C. et. al. An Advanced History of India. Macmillan.

Mahajan, V. D. India Since 1526. New Delhi: S. Chand & Company.

Durant, Will. The Case for India. Bangalore: Strand Book Stall, 2008.

Aurobindo, Sri. The Indian Renaissance / India's Rebirth / On Nationalism.

Nivedita, Sister. The Web of Indian Life. Kolkata: Advaita Ashrama.

Durant, Will. The Story of Civilization. Volume 1 – Our Oriental Heritage. New York: Simon & Schuster.

Ranganathananda, Swami. Eternal Values for A Changing Society. Bombay: Bharatiya Vidya Bhavan.

Ranganathananda, Swami. Universal Message of the Bhagavad Gita. Kolkata: Advaita Ashrama.
Seturaman, V. S. Indian Aesthetics. Macmillan.
Coomaraswamy, Ananda K. The Dance of Shiva. New Delhi: Sagar Publications.
Coomaraswamy, Ananda K. Essays on Indian Idealism. New Delhi: Munshiram Manoharlal.
Danino, Michel. The Invasion That Never Was.
Kautilya. Arthasastra.
Altekar, A. S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.
Altekar, A. S. The Position of Women in Hindu Civilization. New Delhi: Motilal Banarsidass.
Sircar, D. C. Studies in the Religious Life of Ancient and Medieval India. New Delhi: Motilal Banarsidass.
Sircar, D. C. Studies in the Political and Administrative Systems in Ancient and Medieval Times.NewDelhi: Motilal Banarsidass.
Madhavananda, Swami & R. C. Majumdar eds. The Great Women of India. Kolkata: Advaita Ashrama.
Dutt, R. C. The Economic History of India. London, 1902.
Dharampal. Collected Works.
Dharampal. Archival Compilations (unpublished)

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM233	GLIMPSES OF INDIAN ECONOMY AND POLITY	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Introduction

General Introduction; Primitive man and his modes of exchange – barter system; Prehistoric and proto-historicpolity and social organization.

Ancient India – up to 600 B.C.

Early India – the vedic society – the varnashramadharma – socio-political structure of the various institutions based on the four purusarthas; The structure of ancient Indian polity – Rajamandala and Cakravartins – Prajamandala;Socio-economic elements from the two great Epics – Ramayana and Mahabharata – the concept of the ideal King(Sri Rama) and the ideal state (Ramarajya) – Yudhisthira's ramarajya; Sarasvati - Sindhu civilization and India'strade links with other ancient civilizations; Towards chiefdoms and kingdoms – transformation of the polity: kingship – from gopati to bhupati; The mahajanapadas and the emergence of the srenis – states and cities of theIndo-Gangetic plain.

Unit 2

Classical India: 600B.C. – 1200 A.D.

The rise of Magadha, emergence of new religions – Buddhism and Jainism – and the resultant socio-economic impact; The emergence of the empire – the Mauryan Economy and Kautilya's Arthasastra; of Politics and trade –the rise of the Mercantile Community; Elements from the age of the Kushanas and the Great Guptas; India's maritime trade; Dharma at the bedrock of Indian polity – the concept of Digvijaya: dharma-vijaya, lobha-vijaya and asura-vijaya; Glimpses into the south Indian economies: political economies of the peninsula – Chalukyas, Rashtrakutas and Cholas

Medieval India: 1200 A.D. – 1720 A.D.

Advent of Islam – changes in the social institutions; Medieval India – agrarian economy, non-agricultural productionand urban economy, currency system; Vijayanagara samrajya and maritime trade – the story of Indian supremacyin the Indian Ocean region; Aspects of Mughal administration and economy; The Maratha and other provincial economies.

Unit 3

Modern India: 1720 - 1947

the Indian market and economy before the arrival of the European traders; Colonisation and British supremacy (dismantling of everything that was 'traditional' or 'Indian') – British attitude towards Indian trade, commerce and economy and the resultant ruining of Indian economy and business – man-made famines – the signs of renaissance:banking and other business undertakings by the natives (the members of the early Tagore family, the merchants of Surat and Porbander, businessmen of Bombay, etc. may be referred to here) – the evolution of the modern bankingsystem; Glimpses into British administration of India and administrative models; The National movement and nationalist undertakings in business and industry: the Tatas and the Birlas; Modern India: the growth of large- scale industry – irrigation and railways – money and credit – foreign trade; Towards partition – birth of two new nations

– division of property; The writing of the Indian Constitution – India becomes a democratic republic – a new polity is in place.

Independent India – from 1947

India since Independence – the saga of socio-political movements; Indian economy since Independence – the fiscal system – the five year plans – liberalisation – the GATT and after; Globalisation and Indian economy; Impact ofscience and (new/ emerging) technology on Indian economy; Histories of select Indian business houses and business entrepreneurship.

Conclusion

REFERENCES:

The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.Kautilya. Arthasastra.

Altekar, A. S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.

Sircar, D. C. Studies in the Political and Administrative Systems in Ancient and Medieval Times. NewDelhi: Motilal Banarsidass.

Dutt, R. C. The Economic History of India. London, 1902.

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Dharampal. Archival Compilations (unpublished).

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Tripathi, Dwijendra. The Oxford History of Indian Business. New Delhi: Oxford University Press, 2004.

McGuire, John, et al, eds. Evolution of World Economy, Precious Metals and India. New Delhi: OxfordUniversity

Press, 2001.
Tripathi, Dwijendra and Jyoti Jumani. The Concise Oxford History of Indian Business. New Delhi: Oxford University Press, 2007.
Kudaisya, Medha M. The Life and Times of G. D. Birla. New Delhi: Oxford University Press, 2003.
Raychaudhuri, Tapan and Irfan Haib, eds. The Cambridge Economic History of India. Volume
New Delhi: Orient Longman, 2004.
Kumar, Dharma, ed. The Cambridge Economic History of India. Volume 2. New Delhi: Orient Longman,2005.
Sabavala, S. A. and R. M. Lala, eds. J. R. D. Tata: Keynote. New Delhi: Rupa & Co., 2004.
Mambro, Arvind ed. J. R. D. Tata: Letters. New Delhi: Rupa & Co., 2004.
Lala, R. M., For the Love of India: The Life and Times of Jamsetji Tata. New Delhi: Penguin, 2006.
Thapar, Romila. The Penguin History of Early India: From the Origins to AD 1300. New Delhi Penguin,2002.
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

Syllabus

Unit 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:

B. Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.

"Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Councilof Medical Research, ICMR, 2010.

REFERENCE BOOKS:

K Park "Textbook of preventive and social medicine", 2010.

WHO Report on Adolescent Health: 2010

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM235	INDIAN CLASSICS FOR THE TWENTY-FIRST CENTURY	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Introductory study of the Bhagavad Gita and the Upanishads.

Unit 2
The relevance of these classics in a modern age.

Unit 3
Goals of human life - existential problems and their solutions in the light of these classics etc.

REFERENCE:
The Bhagavad Gita, Commentary by Swami Chinmayananda

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM236	INTRODUCTION TO INDIA STUDIES	L-T-P-C: 2-0-0-2

PREAMBLE:
This paper will introduce the students to the multiple dimensions of the contribution of India to the fields of philosophy, art, literature, physical and social sciences. The paper intends to give an insight to the students aboutthe far-reaching contributions of India to world culture and thought during the course of its long journey from thehoary antiquity to the present times. Every nation takes pride in its achievements and it is this sense of pride andreverence towards the achievements that lays the foundation for its all-round progress.

Syllabus

Unit 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:

Selections from The Cultural Heritage of India, 6 volumes, Ramakrishna Mission Institute of Culture(Kolkata) publication.
Selections from the Complete Works of Swami Vivekananda, Advaita Ashrama publication.
Invitations to Indian Philosophy, T. M. P. Mahadevan, University of Madras, Chennai.
Outlines of Indian Philosophy, M. Hiriyanna, MLBD.
An Advanced History of India, R. C. Majumdar et al, Macmillan.
India Since 1526, V. D. Mahajan, S. Chand & Company
The Indian Renaissance, Sri Aurobindo.
India's Rebirth, Sri Aurobindo.
On Nationalism, Sri Aurobindo.
The Story of Civilization, Volume I: Our Oriental Heritage, Will Durant, Simonand Schuster, New York.
Eternal Values for a Changing Society, Swami Ranganathananda, Bharatiya Vidya Bhavan.
Universal Message of the Bhagavad Gita, Swami Ranganathananda, Advaita Ashrama.
Awaken Children: Conversations with Mata Amritanandamayi
Indian Aesthetics, V. S. Seturaman, Macmillan.
Indian Philosophy of Beauty, T. P. Ramachandran, University of Madras, Chennai.
Web of Indian Thought, Sister Nivedita
Essays on Indian Nationalism, Anand Kumaraswamy
Comparative Aesthetics, Volume 2, Kanti Chandra Pandey, Chowkhamba, Varanasi
The Invasion That Never Was, Michel Danino
Samskara, U. R. Ananthamurthy, OUP.
Hayavadana, Girish Karnard, OUP.
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.

Syllabus

Unit 1

Sanskrit Language – Vakya Vyavahara (पथगाठीभा) - 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:

Vakya Vyavahara- Prof. Vempaty Kutumba Sastri, Rashtriya Sanskrit Sansthan, New Delhi
The Wonder that is Sanskrit - Dr.Sampadananda Mishra, New Delhi
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 youthprogramme/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

- To help students acquire the basic knowledge of behavior and effective living
- To create an awareness of the hazards of health compromising behaviours
- To develop and strengthen the tools required to handle the adversities of life

Course Outcome

CO1: Understand the basic concepts of Behavioral Psychology
CO2: Demonstrate self reflective skills through activities
CO3: Apply the knowledge of psychology to relieve stress
CO4: Analyse the adverse effects of health compromising behaviours.
CO5: Evaluate and use guided techniques to overcome and cope with stress related problems.

CO-PO Mapping

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

Syllabus

Unit 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:

V. D. Swaminathan & K. V. Kaliappan "Psychology for effective living - An introduction to Health Psychology. 2nd edition Robert J. Gatchel, Andrew Baum & David S. Krantz, McGraw Hill.

REFERENCE BOOKS:

S. Sunder, 'Textbook of Rehabilitation', 2nd edition, Jaypee Brothers, New Delhi. 2002.
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:

- To strengthen the fundamental knowledge of human behavior
- To strengthen the ability to understand the basic nature and behavior of humans in organizations as awhole
- To connect the concepts of psychology to personal and professional life

Course Outcome

CO1: Understand the fundamental processes underlying human behavior such as learning, motivation,individual differences, intelligence and personality.
CO2: Apply the principles of psychology in day- to- day life for a better understanding of oneself and others.
CO3: Apply the knowledge of Psychology to improve study skills and learning methods
CO4: Apply the concepts of defense mechanisms to safeguard against abusive relationships and to nurturehealthy relationships.

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

Syllabus

Unit 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:

S. K. Mangal, "General Psychology", Sterling Publishers Pvt. Ltd.2007
Baron A. Robert," Psychology", Prentice Hall of India. New Delhi 2001

REFERENCE BOOKS:

Elizabeth B. Hurlock, Developmental Psychology - A life span approach, 6th edition.
Feldman, Understanding Psychology, McGraw Hill, 2000.
Clifford Morgan, Richard King, John Scholper,"Introduction to Psychology", Tata Mcgraw Hill, PvtLtd 2004.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM241	SCIENCE AND SOCIETY - AN INDIAN PERSPECTIVE	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Introduction; Western and Indian views of science and technology
Introduction; Francis Bacon: the first philosopher of modern science; The Indian tradition in science andtechnology: an overview.

Unit 2
Indian sciences
Introduction; Ancient Indian medicine: towards an unbiased perspective; Indian approach to logic; The methodology of Indian mathematics; Revision of the traditional Indian planetary model by Nilakantha Somasutvan in circa 1500 AD
Science and technology under the British rule
Introduction; Indian agriculture before modernization; The story of modern forestry in India; The building ofNew Delhi

Unit 3
Science and technology in Independent India
Introduction; An assessment of traditional and modern energy resources; Green revolution: a historical perspective; Impact of modernisation on milk and oilseeds economy; Planning without the spirit and thedetermination.
Building upon the Indian tradition
Introduction; Regeneration of Indian national resources; Annamahatmyam and Annam Bahu Kurvita: recollecting the classical Indian discipline of growing and sharing food in plenty and regeneration of Indian agriculture to ensure food for all in plenty.

Conclusion

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Joseph, George Gheverghese. The Crest of the Peacock: Non-European Roots of Mathematics. London:Penguin (UK), 2003.
Iyengar, C. N. Srinivasa. History of Hindu Mathematics. Lahore: 1935, 1938 (2 Parts).
Amma, T. A. Saraswati. Geometry in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.
Bag, A. K. Mathematics in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.
Sarma K. V. & B. V. Subbarayappa. Indian Astronomy: A Source-Book. Bombay: Nehru Centre, 1985.
Sriram, M. S. et. al. eds. 500 Years of Tantrasangraha: A Landmark in the History of Astronomy. Shimla:Indian Institute of Advanced Study, 2002.
Bajaj, Jitendra & M. D. Srinivas. Restoring the Abundance: Regeneration of Indian Agriculture toEnsure Food for All in Plenty.Shimla: Indian Institute of Advanced Study, 2001.
Bajaj, Jitendra ed. Report of the Seminar on Food for All: The Classical Indian Discipline of Growingand Sharing Food in Plenty. Chennai: Centre for Policy Studies, 2001.
Bajaj, Jitendra & M. D. Srinivas. Annam Bahu Kurvita: Recollecting the Indian Discipline of Growingand Sharing Food in Plenty. Madras: Centre for Policy Studies, 1996.
Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.
Somayaji, D. A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.
Sen, S. N. & K. V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.
Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.
Bose, D. M. et. al. A Concise History of Science in India. New Delhi: 1971.
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Bajaj, Jitendra & M. D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.
Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.
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:
Swami Chinmayananda, "The Holy Geeta", Central Chinmaya Mission Trust, 2002.
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 message can be applied in daily life for achieving excellence.

Syllabus

Unit 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:

The Message of the Upanishads by Swami Ranganathananda, Bharatiya Vidya Bhavan
Eight Upanishads with the commentary of Sankaracharya, Advaita Ashrama
Indian Philosophy by Dr. S. Radhakrishnan, Oxford University Press
Essentials of Upanishads by R L Kashyap, SAKSI, Bangalore
Upanishads in Daily Life, Sri Ramakrishna Math, Mylapore.
Eternal stories of the Upanishads by Thomas Egenes and Kumuda Reddy
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 foodcombinations, 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 Outcomes:

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

Syllabus

Unit 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:

N. Shakuntalamanay, M. Shadaksharaswamy, "Food Facts and principles", New age international (P)ltd, publishers, 2005.
B. Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.

REFERENCE BOOKS:

B. Srilakshmi, "Food Science", New age international (P) ltd, publishers, 2008.
"Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Councilof 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 give a thorough knowledge on Japanese scripts that is Hiragana and Katakana. Classes will be conducted throughout in 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 and reading for appreciating literary works; to analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech.

Syllabus

Unit 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. BendreSwathantryada 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:

H. S. Krishna Swami Iyangar – Adalitha Kannada – Chetana Publication, Mysuru
N. Murthy Rao – Aleyuva Mana – Kuvempu Kannada Adyayana Samste
Nemi Chandra – Badhuku Badalisabahudu – Navakarnataka Publication
Sanna Kathegalu - Prasaranga, Mysuru University , Mysuru
B. M. Shree – Kannadada Bavuta – Kannada Sahitya Parishattu
K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna Book House (P) Ltd.
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 and reading 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.

Syllabus

Unit 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:

H. S. Krishnaswami Iyangar – Adalitha Kannada – Chetan Publication, Mysuru
Dr. G. S. Shivarudrappa – Samagra Kavya. - Kamadhenu Pustaka Bhavana
Shrikanth - Mankuthimmana Kagga – Taatparya – Sri Ranga Printers & Binders
K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna book house
Dr. Da. Ra. Bendre – Saayo Aata – Shri Maata Publication
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 our culture & 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/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1									2	3					
CO2									2	3					
CO3									2	3					
CO4										3					
CO5									1	1					

Syllabus

Unit 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:

P. K. Balakrishnanan, Thunjan padhanangal, D. C. Books, 2007.
G. Balakrishnan Nair, Jnanappanayum Harinama Keerthanavum, N. B. S, 2005.
M. N. Karasseri, Basheerinte Poonkavanam, D. C. Books, 2008.
4 M. N. Vijayan, Marubhoomikal Pookkumbol, D. C. Books, 2010.
M. Thomas Mathew, Lavanyanubhavathinte Yukthisasthram, National Book Stall, 2009.
M. Leelavathy, Kavitha Sahityacharitram, National Book Stall, 1998.
Thayattu Sankaran, Vallathol Kavithapadhanam, D. C. Books, 2004.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23MAL231	MALAYALAM II	L-T-P-C: 2-0-0-2

OBJECTIVES:

- To appreciate the aesthetics & cultural implications; to enhance creative thinking in mother-tongue; to learn our culture & values; to equip students read & write correct Malayalam; to correct the mistakes in pronunciation; to create awareness that good language is the sign of complete personality.

Course Outcomes:

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

Syllabus

Unit 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 appreciation of literary works (Any one or two as an assignment).

REFERENCES:

Narayana Pillai. P. K, Sahitya Panchanan. Vimarsanathrayam, Kerala Sahitya Academy, 2000
Sankunni Nair. M. P, Chathravum Chamaravum, D. C. Books, 2010.
Gupthan Nair. S, Asthiyude Pookkal, D. C Books. 2005
Panmana Ramachandran Nair, Thettillatha Malayalam, Sariyum thettum etc., D. C. Book, 2006.
M. Achuthan, Cherukatha-Innale, innu, National Book Stall, 1998.
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.

Syllabus

Unit 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-kartharipra yoga

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:

Praveshaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore - 560085
Sanskrit Reader I, II and III, R. S. Vadhyar and Sons, Kalpathi, Palakkad
Prakriya Bhashyam written and published by Fr. John Kunnappally
Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston
Sabdamanjari, R. S. Vadyar and Sons, Kalpathi, Palakkad
Namalinganusasanam by Amarasimha published by Travancore Sanskrit series
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.

Syllabus

Unit 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:

Praveshaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore -560085
Sanskrit Reader I, II and III, R.S. Vadhyar and Sons, Kalpathi, Palakkad
Prakriya Bhashyam written and published by Fr. John Kunnappally
Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston
Sabdamanjari, R. S. Vadyar and Sons, Kalpathi, Palakkad
Namalinganusasanam by Amarasimha published by Travancore Sanskrit series
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:

Corporate Governance, Ethics and Social Responsibility, V Bala Chandran and V Chandrasekaran, PHIlearning Private Limited, New Delhi 2011.

White H. (2005) Challenges in evaluating development effectiveness: Working paper 242, Institute of Development Studies, Brighton.

UNDP (nd) Governance indicators: A users guide. Oslo: UNDP

Rao, Subbha (1996) Essentials of Human Resource Management and Industrial Relations, Mumbai,Himalaya

Rao, V. S. L. (2009) Human Resource Management, New Delhi, Excel Book.,

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, why invest 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:

American Psychiatric Association. "Diagnostic and statistical manual of mental disorders: DSM-IV 4th ed." www.terapiacognitiva.eu/dwl/dsm5/DSM-IV.pdf

American Psychiatric Association. (2000) www.ccsa.ca/Eng/KnowledgeCentre/OurDatabases/ Glossary/Pages/index.aspx.

Canadian Mental Health Association, Ontario "Workplace mental health promotion, A how to guide"wmhp.cmhaontario.ca/

Alberta Health Services Mental Health Promotion. (2012). Minding the Workplace: Tips for employeesand managers together. Calgary: Alberta Health Services.http:// www.mentalhealthpromotion.net/resources/minding-the-workplace-tips-for-employees-and- managers- together.pdf

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

Mental Health Act 1987 (India) www.tnhealth.org/mha.htm

Persons with disabilities Act 1995 (India) socialjustice.nic.in

The Factories Act 1948 (India) www.caaa.in/Image/19ulabourlawshb.pdf

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23TAM230	TAMIL I	L-T-P-C: 2-0-0-2

Course Objectives:

- To introduce the students to different literature- Sangam literature, Epics, Bhakthi literatureandmodern literature.
- To improve their ability tocommunicate with creative concepts, and also to introduce them to theusefulness of basicgrammaticalcomponents in Tamil.

Course Outcomes

CO1: To understand the Sangam literature
CO2: To understand the creative literature
CO3: To understand the literary work on religious scriptures
CO4: To improve the communication and memory skills
CO5: To understand the basic grammar components of Tamil language and their usage and applications.
CO6: 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	PSO1	PSO2	PSO3
CO1									2	2					
CO2									2	2					
CO3									2	2					
CO4									2	2					
CO5									2	2					
CO6									2	2					

Syllabus

Unit1

The history ofTamilliterature: Nāṭṭupuṟap pāṭalkaḷ, kataikkaḷ, paḻamoḻikaḷ - ciṟukataikaḷ tōrramum vaḷarcciyum, cirrilakkiyaṅkaḷ: Kaliṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.
Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai naṭaiyiyal āyvu marrum 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, marrum akappēy cittar pāṭalkaḷ (1-5).

Unit 3

tamiḻ ilakkaṇam: Vākkiya vakaikaḷ – taṉviṉai piṟaviṉai – nērkkūrru ayaṟkūrru

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 parimārram - viḻampara moḻiyamaippu – pēccu - nāṭakam paṭaippu -ciṟukatai, katai, putiṉam paṭaippu.

Textbooks:

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, vañciyūr, 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.

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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 TamilLanguage.

Course Outcomes

CO1: Understand the history of Tamil literature.
CO2: Apply practical and comparative analyses on literature.
CO3: Understand thinai literature, literature on justice, Pathinenkeelkanaku literature.
CO4: Understand the tamil scholars' service to Tamil language and society.
CO5: Understand components of Tamil grammar and its usage
CO6: 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	PSO1	PSO2	PSO3
CO1									2	2					
CO2									2	2					
CO3									2	2					
CO4									2	2					
CO5									2	2					
CO6									2	2					

Syllabus

Unit 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.
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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 parimāṟṟam - viḻampara 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 maṇimāraṉ "aṭōṉ tamiḻ ilakkaṇam "aṭōṉ papḷiṣiṅ kurūp, vañciyūr

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.