AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

(AMRITAPURI, BENGALURU, COIMBATORE, CHENNAI)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B. Tech. in ELECTRICAL AND ELECTRONICS ENGINEERING

(BTC. EEE)

CURRICULUM AND SYLLABI

(2023)

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
Cr	-	Credits
ENGG	-	Engineering Sciences (including General, Core and Electives)
HUM	-	Humanities (including Languages and others)
SCI	-	Basic Sciences (including Mathematics)
PRJ	-	Project Work (including Seminars)
AES	-	Aerospace Engineering
AIE	-	Computer Science and Engineering - Artificial Intelligence
BIO	-	Biology
CCE	-	Computer and Communication Engineering
CHE	-	Chemical Engineering
CHY	-	Chemistry
CSE	-	Computer Science and Engineering
CVL	-	Civil Engineering
CUL	-	Cultural Education
EAC	-	Electronics and Computer Engineering
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
ELC	-	Electrical and Computer Engineering
HUM	-	Humanities
MAT	-	Mathematics
MEE	-	Mechanical Engineering
PHY	-	Physics

Program Educational Objectives (PEOs)

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

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

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

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

Course Outcome (CO) – Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and the behaviour that students acquire in their progress through the course.

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

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

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for
i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Program Specific Outcomes (PSOs)

PSO1: Apply the knowledge of electro dynamic systems and semiconductor devices on electrical and allied services.

PSO2: Employ computational tools for design, analysis and control of power systems integrated with renewable energy and Electric Vehicle.

PSO3: Innovate solutions for Industrial needs employing control techniques, embedded controllers and IoT.

SEMESTER I

Cat.	Code	Title	L T P	Credit
HUM	23ENG101	Technical Communication	2 0 3	3
SCI	23MAT122	Calculus, Matrix Algebra and Ordinary Differential Equations	3 1 0	4
ENGG	23EEE101	Fundamentals of Electrical Engineering	2 0 0	2
ENGG	23MEE102	Engineering Graphics and 3D Modelling	2 0 3	3
SCI	23PHY105/23CHY109	Engineering Physics - A/ Engineering Chemistry - B	2 1 0	3
SCI	23PHY185/23CHY188	Engineering Physics Lab - A / Engineering Chemistry Lab - B	0 0 3	1
ENGG	23MEE182	Manufacturing Practice-B	0 0 3	1
HUM	22ADM101	Foundations of Indian Heritage	2 0 1	2
HUM	22AVP103	Mastery Over Mind	1 0 2	2
		Total	27	21

SEMESTER II

Cat.	Code	Title	L T P	Credit
SCI	23MAT125	Complex Analysis and Transforms	3 1 0	4
ENGG	23CSE115	Algorithmic Thinking and Computer Programming	3 0 2	4
SCI	23PHY105/23CHY109	Engineering Physics - A/Engineering Chemistry - B	2 1 0	3
ENGG	23EEE111	Electric Circuits	3 0 0	3
ENGG	23EEE112	Electronic Circuits	3 0 0	3
ENGG	23EEE113	Materials for Electrical Engineering	2 0 0	2
ENGG	23EEE181	Electric & Electronic Circuits lab	0 0 3	1
ENGG	23EEE183	Electrical Engineering Practice	0 0 2	1
SCI	23PHY185/23CHY188	Engineering Physics Lab - A/Engineering Chemistry Lab - B	0 0 2	1
HUM	22ADM111	Glimpses of Glorious India	2 0 1	2
		Total	29	24

SEMESTER III

Cat.	Code	Title	L T P	Credit
SCI	23MAT224	Statistics and Foundations of Data Science	3 1 0	4
ENGG	23MEE206	Fundamentals of Mechanical Engineering	3 0 0	3
ENGG	23EEE201	Signals & Systems	3 1 0	4
ENGG	23EEE202	Analog Integrated Circuits	3 0 0	3
ENGG	23EEE203	Digital Electronics	3 0 0	3
ENGG	23EEE204	Electromagnetic Theory	3 0 0	3
ENGG	23EEE205	Introduction to Python Programming	1 0 2	2
ENGG	23EEE281	Analog & Digital Electronics Lab	0 0 3	1
HUM		Amrita Value Programme I	1 0 0	1
HUM	23LSE201	Life Skills for Engineers I	1 0 2	P/F
		TOTAL	30	24

SEMESTER IV

Cat.	Code	Title	L T P	Credit
ENGG	23EEE211	Electrical Measurements	3 0 2	4
ENGG	23EEE212	Electrical Machines I	3 0 0	3
ENGG	23EEE213	Introduction to Machine Learning	3 1 0	4
ENGG	23EEE214	Microcontrollers and Applications	3 0 2	4
ENGG	23EEE215	Control Systems	3 0 2	4
ENGG	23EEE282	Electrical Machines I Lab	0 0 3	1
HUM	23LSE211	Life Skills for Engineers II	1 0 2	2
HUM		Amrita Value Programme II	1 0 0	1
		TOTAL	29	23

SEMESTER V

Cat.	Code	Title	L T P	Credit
ENGG	23EEE301	Digital Signal Processing	3 1 0	4
ENGG	23EEE302	Power Electronics	3 0 0	3
ENGG	23EEE303	Electrical Machines II	3 0 0	3
ENGG	23EEE304	Power Systems##	3 1 0	4
ENGG		Professional Elective I*	3 0 0	3
ENGG		Professional Elective II*	3 0 0	3
ENGG	23EEE381	Power Electronics Lab	0 0 3	1
ENGG	23EEE382	Electrical Machines II Lab	0 0 3	1
HUM	23LSE301	Life Skills for Engineers III	1 0 2	2
ENGG	23LIV390	Live In Lab I***		[3]
		TOTAL	29	24+[3]

SEMESTER VI

Cat.	Code	Title	L T P	Credit
ENGG	23EEE311	Power System Analysis	3 0 0	3
ENGG	23EEE312	Electric Drives and Control	3 0 0	3
HUM		Free Elective**	2 0 0	2
ENGG		Professional Elective III*	3 0 0	3
ENGG		Professional Elective IV*	3 0 0	3
ENGG	23EEE383	Power Systems Lab	0 0 2	1
ENGG	23EEE384	Electric Drives and Control lab	0 0 2	1
ENGG	23EEE385	Open Lab	0 0 3	1
HUM	23LSE311	Life Skills for Engineers IV	1 0 2	2
ENGG	23LIV490	Live in Lab II***		[3]
ENGG	23EEE397	Industry Internship		P/F
		TOTAL	24	19+ [3]

SEMESTER VII

Cat.	Code	Title	L T P	Credit
ENGG	23EEE401	Smart Grid & IoT	3 0 2	4
ENGG		Professional Elective V*	3 0 0	3
PRJ	23EEE498	Project Phase I	0 0 18	6
HUM	23ENV300	Environmental Science		P/F
HUM	23LAW300	Indian Constitution		P/F
		TOTAL	26	13

SEMESTER VIII

Cat.	Code	Title	L T P	Credit
ENGG		Professional Elective VI*	3 0 0	3
ENGG		Professional Elective VII*	3 0 0	3
PRJ	23EEE499	Project Phase II	0 0 18	6
		TOTAL	24	12

Total Credits		160

***Professional Elective -** Electives categorised under Engineering, Science, Mathematics, Live-in-Labs, and NPTEL Courses. Student can opt for such electives across departments/campuses. Students with CGPA of 7.0 and above can take upto 20% of the courses from NPTEL.

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

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

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

PROFESSIONAL ELECTIVES

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

Embedded Systems, Control and Automation				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	23ELC341	Robotics and Automation	3 0 0	3
ENGG	23EEE351	Embedded System Design	3 0 0	3
ENGG	23EEE352	Advanced Microcontrollers	3 0 0	3
ENGG	23EEE353	Digital Signal Processors	3 0 0	3
ENGG	23ELC342	Unmanned Aerial Vehicle	3 0 0	3
ENGG	23ELC343	FPGA based System Design	3 0 0	3
ENGG	23EEE354	Industrial Automation	3 0 0	3
ENGG	23ELC344	Wireless Sensor Networks	3 0 0	3
ENGG	23EEE355	Biomedical Instrumentation	3 0 0	3
ENGG	23EEE356	Advanced Control Systems	3 0 0	3
ENGG	23EEE357	Digital Control Systems	3 0 0	3
ENGG	23EEE358	Process Control and Instrumentation	3 0 0	3

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

Computing Technologies				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	**23ELC361**	**Digital Image Processing**	**3 0 0**	**3**
ENGG	**23ELC362**	**Big Data Analytics**	**3 0 0**	**3**
ENGG	**23ELC363**	**Cloud Computing**	**3 0 0**	**3**
ENGG	**23ELC364**	**Deep Learning**	**3 0 0**	**3**
ENGG	**23ELC365**	**Block Chain Technology**	**3 0 0**	**3**
ENGG	**23ELC366**	**Cyber Security**	**3 0 0**	**3**
ENGG	**23ELC367**	**Natural Language Processing**	**3 0 0**	**3**
ENGG	**23ELC368**	**Green Computing**	**3 0 0**	**3**
ENGG	**23ELC369**	**Evolutionary Optimization Techniques**	**3 0 0**	**3**
ENGG	**23ELC370**	**Artificial Intelligence**	**3 0 0**	**3**
ENGG	**23ELC371**	**Operating Systems**	**3 0 0**	**3**
ENGG	**23ELC372**	**Data Structures and Algorithms**	**3 0 0**	**3**
ENGG	**23ELC373**	**Object Oriented Programming**	**3 0 0**	**3**
ENGG	**23ELC374**	**Data Base Management Systems**	**3 0 0**	**3**

Industry offered Courses				
Cat.	**Code**	**Title**	**L T P**	**Credit**
ENGG	**24EEE432**	**Cyber physical system for Industrial Applications**	**3 0 0**	**3**
ENGG	**24EEE431**	**Artificial Intelligence and Edge Computing**	**3 0 0**	**3**
ENGG	**24ELC331**	**Automotive Systems and Layered Architecture**	**2 0 2**	**3**
ENGG	**23MEE371**	**Applied Analytics**	**2 0 3**	**3**

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

EVALUATION PATTERN

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

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

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

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

Continuous Assessment Weightage Split-up for Lab Courses

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

List of courses in Amrita Value Programme I & II			
Course Code	**Title**	**L-T-P**	**Credits**
22ADM201	Strategic Lessons from Mahabharata	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

SYLLABUS

SEMESTER I

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

Course Objectives

- To introduce the students to the elements of technical style
- To introduce the basic elements of formal correspondence
- To introduce technical paper writing skills and methods of documentation
- To improve oral presentation skills in formal contexts

Course Outcomes

CO1: Understand and use the basic elements of formal correspondence and methods of documentation.
CO2: Learn to edit technical content for grammatical accuracy and appropriate tone and style.
CO3: Use the library and Internet recourses for research purposes.
CO4: Demonstrate the ability to communicate effectively through group mock-technical presentations and other activities.

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks

1. *Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 200.2*

2. *Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003.*

References

1. *Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan& Bacon, 1999.*
2. *Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.*
3. *Michael Swan. '' Practical English Usage'', Oxford University Press, 2000*

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

Course Objectives

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

Course Outcomes

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

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

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

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

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

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

Unit 3

Ordinary Differential Equations: Linear Differential Equations and Bernoulli Equation.

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

Textbooks

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

References

1. *Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, Calculus, 3rd Edition, 2002.*
2. *Dennis G. Zill and Michael R.Cullen, Advanced Engineering Mathematics, 2nd edition, CBS Publishers, 2012.*
3. *Bruce A. Finlayson, Introduction to Chemical Engineering Computing, John Wiley & Sons, 2006.*

23EEE101	FUNDAMENTALS OF ELECTRICAL ENGINEERING	L-T-P-C: 2-0-0-2

Course Objectives

- The objective of this course is to provide students a basic understanding in DC and AC electrical circuits containing both active and passive components under steady state.

Course Outcomes

CO1: Understand fundamental laws and characteristics of DC electrical networks.

CO2: Formulate electric circuit models and compute the steady state electrical quantities using mesh and nodal analysis.

CO3: Analyse the circuit parameters in single phase systems.

CO4: Model and analyse Magnetic circuits.

CO-PO Mapping

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

Syllabus

Unit 1

Electric circuit elements- Resistance, Inductance and Capacitance, Independent voltage and current sources, reference, directions and symbols, Ohm's law, Kirchoff's law, Energy and Power – Series parallel combination of R, L and C components. DC series – parallel circuits, Voltage and current division rules. Source Transformation, Network reduction using Star-delta transformation.

Network analysis – Mesh current and Node voltage analysis.

Unit 2

Generation of sinusoidal voltage, instantaneous, average and RMS values of periodic functions, V and I relation in R, L, C circuits, phasor representation. Reactance and impedance, real, reactive, apparent and complex powers, power factor, impedance and power triangle.

Magnetic circuits: Electromagnetic induction, magnetic circuit elements, series and parallel magnetic circuits, self and mutual inductances, dot convention.

Textbooks

1. *Vincent Del Toro, "Electrical Engineering Fundamentals", 2nd edition, Pearson Education India, 2015.*
2. *Hayt W, Kemmerly J, and Durbin S, Engineering circuit analysis, 7th ed. Boston, McGraw Hill Higher Education, 2007.*

References

1. *Nahvi M and Edminister J, Schaum's "Outline of Electric Circuits", 6th edition, New York, McGraw Hill, 2011.*
2. *Van Valkenburg M E, Network Analysis, 3rd ed. New Delhi, Prentice Hall-India, 2011.*
3. *Alexander C K and Sadiku M N O, "Fundamentals of electric circuits", 5th edition New York, McGraw Hill, 2013.*

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

Course Objectives

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Module 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

Module 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.

Module 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

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

Note: *The course is designed to provide students with a comprehensive understanding of engineering graphics, including 2D and 3D modeling techniques. The course will also cover various real-world applications of these techniques and how they are used in different industries. Students will be expected to complete assignments and projects using 3D Modeling Software (Autodesk® Fusion 360®).*
The classroom learning will be supplemented with a workbook, where the students shall have manual drawing practice for all projection-related topics

Textbooks

- 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

Workbook

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

References

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

Semiconductors, Dielectrics Classification of semiconductors, doping, temperature dependence, minority carriers and recombination, diffusion and conduction equations, continuity equation.
Optical Properties Light propagation in a homogeneous medium, absorption, scattering, luminescence, phosphors, LEDs, polarization, LCDs, electro optic effects.

Textbooks

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

References

1. *Halliday, Resnick, Jearl Walker, "Principles of Physics", 10th Edition, Wiley, 2015.*
2. *Charles Kittel, "Introduction to Solid State Physics" 8th Edition, Wiley, 2012.*
3. *David J Griffiths, "Introduction to Quantum Mechanics", 2nd Edition, Pearson Education, 2020.*

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

Course Objectives

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

Course Outcomes

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

CO-PO Mapping

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

List of Experiments

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

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

Course Objectives

- 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

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

CO-PO MAPPING

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

Syllabus

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

Additive Manufacturing Laboratory –12 hours

Introduction to digital manufacturing. Introduction to Additive Manufacturing - types – additive manufacturing applications - Materials for 3D printing, CAD Modelling for Additive Manufacturing, Slicing and STL file generation- G code generation - 3D printing of simple geometries.

Mechanical Engineering Laboratory –12 hours

Study of tools and equipment used for basic manufacturing processes.

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

Introduction to Machine Tools and Machining Processes

Automation Laboratory –12 hours

Design, simulation, and testing of pneumatic and electro-pneumatic circuits. Introduction to PLC–PLC programming for automation applications.

Automobile Engineering Laboratory –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.

References

Laboratory Manual (internal circulation)

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

Pre-Requisite(s): NIL

Course Objectives

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

Course Outcomes

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

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

CO3: Familiarize students with the multidimension of man's interaction with nature, fellow beings and society in general.

CO4: Appreciate the socio-political and strategic innovations based on Indian knowledge systems. Gives an understanding
of bringing Indian teaching into practical life.

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

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

Textbook

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

References

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

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

Pre-Requisite(s): NIL

Course Objectives

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

Course Outcomes

CO1: To be able to describe what meditation is and to understand its healthbenefits.
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 MA OM 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-drivenaction.

CO-PO Mapping

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

Syllabus

Unit 1: Describe Meditation and Understand its Benefits (CO1)
A: Importance of meditation. How does meditation help to overcome obstacles in life *(Pre-recorded video with Swami Shubhamritananda Puri)*
Reading 1: Why Meditate? (Swami Shubamritananda ji)
Reading 2: 'Stillness of the Mind' Chapter 17 in *Amritam Gamaya* (2022). MataAmritanandamayi Mission Trust.
Additional Reading: Abhyasa Yoga: The Yoga of Practice. (Br. Achyutamrita Chaitanya)
B: Understand how meditation works. Understand how meditation helps in improvingphysical and mental health. Understand how meditation helps in the development of personality *(Pre-recorded video with Dr. Ram Manohar)*
Reading 1: Allen, Cynthia (2020) The Potential Health Benefits of Meditation
Additional Reading: Sharma, Hari (2022) Meditation: Process and Effects

Unit 2: Causes of Stress and How Meditation Improves Well-being (CO2)
A: Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced dietin supporting meditation. (*Pre-recorded video with Dr. Ram Manohar)*

B: Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to relieve stress. Basics of stress management at home and the workplace. *(Pre-recorded video with Prof Udhaykumar)*
Reading 1: Mayo Clinic Staff (2022, April 29). *Meditation: A Simple, Fast Way to Reduce Stress.* Mayo Clinic. https://www.mayoclinic.org/tests-procedures/meditation/in-depth/meditation/art-20045858
Reading 2: 'Efficient Action.' Chapter 28 in *Amritam Gamaya* (2022). MataAmritanandamayi Mission Trust.

Unit 3: The Science of Meditation (CO3)
A: A preliminary understanding of the Science of meditation. What can modern science tell us about this tradition-based method? *(Pre-recorded video with Dr. Shyam Diwakar)*
B: How meditation helps humanity according to what we know from scientific research
(Pre-recorded video with Dr. Shyam Diwakar)
Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)
Reading 2: 'Science and Spirituality.' Chapter 85 in *Amritam Gamaya* (2022). MataAmritanandamayi Mission Trust.

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

Unit 5: Improving Communication and Relationships (CO5)
How meditation and mindfulness influence interpersonal communication. The role of meditation in improving relationship quality in the family, at the university and in theworkplace. *(Pre-recorded video with Dr Shobhana Madhavan)*
Reading 1: Seppala E (2022, June 30th) *5 Unexpected Ways Meditation Improves Relationships a Lot.* Psychology Today. https://www.psychologytoday.com/intl/blog/feeling-it/202206/5-unexpected-ways-meditation-improves-relationships-lot
Reading 2: 'Attitude.' Chapter 53 in *Amritam Gamaya* (2022). Mata AmritanandamayiMission Trust.

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

Textbooks/References

1. Meditation and Spiritual Life-Swami Yatiswarananda, Ramakrishna Math
2. The Complete Works of Swami Vivekananda Vol Vii by Advaita Ashram Mayavati Almora Himalayas
3. Dhyana Yoga-Holy Gita Swami Chinmayanda
4. Voice of God, Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
5. Hindu Dharma-Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
6. Mind: It's Mysteries and control-Swami Sivananda Saraswati
7. Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.
8. Books on Amma's teachings like Awaken children, From Amma's Heart etc.
9. The Science of Meditation: How to Change Your Brain, Mind and Body by Daniel Goleman and Richard. J. Davidson.
10. Allen, Cynthia (2020) The Potential Health Benefits of Meditation
11. Seppala E (2022, June 30th Unexpected Ways Meditation Improves Relationships a Lot.Psychology Today

12. Sharma, Hari (2022) Meditation: Process and Effects
13. Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress.
14. Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: What do we (not) know? Current Opinion in Psychology, 44, 151-156

SEMESTER II

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

Course Objectives

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbook

1. *Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.*

References

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

23CSE115	ALGORITHMIC THINKING AND COMPUTER PROGRAMMING	L-T-P-C: 3-0-2-4

Course Objectives

- To provide computational perspectives of problem solving and focus on design principles of algorithms
- To learn fundamentals of programming through C

Course Outcomes

CO1: Apply algorithmic thinking to understand, define and solve problems
CO2: Design and implement algorithm(s) for a given problem
CO3: Apply control structures for algorithms
CO4: Understand standard and user defined data types – arrays, strings and pointers.
CO5: Analyze a given program by tracing, identify coding errors and debug them

CO-PO Mapping

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

Syllabus

Unit 1

Problem Solving and Algorithmic Thinking Overview – problem definition, logical reasoning; Algorithm – definition, practical examples, properties, representation, algorithms vs programs. Algorithmic thinking – Constituents of algorithms – Sequence, Selection and Repetition, input-output; Computation. – expressions, logic; algorithms vs programs, Problem Understanding and Analysis – problem definition, input- output, variables, name binding, data organization: lists, arrays etc. algorithms to programs.

Unit 2

Structure of C programs, data types, data input-output statements, control structures. Functions – inter function communication, standard functions, scope. Arrays – 1D & 2D arrays. Recursion – recursive functions. Strings: fixed length and variable length strings, strings and characters, string input, output, array of strings, string manipulation functions.

Unit 3

Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic. File handling. Overview of Structures & Union.

Textbooks

1. *Riley D. D., Hunt K. A., "Computational Thinking for the Modern Problem Solver", CRC press, 2014*
2. *Forouzan B. A., Gilberg R. F., "Computer Science: A structured programming approach using C", 3rd Edition, Cengage Learning, 2006*

References

1. *Ferragina P and Luccio F., "Computational Thinking: First Algorithms, Then Code", Springer, 2018.*
2. *Beecher K., "Computational Thinking: A beginner's guide to Problem-solving and Programming" BCS Learning & Development Limited, 2017.*
3. *Byron Gottfried, "Programming With C", 4th Edition, McGrawHill, 2018.*
4. *Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", 2nd Edition, Prentice Hall, 1988.*
5. *Eric S. Roberts, "Art and Science of C", Addison Wesley, 1995.*

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

Course Objectives

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

Course Outcomes

CO1: Characterize the solids using X-ray diffraction technique and analyse the materials using computational tools.

CO2: Apply the fundamental principles of electrochemistry to illustrate the functioning of electrochemical energy systems.

CO3: Understand the application of polymers in fabricating integrated electronic devices.

CO-PO Mapping

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

Syllabus

Unit 1: Solid state

Crystalline and amorphous solids, isotropy and anisotropy, - Miller indices, space lattice and unit cell, Bravais lattices, the seven crystal systems and their Bravais lattices, X-ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique), types of crystals - molecular, covalent, metallic and ionic crystals - close packing of spheres – hexagonal, cubic and body centred cubic packing, elements of symmetry in crystal systems, defects in crystals – stoichiometric, non-stoichiometric, extrinsic and intrinsic defects. Vesta – for visualization of crystal structures.

Solar energy - introduction, utilization and conversion, photovoltaic cells - design, construction and working, panels and arrays. Advantages and disadvantages of PV cells. DSSC (elementary treatment).

Unit 2 : Electrochemical energy system

Faradays laws, origin of potential, electrochemical series, reference electrodes, Nernst equation, introduction to batteries - classification - primary, secondary and reserve (thermal) batteries. Characteristics - cell potential, current, capacity and storage density, energy efficiency. Construction, working and application of Leclanche cell-Duracell, Li-MnO2 cell, lead acid batteries. Ni-Cd battery, Lithium ion batteries. Fuel cell - construction and working of PEMFC.

Unit 3: Polymer and composite materials

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

Textbooks/References

1. *Jain and Jain, "Engineering Chemistry", Dhanpat Rai Publishing company, 2015.*
2. *Patrick M. Woodward, Pavel Karen, John S. O. Evans, Solid State Materials Chemistry, Cambridge University Press, 2021.*

3. *Vladimir S. Bagotsky, Alexander M. Skundin, Yurij M. Volfkovich, Electrochemical Power Sources, Batteries, Fuel Cells, and Supercapacitors, John Wiley and Sons, 2015.*
4. *Bansi D. Malhotra, Handbook of Polymers in Electronics, Rapra Technology Limited, 2002.*
5. *Ye Zhou, Guanglong Ding, Polymer Nanocomposite Materials: Applications in Integrated Electronic Devices, Wiley-VCH, 2021.*

23EEE111	ELECTRICAL CIRCUITS	L-T-P-C: 3-0-0-3

Course Objective

To impart knowledge on electric circuit analysis under steady state and transient conditions.

Course Outcomes

CO1: Understand fundamental laws and characteristics of DC and AC electrical networks.
CO2: Formulate electric circuit models and compute the steady state electrical quantities using network theorems and graph theory.
CO3: Analyze the behavior of electric circuits under transient conditions.
CO4: Analyze three phase circuits and two port networks.

CO-PO Mapping

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

Syllabus

Unit 1

Steady state analysis of DC and AC circuits: Mesh current and Node voltage analysis of circuits with independent and dependent sources. Network Theorems: Thevenin and Norton's theorems, Superposition theorem, Maximum Power Transfer Theorem, Tellegen's and Reciprocity Theorem. Coupled circuits – Dot convention analysis.

Unit 2

Transient Analysis: Time domain analysis of first and second order electric circuits, Analysis of AC circuits using Laplace transforms. Frequency response of series and parallel circuits: RLC Resonance, Q-factor and Bandwidth.

Unit 3

Three phase systems – Three phase 3-wire and 4-wire circuits, balanced and unbalanced, Star and Delta connected source and loads, Phasor Diagrams. Two-Port Networks: Z, Y, ABCD, hybrid and inverse hybrid parameters, interconnections and relationships among different network parameters.
Graph Theory: Incidence matrix, Fundamental Tie-Set Matrix, Fundamental Cutset Matrix, Formulation of network equations using KCL and KVL.

Textbook

1. *Alexander C K and Sadiku M N O, Fundamentals of electric circuits, 5th ed. New York, McGraw-Hill, 2013.*

References

1. *Nahvi M and Edminister J, Schaum's Outline of Electric Circuits, 5th ed. New York, McGraw-Hill, 2011.*
2. *Hayt W, Kemmerly J, and Durbin S, Engineering circuit analysis, 7th ed. Boston, McGrawHill Higher Education, 2007.*
3. *Van Valkenburg M E, Network Analysis, 3rd ed. New Delhi, Prentice Hall-India, 2011.*

23EEE112	ELECTRONIC CIRCUITS	L-T-P-C: 3-0-0-3

Course Objective

- To provide understanding of electronic devices such as diodes, BJTs and MOSFETs and familiarize with their applications.

Course Outcomes

CO1: Understand the structure and working principle of of electronic devices.
CO2: Analyze the characteristics of Diodes, transistors, MOSFET.
CO3: Construct biasing circuits for transistors.
CO4: Develop application circuits using diodes, BJT and MOSFETs

CO-PO Mapping

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

Syllabus

Unit 1

Overview of Semiconductor devices. PN- Junction Diode- characteristics, rectifiers – Clippers and clampers. Zener Diode- Regulated power supplies. BJT: Current – Voltage characteristics, BJT as an amplifier and as a switch, brief idea of dc analysis, Biasing circuits, small signal operation and models, single stage BJT amplifiers, Frequency response of CE amplifier. Emitter follower.

Unit 2

MOS Field Effect Transistors: Introduction, device structures and physical operations, i-v characteristics, MOSFET as switch, Biasing, small signal operation and models, single stage MOS Amplifiers, frequency response of CS amplifiers, Differential Amplifiers: MOS differential Pair. Overview of CMOS, CMOS Inverter circuits and Logic Gate circuits.

Unit 3

Power amplifier: Classification and Comparison of power amplifiers. Linear Voltage Regulators: Characteristics, design and analysis of voltage regulators. Types of feedback, Feedback amplifiers. Oscillators and multivibrators – introduction, types and applications.

Textbook

Adel.S.Sedra, Kenneth.C. Smith, "Microelectronic Circuits", Oxford University Press, Fifth Edition, 2005.

References

1. *Donald.E.Neaman, "Electronic Circuit, Analysis and Design", Tata McGraw Hill Publishing Company Limited, Second Edition, 2006.*
2. *David A. Bell, "Electronic devices and Circuits", 5th Edition, Oxford University Press India, 2008.*
3. *Thomas L. Floyd, David M. Buchla, Electronics Fundamentals: Circuits, Devices & Applications, 8th Edision, Pearson education*
4. *Boylestad and Nashlesky – Electronic Devices and Circuit Theory, PHI, 10th Edition*

23EEE113	MATERIALS FOR ELECTRICAL ENGINEERING	L-T-P-C: 2-0-0-2

Course Objective

This course helps to understand the structure and properties of materials used in Electrical Engineering.

Course Outcomes

CO1: Understand the structure and properties of conducting materials
CO2: Understanding semiconductors and its properties
CO3: Understand the classification of magnetic materials and its properties
CO4: Understanding properties of dielectric materials

CO-PO Mapping

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

Syllabus

Unit 1

Conducting Materials: The nature of chemical bond, crystal structure, Ohm's law and relaxation time, collision time, electron scattering and resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity.
Semiconducting Materials: Chemical bonds in Si, Ge and its consequences, density of carriers in intrinsic semiconductors, carrier densities in n type semiconductors, Hall effect and carrier density

Unit 2

Magnetic Materials: classification, diamagnetism, magnetic dipoles, paramagnetic spin systems, ferromagnetism and coercive force, anti-ferromagnetic materials, ferrites and its applications
Dielectric Materials: Static dielectric constant, polarization and dielectric constant, internal fields in solids and liquids, piezoelectricity.

Text Book

J Decker, "Electrical Engineering Materials", PHI, Newdelhi, 1957

References

1. *A.J.Decker, "Solid State Physics", Prentice Hall, Englewood Cliffs, 1957*
2. *F.K. Richtmyer E H Kennard, John N Copper, "Modern Physics" Tata Mc Graw Hill, 1995.*

23EEE181	ELECTRIC & ELECTRONIC CIRCUITS LAB	L-T-P-C: 0-0-3-1

Course Objective

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

Course Outcomes

CO1: Ability to demonstrate network theorems, fabricate circuits and validate performance through simulation and hardware.

CO2: Ability to demonstrate electronic circuit performance through hardware and simulation.

CO-PO Mapping

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

Syllabus

Hardware/Simulation experiments in Kirchhoff's laws, Network Theorems, Transients, Resonance etc. Hardware/Simulation experiments in Diode Applications, BJT Characteristics and Amplifier Design, MOSFET Switching characteristics, Regulators, Oscillators.

Textbooks

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

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

Course Objectives

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

Course Outcomes

CO1: Knowledge on electrical safety measures and familiarity with electrical tools, electronic components and their symbols.
CO2: Understanding of operation of electrical and electronic appliances.
CO3: Knowledge of domestic wiring and soldering practice.

CO-PO Mapping

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

Syllabus

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

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

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

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

List of Experiments

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

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

Pre-Requisite(s): NIL

Course Objectives

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

Course Outcomes

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

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

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

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

CO-PO Mapping

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

Syllabus

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

Chapter 12 - Indian Approach to Science

Textbook

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

References

1. *Fear Not: Be Strong (Swami Tathagatananda).*
2. *Essays on Gita (Sri Aurobindo)- Aurobindo Ashram.*
3. *Indian Contribution to Science (Vijana Bharati Publication).*
4. *The Culture and Civilisation Of Ancient India In Historical Outline (D. D. Kosambi).*
5. *The Kautilya Arthashastra by Chankaya – Translation with critical and explanatory note by R P Kangle – Motilal Banarasidass Publishers- 1972.*
6. *Chanakya Neeti – Strategies for success – Radhakrishnan pillai – Jaico Publishing house -2020.*
7. *Universal Message of the Bhagavad Gita: An exposition of the Gita in the Light of Modern Thought and Modern Needs. - Swami Ranganathananda, Advaita Ashrama Belur Math, 2000.*
8. *A Concise History Of Science In India – D M Bose, S N Sen, B V Subbarayappa,The Indian National Science Academy 1971.*
9. *Indian Culture and India's Future – Michel Danino - D.K. Printworld (P) Ltd -2011.*

SEMESTER III

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

Course Objectives

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks

1. *E Kreyszig, John Wiley and Sons, "Advanced Engineering Mathematics", Tenth Edition, 2016.*

2. Adi Adhikari and John DeNero, "Computational and Inferential Thinking: The Foundations of Data Science", e-book.

References

1. *Data Mining for Business Analytics: Concepts, Techniques and Applications in R, by Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl Jr., Wiley India, 2018.*
2. *Rachel Schutt & Cathy O'Neil, "Doing Data Science" O' Reilly, First Edition, 2013.*
3. *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.*
4. *J. Ravichandran, "Probability and Random Processes for Engineers", First Edition, IK International, 2015.*
5. *Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition (2007), Pearson Education Asia.*

23MEE206	FUNDAMENTALS OF MECHANICAL ENGINEERING	L-T-P-C: 3-0-0-3

Course Objectives

The objective of this is to understand the basic concepts of machine operation and mechanical system design, physical properties of force, motion, stress and elasticity. It also introduces the principles of equilibrium and thermodynamic laws. It also introduces the principles of fluid mechanics.

Course Outcomes

CO1: Apply the concept of equilibrium to systems which can be modelled as particles in 2D and to rigid bodies in 2D

CO2: Analyse simple statically determinate structures such as beams subject to various loadings and support conditions

CO3: Define the concepts of heat, work, and energy and discuss the first law of thermodynamics

CO4: Discuss the second law of thermodynamics. and explain the concept of entropy and principle of increase of entropy.

CO-PO Mapping

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

Syllabus

Unit 1

Principles of Statics- Introduction to mechanics, basic concepts, fundamentals and principles. Statics of particles in two dimension- resolution of forces, resultant force, equilibrium of particle, free body diagram, Lami's Theorem. Statics of rigid bodies in two dimension- moment of a force about a point, Varignon's Theorem, moment of a couple, resolution of a force system into a force couple system, reduction to a single force system. Equilibrium of rigid bodies- analysis of beams, supports and reactions.

Unit 2

Thermodynamics- Introduction, concepts of Thermodynamic system, properties- specific volume, pressure, temperature- zeroth law of thermodynamics, energy forms- work and heat.

First law of Thermodynamics- For a closed system undergoing a cycle, for a process, energy as a property, specific heats, first law of Thermodynamics applied to steady flow devices.

Second law of Thermodynamics- Concept of heat engines and refrigerators, Kelvin Plank and Clausius statements, irreversibility, carnot cycle, Clausius inequality, thermodynamic temperature scale, concept of Entropy, principle of increase of entropy.

Unit 3

Fluid mechanics and fluid machinery: Fluid properties-viscosity - surface tension - fluid pressure -measurement of viscosity and pressure, Centre of pressure, Buoyancy, Classifications of flow, Continuity equation, Bernoulli's equation, Momentum equation – applications, Friction in flow passages, Flow measuring instruments. Fluid machinery: Air compressors -- working principles – loads – characteristics and electric power requirement. Hydraulic turbines – classifications -- performance characteristics-governing - cavitation, Hydraulic pumps – classification -- performance characteristics – cavitation - electric power requirements

Textbooks:

1. R.C.Hibbeler. "Engineering Mechanics-Statics", Pearson Education Asia, 2012

2. Y.A. Cengel and Michael A. Boles, "Thermodynamics – An Engineering Approach", Tata McGrawHill, 2013.

3. F. M. White, "Fluid Mechanics", fifth edition, McGraw Hill New York, 2005.

References:

1. *J. L.Meriam & L.G Kraige. "Engineering Mechanics- Statics", 7th edition, Wiley India Pvt. Ltd, 2013.*
2. *Beer and Johnston, "Vector Mechanics for Engineers", Tata Mc Graw Hill Publishing Company Ltd, 2012N.H Dubey. "Engineering Mechanics Statics and Dynamics" Mc Graw Hill, 2012.*
3. *R.E. Sonntag, C. Borgnakka and G. J. Van Wylen, "Fundamentals of Thermodynamics", John Wiley and Sons, 2002.*
4. *R.L. Daugherty, J.B. Franzini, Fluid Mechanics with Engineering Applications, 7th ed., McGraw Hill, New York, 1977.*

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbook

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

References

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

23EEE202	ANALOG INTEGRATED CIRCUITS	L-T-P-C: 3-0-0-3

Course Objectives

To provide fundamental knowledge of the characteristics and expose to linear and non-linear applications of operational amplifiers.

Course Outcomes

CO1: Understand the characteristics and parameters of operational amplifiers
CO2: Design linear and non-linear applications using operational amplifiers.
CO3: Analyze the frequency response characteristics of active filters.
CO4: Exposure to interpret special function integrated circuits.

CO-PO Mapping

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

Syllabus

Unit 1

Operational amplifiers**:** Equivalent circuit, voltage transfer curve-Open loop Op-amp configurations –Voltage series, Voltage shunt feedback amplifiers configurations–inverting and non-inverting amplifier, closed loop differential amplifiers for single and differential outputs. AC and DC characteristics of OPAMP.

Unit 2

Applications of Op Amp: DC & AC amplifiers, Summing, Scaling and Averaging amplifiers **-** Instrumentation Amplifier- voltage to current converter - Current to voltage converter - Integrator, Differentiator. Voltage comparators – ZCD -Schmitt trigger with voltage limiter- Precision Rectifier Circuits - Peak Detector-Sample and Hold circuit.

Active Filters**:** Frequency response characteristics, first and higher order low pass and high pass filters, all pass filters.

Unit 3

Oscillators**:** Requirements for oscillations, Op- amp RC oscillators, Voltage controlled oscillators

Waveform generators: square wave, triangle and saw tooth. 555 timer - Astable and monostable operation, PLL-An overview and Monolithic Voltage Regulators

Textbooks

1. *Ramakant A. Gayakwad, "Op-Amps and Linear integrated circuits", PHI, 4th Edition, 2000.*
2. *Donald.E.Neaman, "Electronic Circuit, Analysis and Design", Tata McGraw Hill Publishing Company Limited, Second Edition, 2002.*

References

1. *Adel.S.Sedra, Kenneth.C.Smith, "Microelectronic Circuits", Oxford University Press, Fifth Edition, 2004.*
2. *Sergio Franco,"Design with operational amplifiers and Analog Integrated circuits", Tata McGraw Hill, Third Edition 2002.*
3. *Tony Chan Carusone, David Johns, Kenneth Martin, "Analog Integrated Circuit Design", second edition, Wiley, 2011.*

23EEE203	DIGITAL ELECTRONICS	L-T-P-C: 3-0-0-3

Course Objective

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

Course Outcomes

CO1: Understand the basics concepts of digital systems.
CO2: Develop Boolean equations and truth tables for synthesis of logic functions and optimize the same using various minimization methods.
CO3: Analyze logic processes and implement logical operations using combinational logic circuits.
CO4: Synthesis and analysis of synchronous and asynchronous sequential circuits.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to Logic Circuits, Logic Families: Logic Gates and Networks, Truth tables, Boolean algebra, Synthesis using logic gates, Design Examples, Introduction to Logic families such as ECL, TTL.
Implementation Technology: Transistor Switches, NMOS and PMOS logic gates, Introduction to CMOS Logic Gates, Negative Logic System, tri-state logic.
Optimized Implementation of Logic Functions: Karnaugh map, Strategies for minimization, incompletely specified Functions, Multiple – output Circuits, Tabular Method for minimization.
Number Representation and Arithmetic Circuits: Addition of unsigned Numbers, Signed numbers, Adder Circuits.

Unit 2

Combinational Circuit Building Blocks: Multiplexers, Decoders, Encoders, Code Converters, Arithmetic Comparison Circuits.
Flip Flops, Registers, Counters: Basic Latch, Gated SR latch, master slave and edge triggered D flip-flops, T flip-flop, JK flip-flop, registers, counters, types of counters, Simple Control for MCB.

Unit 3

Synchronous Sequential Circuits: Basic Design Steps, State Assignment Problem, Mealy state Model, Moore State Model, Serial Adders Example, State minimization, Sequential Circuit design for drive control.
Asynchronous Sequential Circuits: Asynchronous Behavior, Analysis of Asynchronous circuits.

Textbooks

1. *Stephen Brown, ZvonkoVranesic, "Fundamentals of Digital logic with Verilog Design", Tata. McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.*
2. *Morris Mano, "Digital Design", Pearson Education, Third Edition, 2006.*

References

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

23EEE204	ELECTROMAGNETIC THEORY	L-T-P-C: 3-0-0-3

Course Objective
To introduce different coordinate systems, concepts of electrostatic, magneto static and time varying electromagnetic fields.

Course Outcomes
CO1: Understanding of coordinate systems, conversions and governing laws of Electric and Magnetic fields
CO2: Ability to analyze Electric and Magnetic field distributions using Maxwell's equations
CO3: Ability to evaluate electromagnetic and electrostatic fields in scalar and vector forms
CO4: Ability to formulate Travelling Waves in different media.

CO-PO Mapping

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

Syllabus
Unit 1
Vectors and co-ordinate systems: - Cartesian, cylindrical and spherical co-ordinate systems- scalar and vector fields.
Electric and Magnetic fields: - line, surface and volume integrals- Coulomb's law- Gauss's law- Biot-Savart's law- Ampere's circuital law- applications- boundary conditions for electric and magnetic fields- Lorentz force equation.

Unit 2
Maxwell's equations: - gradient, curl and divergence- Maxwell's equation in integral form- Law of conservation of charge- Maxwell's equation in differential form- continuity equation- boundary condition for electromagnetic fields.
Electric potential- Poisson's and Laplace's equations- capacitance- energy stored- magnetic scalar and vector potentials- magnetic circuits- inductance- energy stored- conductance.

Unit 3
Uniform plane waves and sinusoidally varying waves in time domain and in free space- polarization- power flow and Poynting vector- wave parameters- plane waves in material media- skin effect- reflection and transmission of uniform plane waves- normal and oblique incidence in conductor and dielectric interfaces.

Virual lab platforms /simulation demos/ animated videos can be used for effective classroom teaching.

Textbooks

1. *N.Narayana Rao, "Elements of Engineering Electromagnetics", Sixth Edition, Pearson Education, 2006.*
2. *William H. Hayt, John. A. Buck, "Engineering Electromagnetics," Seventh Edition, Tata. McGraw Hill, 2007.*

References

1. *David.K.Cheng, "Field and Wave Electromagnetics", Second Edition, Pearson Education, 2002.*
2. *Sadiku, "Elements of Electromagnetics", Second Edition, Oxford University press. 2007.*

23EEE205	INTRODUCTION TO PYTHON PROGRAMMING	L-T-P-C: 1-0-2-2

Pre-requisite: ATP / PSAT

Course Objective:
To understand the basics of python programming

Course Outcomes:
CO1: Understand typical python programming constructs
CO2: Apply control structures and functions
CO3: Apply operations of list, tuples and dictionaries to scenarios.
CO4: Understand OOP using Python constructs.

CO-PO Mapping

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

Syllabus
Unit 1
Python basic syntax, interactive shell, editing, saving, and running a script.. Data types; variables, immutable variables operators and expressions, Control statements: if-else, loops (for, while); Lists, tuples, and dictionaries; basic operations, Recursive functions.

Unit 2
Importing libraries and modules – NumPy, time, etc.String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa.

Unit 3
OOP: classes, objects, attributes and methods; defining classes; apply OOP to scenarios.

Textbook

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

References

1. *Tony Gaddis, "Starting Out with Python", Pearson, 3rd Edition, 2014.*
2. *Kenneth A. Lambert, "Fundamentals of Python: First Programs", Cengage Learning, 2nd Edition, 2018.*
3. *Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", O'Reilly Media, 2012.*

23EEE281	ANALOG AND DIGITAL ELECTRONICS LAB	L-T-P-C: 0-0-3-1

Course Objective

To provide fundamental knowledge of the characteristics and expose to linear and non-linear applications of operational amplifiers.

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

Course Outcomes

CO1: Understand the basic concepts of analog and digital electronics.

CO2: Design and apply the analog and digital electronics circuits for various applications

CO3: To enable the students to solve the engineering problems in the perspective of electronics.

CO-PO Mapping

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

Syllabus

Opamp characteristics, Applications like adder, integrator, differentiators, comparators, waveform generator using Operational amplifiers - Schmitt trigger, oscillators and time circuits, frequency response of active filter.

Verification of Boolean Theorems using basic gates, Design and implementation of combinational circuits using basic gates for arbitrary functions, code converters, multiplexers and de-multiplexers, Design and implementation of shift-registers, counters. Implementation on FPGA.

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

Course Objectives

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

Course Outcomes

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

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

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

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

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

CO-PO Mapping

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

Textbooks/ References

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

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

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

Course Objectives

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

Course Outcomes

CO1: Soft Skills: To develop greater morale and positive attitude to face, analyse, and manage emotions in real life situations, like placement process.
CO2: Soft Skills: To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.
CO3: Aptitude: To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.
CO4: Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis.
CO5: Verbal: To infer the meaning of words and use them in the right context. To have a better understanding of the basics of English grammar and apply them effectively.
CO6: Verbal: To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively.

CO-PO Mapping

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

Syllabus

Soft Skills

Soft Skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Learning to benefit from constructive criticisms and feedback, Need for change in mindset and up-skilling to keep oneself competent in the professional world.
Managing Self: Knowing oneself, Self-perception, Importance of positive attitude, Building and displaying confidence, Avoiding being overconfident, Managing emotions, stress, fear. Developing Resilience and handling failures. Self-motivation, Self-learning, and continuous knowledge up-gradation / Life-long learning. Personal productivity - Goal setting and its importance in career planning, Self-discipline, Importance of values, ethics and integrity, Universal Human Values.

Aptitude

Problem Solving I

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.
Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.
Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.
Averages: Basics, and Weighted Average.

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

Verbal

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

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

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

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

References

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

Evaluation Pattern

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

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

SEMESTER IV

23EEE211	ELECTRICAL MEASUREMENTS	L-T-P-C: 3-0-2-4

Course Objective

To study the characteristics of basic electrical measuring instruments and to understand and apply concepts of transduction, signal conditioning and monitoring of electrical parameters.

Course Outcomes

CO1: Understanding on the characteristics and standards of measurement systems
CO2: Familiarization with operation of electro-mechanical and electronic instruments
CO3: Ability to use transducers, Signal conditioning and signal monitoring in electrical measurements
CO4: Ability to apply modern digital methods in data acquisition systems for measuring electrical parameters.
CO5: Exposure to laboratory implementation of measurement systems and performance analysis through simulation and hardware.

CO-PO Mapping

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

Syllabus

Unit 1

Qualities of measurements: Introduction, performance characteristics, errors in measurements, types of static error, sources of error, dynamic characteristics, statistical analysis, standards.
DC and AC bridges: Wheatstone bridge, Kelvin's Bridge, inductance and capacitance Measurements-Maxwell's bridge, De-sauty's bridge, Schering bridge, Wein bridge and Anderson bridge.
Analog meters: Basic meter movement, taut band, Electrodynamometer type (EDM), Moving Iron Instruments. Measurement of current –ammeter, multirange ammeter, Ayrton shunt, extension of ammeter ranges. Measurement of voltage –basic meter as voltmeter, multirange voltmeter, extension of voltmeter range, loading effect, AC voltmeter using half wave and full wave rectifier, average, peak and true RMS voltmeters.

Unit 2

Instrument Transformers: Current Transformer, potential transformer.
Measurement of Power and Energy: Different wattmeter connections in 3 phase circuits, EDM type wattmeter and Power factor meters, energy meter, calibration of meters.
Oscilloscope: Basic principle, CRT features, block diagram of oscilloscope, types, Digital storage oscilloscope, applications of CRO.
Transducers: Electrical transducers, resistive transducers, strain gauge, thermistor, RTD, inductive transducers, LVDT, capacitive transducer, piezo electric, photo voltaic cell, photo diode, photo transistors.

Unit 3

Digital Voltmeters: Ramp and dual slope integrating type DVM, Successive approximation type analog to digital conversion techniques, resolution and sensitivity of digital meters, digital frequency, time and phase measurements. Smart energy meter and net metering.
Instrumentation Systems: Block diagram, Signal conditioning systems, Instrumentation amplifier.

Data Acquisition and Data transmission: Objectives of DAS, single/multichannel DAS, digital to analog converters, data loggers, data transmission systems, advantages of digital transmission, time division multiplexing.
Virtual Lab Platform/ Simulation demos can be used for effective teaching in class room.

Textbooks

1. *H.S Kalsi, "Electronic Instrumentation", Tata McGraw-Hill Publishing Company Limited, 2010.*
2. *E.W Golding and F.C Widdis, "Electrical measurements and measuring instruments", The English Language Book society, 5th Edition, 2011.*

References

1. *A.K. Sawhney, "A Course in Electrical & Electronics Measurements and Instrumentation", Dhanpat Rai and Sons,2 008.*
2. *Deobeling E.O, "Measurement systems, Applications and design", Tata McGraw-Hill Publishing Company Limited, 2004.*
3. *John G. Webster & Halit Eren, "Measurement, Instrumentation, and Sensors Handbook, Second Edition: Spatial, Mechanical, Thermal, and Radiation Measurement," CRC Press, 2014*

23EEE212	ELECTRICAL MACHINES I	L-T-P-C: 3-0-0-3

Course Objective
To introduce fundamental concepts, operation, control and application of DC machines and transformers.

Course Outcomes
CO1: Understand the principles and construction of DC machines and transformers.
CO2: Develop equivalent circuit model and steady state equations of DC machines and transformers.
CO3: Analyze the performance characteristics of DC machines and transformers.
CO4: Familiarize the selection and applications of DC machines and transformers.

CO-PO Mapping

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

Syllabus
Unit 1
Review of electric and magnetic circuits, Principles of electromechanical energy conversion, DC Machines: Construction- DC generator - EMF equation, Armature Reaction, Commutation, Types and Characteristics.

Unit 2
DC motors – Torque equation, Types and Characteristics, Starting, Speed Control and braking of DC Motors, Losses and Efficiency, Testing.
Application and selection of DC machines - Universal motors, Permanent Magnet DC Machine - Electric traction and Electric Vehicles.

Unit 3
Transformer: Construction and principle of operation. Ideal Transformer, Transformer on No-load and load, Equivalent Circuit, Performance evaluation: Losses, Efficiency and Regulation – all day efficiency – Testing. Autotransformers, Three-phase Transformers, connections. Parallel operation of transformers - Cooling methods. Application and selection of Transformers- Tap changing transformers, phase shifting transformers, instrument transformers.

Textbooks

1. *Kothari D.P. and Nagrath I.J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.*
2. *Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.*

References

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

23EEE213	INTRODUCTION TO MACHINE LEARNING	L-T-P-C: 3-1-0-4

Course Objective

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

Course Outcomes

CO1: Understand the basic concepts of optimization for learning.

CO2: Design classification models for real time applications.

CO3: Develop prediction models using regression.

CO4: Analyse modern tools for real world scenarios.

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbook

1 Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", Third Edition, 2022.

2. Christopher M. Bishop, "Pattern Recognition and Machine Learning (Information Science and Statistics)", 2016

References

1. Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, "An Introduction to Statistical Learning", Springer, Second Edition, 2017.

2. Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly Media, Inc.2016.

3. Fabio Nelli, "Python Data Analytics: Data Analysis and Science Using Pandas, matplotlib, and the Python Programming Language", APress, 2015.

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

Pre-requisite: Digital Electronics.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit1

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

Unit2

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

Unit3

Peripherals: Port configuration, Parallel Slave Port, LED and Keyboard interface, Timers/Counters, Watchdog Timer, ADC, USART, CCP module. Introduction to 8051 micro controller: Architecture, Instruction Set, Interrupts, Ports, Timers.

Textbooks

1. *Myke Predko, "Programming and customizing the PIC microcontroller", Tata McGraw Hill Publishing Company Limited, Third Edition, 2008.*
2. *PIC Micro mid-Range MCU Family Reference Manual - Micro Chip Technology Inc.*

References

1. *T. R. Padmanabhan, "Introduction to microcontrollers and applications", First Edition, Narosa publishing house private limited, 2007.*
2. *Lucio Di Jasio , "PIC Microcontrollers" Elsevier Science & Technology, 2007*
3. *Mazidi MA And Mckinlay "PIC Microcontroller and Embedded Systems Using Assembly And C For Pic 18", Pearson India , first edition, 2015.*

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Lab Practice: Experiments in modelling, design and analysis of controllers using Simulation / Hardware.

Textbooks

1. *Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson, 2011.*
2. *Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.*

References

1. *M. Gopal, "Modern Control System Theory", New Age International, 3rd edition 2014.*
2. *Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013.*
3. *Nagrath I.J., Gopal M., "Control Systems Engineering", New Age Publishers 2017*

23EEE282	ELECTRICAL MACHINES –I LAB	L-T-P-C:

Course Objectives

- Illustrate operating principles, characteristics and performance of various DC machines and transformers.
- Select suitable starting technique and perform the speed control of DC motors.
- Develop the equivalent circuit of transformers and analyse the performance characteristics.
- Analyse the various configurations of transformers and perform parallel operation

Course Outcomes

CO1: Understand the performance characteristics of DC machines
CO2: Analyze the speed control of DC motors
CO3: Analyze the performance characteristics of transformer
CO4: Demonstrate the Parallel operation of transformer and three phase transformer connections

CO-PO Mapping

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

Syllabus

DC Generator: OCC, Internal and External Characteristics. DC motor: Speed control, Swinburn's test, Load test. - Transformers: OC & SC tests, Sumpner's test, Parallel operation, Load test, Three-phase transformer connections -Separation of Losses.

Textbook

1. D. *P. Kothari, B S Umre, "Laboratory Manual For Electrical Machines", second edition, I K International, 2017.*

References

1. Kothari D.P. and Nagrath I.J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.
2. *Stephen J. Chapman, "Electric Machinery Fundamentals", 4th edition, McGraw Hill Education Pvt. Ltd, 2010.*

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
CO1							2	3	3		3
CO2								2	3		3
CO3		3		2							
CO4		3		2							
CO5									3		3
CO6								3	3		3

Syllabus

Soft Skills

Communication: Process, Language Fluency, Non-verbal, Active listening. Assertiveness vs. aggressiveness. Barriers in communication. Digital communication
Presentations: Need, importance, preparations, research and content development, structuring and ensuring flow of the presentation. Ways and means of making an effective presentation: Understanding and connecting with the audience – using storytelling technique, managing time, appropriate language, gestures, posture, facial expressions, tones, intonations and grooming. Importance of practice to make an impactful presentation.

Aptitude

Problem Solving II

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.
Logarithms, Inequalities and Modulus: Basics
Time and Work: Basics, Pipes & Cistern, and Work Equivalence.
Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.
Logical Reasoning: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives.

Verbal

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

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

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

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

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

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

References

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

Evaluation Pattern

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

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

22ADM201	STRATEGIC LESSONS FROM MAHABHARATA	L-T-P-C: 1-0-0-1

Course Objectives

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

Course Outcomes

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

CO2: Enabling students to importance of fighting *adharma* for the welfare of the society through Sabha and Vanaparva

CO3: Understand the nuances of dharma through the contrast between noble and ignoble characters of the epic as depicted in the Vana, Virata, Udyoga and Bhishma parvas

CO4: Getting the deeper understanding of the Yuddha Dharma through the subsequent Parvas viz., Drona, Karna, Shalya, Sauptika Parvas.

CO5: Making the students appreciative of spiritual instruction on the ultimate triumph of dharma through the presentations of the important episodes of the MB with special light on Shanti, Anushasana, Ashwamedhika, Ashramavasika, Mausala, Mahaprasthanika and Swargarohana Parvas.

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

Popular Regional Tales.

Maha Prasthanam – The Last Journey.

Unit 5

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

Textbooks/ References

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

SEMESTER V

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

Pre-requisites: Signals and Systems

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

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

Textbooks

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

References

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

2. Li Tan & Jean Jiang, "Digital Signal Processing, Second Edition: Fundamentals and Applications", AP, 2nd edition, 2013.

3. Dimitris G. Manolakis and Vinay K. Ingle, "Applied Digital Signal Processing: Theory and Practice", Cambridge University Press, 2011.

4. Bernard Mulgrew, Peter Grant and John Thompson "Digital Signal Processing: Concepts and Applications", 2nd Edition, Palgrave Macmillan,2002

23EEE302	POWER ELECTRONICS	L-T-P-C: 3-0-0-3

Course Objective
To impart knowledge on the characteristics of various power semiconductor devices, converters and their operation. Design and synthesis of power conversion circuits for various applications.

Course Outcomes
CO1: Understand the static and dynamic characteristics of power semiconductor devices and various power electronic converters.
CO2: Analyze the behaviour of converters and their control under different modes of operation.
CO3: Design different converter circuits under different operating modes.
CO4: Evaluate the performance of power converters for various applications.

CO-PO Mapping

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

Syllabus
Unit 1
Power Semiconductor Devices: Power diodes, Thyristors, BJT, Power MOSFET, IGBT -Structure, turn ON and turn OFF operation, steady state and switching characteristics. Introduction to wide band gap power semiconductor devices, Comparison and selection of controllable switches – Introduction to driver circuits - Power loss in switching devices, Temperature rise and heat sink.
Unit 2
Phase Controlled Converters: Single phase and Three phase Converters in CCM - performance parameters, DCM operation, Analysis of Single-phase converter with different loads - Non-Sinusoidal Analysis. Inverter mode of operation - Effect of Source Inductance.
Single-phase AC Voltage Controllers with different loads - Thyristor Controlled Reactor.
Choppers: Step down and step up choppers - Steady state operation - CCM. Applications of choppers - power factor correction.
Unit 3
Inverters: Single phase half bridge and full bridge inverter, Inverter control - square wave, sine PWM - Unipolar and Bipolar voltage switching, performance parameters, AC and DC side current. Three phase inverters – sine PWM. Rectifier mode of operation - AC side filter – Applications.

Textbooks

1. *Ned Mohan, Tore M. Underland and William P. Robbins, "Power Electronics: Converters, Applications and Design", Third Edition, John Wiley & Sons, 2007.*
2. *Erickson, Maksimovic, and Dragan "Fundamentals of Power Electronics", Kluwer academic publishers, 2020.*

References

1. *L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.*
2. *Joseph Vithayathil "Power Electronics" Tata McGraw Hill, 2010.*
3. *Muhammed H Rashid, " Power Electronics- circuits, devices and applications" Pearson Education; Fourth edition 2017.*
4. *Shaffer, Randall, "Fundamentals of Power Electronics with Matlab", Firewall media, 2013*

23EEE303	ELECTRICAL MACHINES II	L-T-P-C: 3-0-0-

Course Objective
To introduce fundamental concepts, operation, control and application of AC machines.

Course Outcomes
CO1: Understand the construction and principle of operation of AC machines.
CO2: Develop equivalent circuit, phasor diagrams and steady state equations of AC machines.
CO3: Analyze performance characteristics of AC machines.
CO4: Familiarize the selection and applications of AC machines.

CO-PO Mapping

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

Syllabus
Unit 1
Synchronous machines – principle and construction, salient pole and non-salient pole machines- damper winding - characteristics, armature reaction - regulation, parallel operation, operation on infinite bus, real and reactive power control, power angle curve, stability, transient and sub-transient reactance. Synchronous motors – Characteristics and starting – Synchronous Condensers.

Unit 2
Induction machines - Construction, principle of operation, squirrel cage and slip ring induction motors, losses and efficiency, equivalent circuit and circle diagram, testing, torque speed characteristics, starting and speed control, linear induction motor, induction generators.

Unit 3
Fractional horsepower motors, types, single phase Induction Motor, principle, construction, starting, equivalent circuit, shaded pole motors, hysteresis motor, universal motor.
Applications of Induction and Synchronous machines: SEIG, DFIG, SRM, PMSG - Electric traction - Electric Machines for Renewable and Electric Vehicles applications. Introduction to machine design.

Textbooks
1. Kothari D.P. and Nagrath I.J., "Electric Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.
2. Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.

References

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

23EEE304	POWER SYSTEMS	L-T-P-C: 3-1-0-4

Course Objective
To familiarize with the structure, design and analysis of components in power system network.

Course Outcomes
CO1: Understand the structure and functioning of power grid.
CO2: Determine the behaviour of load and tariff mechanism.
CO3: Evaluate the transmission line/cable parameters for various conductor configurations
CO4: Analyze the performance of power system components.
CO5: Validate the performance of power system components and network through simulation.

CO-PO Mapping

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

Syllabus
Unit1
Introduction-Structure of Electric Power System-Conventional, Deregulated Structure, Grid Structure Micro-grid and Smart Grid Structure; Methods of electric power generations – Conventional- Renewable Energy based generation, need for interconnected system- necessity of EHV transmission: EHVAC and HVDC transmission, Variable load on power system- Load Curve and Load Duration Curve, Tariff-Types.

Unit 2
Introduction to Modeling and performance analysis, Transmission line Models- Line parameter estimation- symmetrical and unsymmetrical spacing of lines, bundled conductor, double circuit lines- corona- Regulation, Efficiency, Real and reactive power flow in transmission lines- Compensation- shunt and series compensation.

Unit 3
Insulators and Underground cables -classification and grading. Mechanical design of transmission lines. Distribution systems –Types and comparison–Ring main- Radial distribution. Substation layouts.

Representation of power system: Power system components model, Single line diagram and per unit representation, Bus Admittance and Impedance matrix.

Virtual lab platforms / simulation demos can be used for effective classroom teaching.
Lab Practice: Experiments and field visit – Structure of Electric Power System, modeling and performance analysis of transmission and distribution systems, power system representation.

Textbook

1. *John J. Grainger and Stevenson Jr. W. D, "Power System Analysis", McGraw Hill International edition, 2016 4th Edition, 2017.*
2. *HadiSaadat, "Power system analysis", McGraw Hill publishing company,2003*

References

1. *Kothari, D. P and Nagrath J., 'Power System Engineering' Tata McGraw Hill Publishing Company, 200.*
2. *B. R. Gupta, "Power system analysis and design", S.Chand & Company Ltd.,2004.*

3. *Wadhwa C L 'Electric Power System', Wiley Eastern Limited, India 2007.*
4. *L.L. Grigsby, "Electrical power engineering Handbook", IEEE press,2001.*

23EEE381	POWER ELECTRONICS LAB	L-T-P-C: 0-0-3-1

Course Objectives

To understand the characteristics of power semiconductor devices, and power converters for various applications.

Course Outcomes

CO1: Understand the static and dynamic characteristics of power semiconductor devices, power electronic converters.

CO2: Validate the performance of power converters using simulation and hardware.

CO-PO Mapping

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

Syllabus

Characteristics of Power diode and Power MOSFET, harmonic analysis of single phase full converter, AC phase control, DC – DC Chopper, Single phase PWM inverter

Textbook

1. *Daniel W. Hart, "Introduction to Power Electronics", McGraw Hill Education, 2017.*

23EEE382	ELECTRICAL MACHINES-II LAB	L-T-P-C: 0-0-3-1

Course Objectives

To understand and analyse the performance characteristics of three phase Induction machines, Synchronous machines and special electric machines.

Course Outcomes

CO1: Perform load test on single phase and three phase induction motor to access the performance
CO2: Conduct test on induction motor to pre-determine the performance characteristics
CO3: Conduct test on synchronous machine to draw the performance curve
CO4: Compute the voltage regulation of synchronous machine
CO5: Evaluate the performance analysis of synchronous machine
CO6: Assess the performance of synchronous generator connected to infinite bus bar

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	2	-	-	2	2	2	-	-	2	2	-
CO2	3	3	-	2	-	-	2	2	2	-	-	2	2	-
CO3	3	3	-	2	-	-	2	2	2	-	-	2	2	-
CO4	3	3	-	2	-	-	2	2	2	-	-	2	2	-
CO5	3	3	-	2	-	-	2	2	2	-	-	2	2	-
CO6	3	3	-	2	-	-	2	2	2	-	-	2	2	-

Syllabus

Induction Machines: Performance evaluation- Direct and indirect testing, speed control methods.
Synchronous Machines: Characteristics and regulation of synchronous machines, load test, synchronization of alternator.

Textbook

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

References

1. *Fitzgerald A.E., Charles Kingsley, Jr. and Stephen D.Umans, "Electric Machinery", Tata McGraw-Hill Publishing Company Limited, 2002.*
2. *M.G. Say, "Performance and Design of Alternating Current Machines", CBS Publishers, New Delhi, 1993.*
3. *Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall of India Private Ltd, 2002.*
4. *S.K. Bhattacharya, "Electrical Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi.*

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
CO1	-	-	-	-	-	-	-	3	3	2	3
CO2	-	-	-	-	-	-	-	-	3	2	2
CO3	-	3	-	2	-	-	-	-	-	-	-
CO4	-	3	-	2	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	3	-	3
CO6	-	-	-	-	-	-	-	-	3	-	3

Syllabus

Soft Skills

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

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

Aptitude

Problem Solving III

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

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.
Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.
Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

Logical Reasoning: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding \& Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Verbal
Vocabulary: Create an awareness of using refined language through idioms and phrasal verbs.
Grammar (**Upper Intermediate-Advanced**): Train Students to comprehend the nuances of Grammar and empower them to spot errors in sentences and correct them.
Reasoning: Enable students to connect words, phrases and sentences logically.
Oral Communication Skills: Aid students in using the gift of the gab to interpret images, do a video synthesis, try a song interpretation or elaborate on a literary quote.
Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.

References

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

Evaluation Pattern

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

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

23LIV390	LIVE IN LAB I	[3]

Course Objectives

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Centered Design and Participatory Rural Appraisal.
- User Need Assessment through Quantitative and Qualitative Measurements
- Designing a solution by integrating Human Centered Design concepts
- Devising proposed intervention strategies for Sustainable Social Change Management

Course Outcome

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
CO1	-	3	-	3	-	1	-	3	3	-	3
CO2	-	3	-	-	-	-	3	3	3	-	-
CO3	-	3	-	-	-	1	-	3	3	-	3
CO4	3	-	3	-	-	3	3	3	3	-	3

Syllabus

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

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

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

SEMESTER VI

23EEE311	POWER SYSTEM ANALYSIS	L-T-P-C: 3-0-0-3

Pre-requisites: Power Systems

Course Objective

- To perform power flow studies, fault analysis and stability analysis of power system.

Course Outcomes

CO1: Employ computational techniques in power system analysis.
CO2: Analyse the power system network for load flow and short circuit.
CO3: Evaluate the power system stability under steady state and transient conditions.
CO4: Validate the performance of power system network using modelling and simulation.

CO-PO Mapping

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

Syllabus

Unit 1

Analysis of Power Networks in Steady State - Load flow analysis problem formulation, solution methods- Gauss seidel, Newton Raphson and Fast decoupled load flow methods. Concept of optimal power flow.

Unit 2

Short circuit analysis – symmetrical faults – behavior of short circuit transients in generator and transmission line- unbalanced system- symmetrical components, sequence diagram – unsymmetrical faults – open conductor fault – LG, LL and LLG faults.

Unit 3

Power System stability – dynamics of synchronous machine – swing equation – steady state and transient stability – equal area criterion – critical clearing time –Multi machine stability.

Virtual lab platforms / simulation demos can be used for effective classroom teaching.
AI and ML algorithms for power flow analysis

Lab Practice: Experiments and Case studies – Basic concepts of power system, load flow analysis, fault analysis and stability analysis.

Textbooks

1. *John J. Grainger and Stevenson Jr. W. D, "Power System Analysis", McGraw Hill International edition, Fourth Edition, 2017.*
2. *Hadi Saadat, "Power System Analysis", McGraw Hill Publishing Company, Third Edition, 2010.*

References

1. *Kothari, D. P. and Nagrath, I.J., "Modern Power System Analysis", Fourth Edition, Tata McGraw Hill Publishing Company, Fourth Edition, 2011.*
2. *Wadhwa, C.L., "Electrical Power Systems", Wiley Eastern Limited, India, Sixth Edition, 2007.*

3. *Kothari, D. P. and Nagrath, I.J., "Power System Engineering", Second Edition, Tata McGraw Hill Publishing Company, Third Edition, 2019.*
4. *Abhijith Chakrabarti, D. P. Kothari and A.K Mukhopadhyay, "An Introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems", PHI learning private limited, India, First Edition, 2010.*

23EEE312	ELECTRIC DRIVES AND CONTROL	L-T-P-C: 3-0-0-3

Pre-requisites: Electrical Machines & Power Electronics

Course Objectives

- To impart knowledge on DC and AC electric drives for various applications and identify right choice of electric drive for major applications.

Course Outcomes

CO1: Understand the steady state and dynamic characteristics of AC, DC & Special electrical drives
CO2: Apply the fundamental concepts of machines and power converters for the development of electric drive systems.
CO3: Evaluate the performance of DC and AC drives under various operating modes
CO4: Analyse various control techniques for DC and AC electric drives

CO-PO Mapping

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

Syllabus

Unit 1

Introduction: Concepts, and classification of Electric drives. Selection of motors. Dynamics of Electric drives: Types of loads, Multi quadrant operations, motor dynamics steady state stability and transient stability. Rating and Heating of motors: Heating effects, heating and cooling curves, classes of duty, load equalization, environmental factors.
DC motor drives: Basic characteristics, Operating modes, Single phase and three phase-controlled rectifier fed DC drives, Dual converters drives, Chopper drives, Rheostatic and regenerative braking, effects of changes in supply voltage and load torque, closed loop control schemes.

Unit 2

AC motor drives: Induction motor drives, stator voltage control, V/f control, rotor voltage control- Slip power recovery, Concepts of Static Kramer drives and Static Scherbius drive, Current control method. Need for harmonic filter, Closed loop control. Introduction to vector control scheme.

Unit 3

Synchronous motors: Speed torque characteristics and torque angle characteristics. Fixed and variable frequency operation modes, Self-control modes.
Special machines: Brushless DC motor, Switched Reluctance Motor, Introduction to the relevant converter circuits and closed loop control schemes.
AI based control of electric drives.

Textbooks

1. Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, Fifth Edition 2020.
2. R. Krishnan, 'Electric Motor Drives, Modelling, Analysis and Control', Prentice Hall, NJ, Third Edition, 2016.

References

1. Pillay. S.K, "A First Course on Electric Drives", Willey Eastern Limited, Bombay, 2012
2. B.K Bose, "Power Electronics and AC Drives", Prentice Hall, New Jersy, 2002.
3. V. Subrahmanyam, "Thyristor Control of Electric Drives", Tata McGraw Hill, New Delhi, 1988.
4. Theodore Wildi , "Electrical Machines, Drives and Power Systems", Pearson, Sixth Edition,2013

23EEE383	POWER SYSTEMS LAB	L-T-P-C: 0-0-2-1

Course Objectives

- To equip as power system engineers towards plan, monitor, control and protect the power system.

Course Outcomes

CO1: Validate the behaviour of power system subjected to load flow, short circuit and stability studies.
CO2: Apply passive and active compensation techniques for power flow control.
CO3: Analyse the operation of power system grid.
CO4: Develop protection scheme for power system components and systems.

CO-PO Mapping

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

Syllabus

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

23EEE384	ELECTRIC DRIVES AND CONTROL LAB	L-T-P-C: 0-0-2-1

Course Objectives

- To analyse speed control techniques of DC, AC and Special electrical drives

Course Outcomes

CO1: Understand the fundamental concepts of Electric Drives
CO2: Ability to validate various AC, DC and Special electrical drives using simulation and hardware.

CO-PO Mapping

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

Syllabus

DC Speed control- Converter fed DC motor – Phase controlled DC motor drives, Chopper controlled DC motor drives-modelling of DC motor- Induction motor drive- Speed Control- Speed control of BLDC motor

Textbook

1. *Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, Fifth Edition, 2020.*

23EEE385	OPEN LAB	L-T-P-C: 0-0-3-1

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

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

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

Pre-requisite: Self-confidence, presentation skills, listening skills, basic English language skills, knowledge of high school level mathematics.

Course Objectives

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

Course Outcomes

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

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

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

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

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

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

CO-PO Mapping

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

Syllabus

Soft Skills

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

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

Facing an interview: Importance of verbal & aptitude competencies, strong foundation in core competencies, industry orientation / knowledge about the organization, resume writing (including cover letter, digital profile and

video resume), being professional. Importance of good communication skills, etiquette to be maintained during an interview, appropriate grooming and mannerism.

Aptitude

Problem Solving II

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

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

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

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

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

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

Verbal

Vocabulary: Empower students to communicate effectively through one-word substitution.

Grammar: Enable students to improve sentences through a clear understanding of the rules of grammar.

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

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

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

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

References

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

Evaluation Pattern

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

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

23LIV490	LIVE IN LAB II	[3]

Course Objectives

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

Course Outcome

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

CO-PO Mapping

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

Syllabus

The students shall visit villages or rural sites during the vacations (after 6th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.

Thematic Areas

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

23EEE397	INDUSTRY INTERNSHIP	P/F

Course Objectives

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

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

Evaluation Pattern

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

SEMESTER VII

23EEE401	SMART GRID AND IoT	L-T-P-C: 3-0-2-4

Pre-requisites: Power Systems

Course Objective:
To impart knowledge of Smart Grid using IoT.

Course Outcome
CO1: Understanding on fundamental concepts and challenges in smart grid
CO2: Familiarity with various smart grid technologies.
CO3: Exposure on standards and protocols for smart grid.
CO4: Knowledge on IoT applications and computational intelligence in smart grid

CO-PO Mapping

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

Syllabus
Unit 1
Smart Grid: Comparison with existing grid, Concept of smart grid- Definition, Features, Applications, International policies, Opportunities & Barriers. Smart grid Architecture. Distributed energy resources (DERs), Energy Storage, Renewable Energy Integration, Electric Vehicle integration.
Unit 2
Smart grid Technologies: Overview - Metering Technologies: SCADA, Wide Area Measurement Systems (WAMS), Phasor Measurement Unit (PMU), Advanced metering infrastructure (AMI) - Communication Technologies: LAN, HAN, WAN, interoperability and Scalability. Smart grid: Protocols and Standards. Energy Management System, Demand Side management: Demand Dispatch and Demand Response.
Unit 3
IoT in Smart grid: IoT Architecture, IoT Messaging Protocols - MQTT, CoAP, AMQP, and DDS, IoT Hardware and Software; Data Analytics in the Smart Grid- Definition, Benefits, Tools, Challenges, Application of artificial intelligence and machine learning in Smart grid, Standards for Information Exchange - Data Security methods; Application of cloud computing, edge computing, multi-agent technology in Smart grid, Embedded web servers, Protocols for internet connectivity and interoperability- IPV6 and IPV4 protocols. Case study in smart grid.

Textbooks

1. *Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", John Wiley & Sons, IEEE Press, First Edition, 2011.*
2. *James Momoh, "Smart Grid - Fundamentals of Design and Analysis", John Wiley & Sons, IEEE Press, First Edition, 2012.*

References

1. *Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyam, Nick Jenkins, "Smart Grid Technology and Applications" John Wiley & Sons, First Edition, 2012.*
2. *Clark W. and Gellings P. E., "The Smart Grid: Enabling Energy Efficiency and Demand Response", The Fairmont Press, Taylor & Francis, First Edition, 2009.*
3. *Bernd M. Buchholz & Zbigniew Styczynsk, " Smart Grids – Fundamentals and Technologies in Electricity Networks", Springer, 2014.*

23EEE498	PROJECT PHASE I	L-T-P-C: 0-0-18-6

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

Course Outcome:
CO1: Investigate an engineering problem and design/develop the proof of concept of its solution
CO2: Estimate and manage the cost and time of the project
CO3: Present the project with clarity and ethics in both oral and written mode
CO4: Develop a team and effectively participate in the team to execute the project
CO5: Support the environmental, social and engineering discipline through the project.

CO-PO Mapping

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

23ENV300	ENVIRONMENTAL SCIENCE	P/F

Course Objectives

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

Course Outcomes

CO1: Ability to understand aspects of nature and environment

CO2: Ability to analyze impact of environment on human world

CO3: Ability to comprehend pollution control and waste management

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

Ecology, biodiversity loss and related international conventions – treaties and regulations – Deforestation and land degradation – food crisis – water pollution and related International and local conventions – treaties and regulations – Sewage domestic and industrial and effluent treatment – air pollution and related international and local conventions – treaties and regulations – Other pollution (land – thermal - noise).

Unit 3

Solid waste management (municipal, medical, e-waste, nuclear, household hazardous wastes) – environmental management – environmental accounting – green business – eco-labelling – environmental impact assessment – Constitutional – legal and regulatory provisions – sustainable development.

Textbook

1. *R. Rajagopalan, "Environmental Studies – From Crisis to Cure", Oxford University Press, Second Edition, 2010.*

References

1. *G. T. Miller Jr., "Environmental Science", 16th Edition, Cenage Learning Pvt. Ltd., 2021.*
2. *Benny Joseph, "Environmental Studies", Tata McGraw-Hill Publishing company Limited, Third Edition, 2017.*

Evaluation Pattern

Assessment	Internal	External
Online Test	-	100
		P/F

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

Course Objectives

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

Course Outcomes
CO1: Understand the functions of the Indian government
CO2: Understand and abide the rules of the Indian constitution
CO3: Understand and appreciate different culture among the people

CO-PO Mapping

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

Syllabus
Unit 1
Historical Background – Constituent Assembly of India – Philosophical Foundations of The Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for Citizens.

Unit 2
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

Unit 3
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

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

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

Evaluation Pattern

Assessment	Internal	External
Online Test	-	100
		P/F

SEMESTER VIII

23EEE499	PROJECT PHASE II	L-T-P-C: 0-0-18-6

Course Objectives

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

Course Outcomes

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

CO-PO Mapping

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

PROFESSIONAL ELECTIVES

Power & Energy systems

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

Pre-requisite: Power Systems/ Power System Analysis.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

Course objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks

1. *A.G. Ter-Gazarian, "Energy Storage for Power Systems", 2nd Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.*
2. *Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt, "Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.*

References

1. *R. Pendse, "Energy Storage Science and Technology", SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN - 13:9789380090122), 2011.*
2. *Electric Power Research Institute (USA), "Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits" (1020676), December 2010.*

3. *Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) - A National Laboratory of the U.S. Department of Energy - Technical Report NREL/ TP6A2-47187, January 2010.*

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

Pre-requisites: Measurements and instrumentation, Control Systems.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks

1. *D.V.S.Murty, "Transducers and Instrumentation", Second Edition, Prentice-Hall of India Private Limited, 2008.*
2. *ArunK.Ghosh, "Introduction to Measurements and Instrumentation", Third Edition, PHI Learning Private Limited, 2009.*

References

1. *S. K. Singh, "Computer Aided Process Control", Prentice-Hall of India Private Limited, 2003.*

2. *William Stallings, "Wireless Communications and Networks", Second Edition, Pearson Education, 2005.*
3. *K. Sawhney, Puneet Sawhney, "Mechanical Measurements and Instrumentation & Control", Dhanpat Rai and Co., 2015.*
4. *D. Patranabis, "Principles of Industrial Instrumentation", Third edition, McGraw Hill Education Pvt Ltd., 2010.*

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

Pre-requisites: Power Systems & Power System Analysis

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

Power system operation – state transition and control, SCADA in power systems-data acquisition, state estimation, security assessment and security enhancement – functions of control centers, - system load variations – system load characteristics

Economic load dispatch with and without losses – solution by iteration method (no derivation of loss coefficient) – Base point and participation factor. Real and Reactive power flows and control.

Unit 2

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

Unit 3

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

Textbooks

1. *Olle I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing company, 2004.*
2. *Prabha Kundur, "Power System stability and control", Tata McGraw Hill, 2008.*

References

1. *Kothari, D. P. and Nagrath, I.J., "Modern Power System Analysis", Tata McGraw Hill Publishing Company, 2011.*
2. *Allen J. Wood and Bruce F. Wollenberg, "Power Generation Operation and Control", John Wiley & Sons, 1996.*
3. *L.K. Kirchmayer, "Economic operation of Power System", John Wiley & Sons, 1967.*

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

Pre-requisites: Power Systems & Power System Analysis

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks

1. *G. Phadke and J S Thorp, Computer relaying for power systems, John Wiley and Sons Ltd 2009.*
2. *Ravindra P Singh, "Switchgear and power system protection", Prentice Hall of India,2009.*
3. *Badriram, D.N. Vishwakarma, "Power system protection & switchgear" Tata McGraw Hill Publishing Company Ltd 2011.*

References

1. *Modern Solutions for Protection, Control and Monitoring of Electric Power Systems, Hector Altuve Edmund O. Schweitzer III, Quality Books, Inc. (January 1, 2010).*
2. *Power system relaying- S. H. Horowitz and a. G. Phadke, John Wiley and sons ltd 2008.*
4. *Numerical differential protection: Principles and Applications. G. Ziegler, 2012, Wiley.*
5. *Sunil S Rao, 'Switchgear protection & power system' Khanna Publications.*

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

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

Conduction and breakdown in liquid dielectrics; Classification of liquid dielectrics, breakdown in liquid dielectric.

Different types of solid dielectric materials-breakdown in solid dielectrics-field configuration in the presence of voids.

Breakdown in composite dielectric.

Unit 2

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

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

Unit 3

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

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

Textbooks / References

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Optimal design of 3-phase induction motor: Design of stator, Windings Design of rotor.

Textbooks / References

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

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

Course Objective

- To impart knowledge on EHVAC and HVDC transmission systems

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

Comparison of EHV AC and DC transmission, modern trends in AC and DC transmission, Corona and corona loss in transmission lines.
EHV AC Systems: Limitations of extra-long AC transmission, Voltage profile and voltage gradient of conductor, Electrostatic field of transmission line, Reactive Power planning and control, traveling and standing waves, EHV cable transmission system.
Reactive VAR requirements, Static VAR systems, design concepts and analysis for system dynamic performance.

Unit 2

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

Unit 3

Harmonics and filters: Generation of harmonics by converters, characteristic variation of harmonic currents with variation of firing angle and overlap angle.
Fault and protection schemes in HVDC systems: Nature and types of faults, faults on AC side of the converter stations, converter faults, fault on DC side of the systems, protection against over currents and over voltages, protection of filter units.

Textbooks / References

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

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

Prerequisites: Power Electronics/ Power Electronics & Drives.

Course Objective

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

Course Outcomes

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

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

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

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

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

Design of snubbers, drive circuits, design of high frequency inductors and transformers, Voltage feed forward - PWM control and current mode control, Feedback compensators and design, unity power factor rectifiers.
Introduction to resonant converters – classification of resonant converters – Basic resonant circuit concepts. Zero current and Zero voltage switching, introduction to ZVT.

Textbooks / References

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

1. *Hamies, "Energy Auditing and Conservation; Methods, Measurements, Management and Case Study", Hemisphere Publishers, Washington, 2003.*
2. *C.W. Gellings and J.H. Chamberlin, "Demand-Side Management Planning", 2nd Edition, Prentice Hall, 1993.*
3. *Wayne C Turner, "Energy Management Handbook", 9th Edition, River Publishers, 2018.*

4. *Bureau of Energy Efficiency Study Material for Energy Managers and Auditors Examination: Paper I to IV, www.energymanagertraining.com*
5. *S. Pabla, "Electric Power Systems Planning, 2nd Edition, McGraw Hill, Second Edition, 2015.*
6. *Moncef Krarti, "Energy Audit of Building Systems: An Engineering Approach", 3rd Edition, CRC Press,2020.*
7. *Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.*

Embedded Systems, Control and Automation

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

Pre-requisite: Microcontrollers & Applications.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

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

Textbooks/ References

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

23EEE351	EMBEDDED SYSTEM DESIGN	L-T-P-C: 3-0-0-3

Pre-requisite: Microcontrollers and applications.

Course Objective

- To develop real world applications using advanced microcontrollers.

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks

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

References

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

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

Pre-requisite: Microcontrollers and Applications

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks/References

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

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

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

Course objective

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

Course Outcomes

CO1: Understand the architecture of Digital Signal Processors (DSPs).
CO2: Analyse instruction set and addressing modes of DSPs.
CO3: Implement basic signal processing operations.
CO4: Develop real time signal processing applications.

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

Pre-requisites: Control systems, Microcontrollers and applications.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

Pre-requisite: Digital Systems.

Course Objective

- To provide understanding of digital system design using FPGA.

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

1. *A. K. Shawney, "Electrical and Electronics Measurement and Instrumentation", Dhanpatrai & sons publications.*
2. *John W. Webb and Ronald A. Reiss, "Programmable logic controllers-Principle and applications", 5th Edition, PHI.*
3. *Gopal K., "Fundamentals of Electrical Drives", Narosa publishing house pvt.*

4. *Bimal K. Bose, "Modern Power Electronics and AC Drives", pea*rson Publishing pvt.
5. *E.O. Doebelin, "Measurement Systems – Application and Design", TMH Publication.*
6. *Hackworth and Hackworth F.D, "Programmable logic controllers- Programming Method and applications", Pearson, 2004.*
7. *Liuping Wang, "PID and Predictive Control of Electric Drives and Power Supplies Using MATLAB / Simulink".*

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

Pre-requisite: Microcontrollers & Applications.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

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

Course Objective

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

Course Outcomes

CO1: Understand the basics of bio-medical signals and sensors.
CO2: Apply the concepts of sensors and transducers for acquiring bio-signals and related signal conditioning circuits.
CO3: Familiarize the therapeutic and diagnostic methods used in bio-medical instrumentation systems.
CO4: Comprehend the modern methods of imaging techniques used for bio-medical applications.

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

Pre-requite: Control Systems.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

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

Textbooks / References

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

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

Pre-requite: Control Systems.

Course objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

1. *K. Ogata, "Discrete-Time Control Systems", Pearson Education, 2011.*
2. *Gene F. Franklin, J. David Powell, Michael Workman, "Digital Control of Dynamic Systems", Pearson, 3rd Edition, 2006.*
3. *M. Sami Fadali, Antonio Visioli, "*Digital Control *Engineering: Analysis and Design", Elsevier, 2013.*
4. *IoanDoré Landau, GianlucaZito, "*Digital Control *Systems: Design, Identification and Implementation", Springer, 2006.*
5. *Cheng Siong Chin, "Computer-Aided Control Systems Design" CRC Press, 2013.*

6. *Hemchandra Madhusudan Shertukde, "Digital Control Applications-Illustrated with MATLAB" CRC Press Inc., 2015.*
7. *C. L. Philips, Troy Nagle, AranyaChakrabortty, "Digital Control System Analysis and Design", Prentice-Hall, 2014.*
8. *M. Gopal, "Digital Control and State Variable Methods", Tata McGraw-Hill, 2012.*

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

Pre-requite: Control Systems.

Course Objective

- To model and design controllers for process control systems.

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

Automotive Systems & Electric Vehicles

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to Electric Vehicles, System Engineering and Simulation. Overview of electric vehicles, including the history of EV, EV Components, Performance specifications and basic design concepts, Benefits and limitation of EV as compared with IC Engine based Vehicles. The basics of system engineering, definition, and principles of system engineering, system requirement specification, simulation techniques, and its application in EV design and validation

Various forces acting on the moving vehicle (Rolling resistance force, Aerodynamic drag force, Acceleration force, Climbing force, etc.), Vehicle motion equations, Longitudinal vehicle dynamics modelling and simulation, EV component sizing, Drive cycle analysis.

Unit 2

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

Unit 3

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

Textbooks / References

1. *James Larminie, John Lowry,"Electric Vehicle Technology Explained", Wiley, 2nd Edition, 2012.*
2. *Goodarzi, Gordon A., Hayes, John G, "Electric powertrain: energy systems, power electronics & drives for hybrid, electric & fuel cell vehicles", Wiley, 1st Edition, 2018.*
3. *Mehradad Eshani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Fundamentals, Theory and Design", Second Edition, CRC Press, Taylor and Francis Group, 3rd Edition, 2019.*
4. *Iqbal Husain, "Electric and Hybrid Electric Vehicles: Design Fundamentals", CRC Press, 3rd Edition, 2021.*
5. *De Doncker, Rik, Pulle, Duco W.J., Veltman, Andre, "Advanced Electrical Drives", 1st Edition, CRC Press, Taylor and Francis Group, 2nd Edition, 2020.*

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

Pre-requisites: Electrical machines, Power electronics & Drives

Course Objective

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

Course Outcomes

CO1: Understand the electric vehicles architecture, vehicle propulsion system and vehicular communication protocols.
CO2: Apply the concepts of electric drives, energy storage and communication in EV.
CO3: Demonstrate big data analytics in vehicular network control.

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbook

1. *M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2015.*
2. *Iqbal Hussain, "Electric & Hybrid Vechicles – Design Fundamentals", Second Edition, CRC Press, 2011.*

References

1. *Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.*
2. *James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.*
3. *Paul, A., Chilamkurti, N., Daniel, A. and Rho, S. Intelligent Vehicular Networks and Communications. Elsevier Science and Technology Books, Inc. 2017.*
4. *Wai Chen, "Vehicular Communications and Networks: Architectures, Protocols, Operation and Deployment", Elsevier Science and Technology Books 2015.*
5. *Laun T.H, Shen X.(Sherman) and Bai F, "Enabling Content Distribution in Vehicular AdHoc Networks", Springer, 2014.*

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

Pre-requisite: Control Systems.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks

1. *Kiencke, Uwe and Nielsen, Lars, "Automotive Control Systems for Engine, Driveline and Vehicle", Springer, 2005*
2. *I.J Nagrath and M. Gopal, "Control Systems Engineering", Wiley Eastern Limited, New Delhi, 2008*

References

1. *M.Gopal, "Modern Control System Theory", New Age International, 2005.*
2. *Katsuhiko Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall, 2010.*

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

Pre-requisite: Control Systems.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

Pre-requisites: Circuits Analysis and Control Systems.

Course Objective

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

Course Outcomes

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

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

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

Pre-requisites: Electrical machines and Power Electronics

Course Objective

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

Course Outcomes

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

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

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

CO4: Design various electrical machines used in electric vehicles.

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

Switched Reluctance Motor Drives – Converter topologies, Control, Design Criteria and Examples.
Stator Permanent Magnet Motor Drives – Types, Magnetic Geared Motor Drives – Magnetic gears, Inverter and Control, Vernier Permanent Magnet Motor Drives – Structure, Principle, Inverter and Control, Advanced Magnetless Motor Drives.

Unit 3

Integrated Starter-Generator Systems, Planetary Geared Electric Variable Transmission System, Double Rotor Electric Variable Transmission System, Magnetic Geared Electric Variable Transmission System.
Finite Element Analysis: Induction Motor, PMSM.

Textbooks / References

1. *Chau, Kwok Tong, "Electric Vehicle Machines and Drives: Design, Analysis and Application", John Wiley & Sons, 2015.*
2. *Emadi, Ali. "Advanced electric drive vehicles", CRC Press, 2014.*

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

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

1. *Pistoia, Gianfranco, and Boryann Liaw, "Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost", Springer International Publishing AG, 2018.*
2. *Plett, Gregory L., "Battery management systems, Volume I: Battery modeling", Artech House, 2015.*

3. *Plett, Gregory L., "Battery management systems, Volume II: Equivalent-circuit methods", Artech House, 2015.*
4. *Bergveld, H.J., Kruijt, W.S., Notten, P.H.L., "Battery Management Systems -Design by Modelling", Philips Research Book Series 2002.*
5. *Davide Andrea,"Battery Management Systems for Large Lithium-ion Battery Packs", Artech House, 2010.*
6. *Pop, Valer, et al., "Battery management systems: Accurate state-of-charge indication for battery-powered applications", Vol. 9, Springer Science & Business Media, 2008.*

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

Pre-requisites: Electrical machines and Signal processing.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

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

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

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References:

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

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

Pre-requisite: Data Base Systems, Machine learning.

Course Objective

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

Course Outcomes

CO1: Understand the core concepts of big data problems.
CO2: Comprehend the big data storage frameworks.
CO3: Apply big data analytics using Hadoop and Spark.
CO4: Analyse modern tools and applications for real world scenarios.

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks /References

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

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

Pre-requisite: Computer Programming

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbook

1. *Anthony T Velte, "Cloud Computing: A practical Approach", Tata McGraw Hill, 2009.*
2. *Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Gustavo Azzolin et al.. "Cloud Computing: Concepts, Technology & Architecture, Pearson/Dorling Kindersley India Pvt. Limited, 2014.*
3. *Ajay D. Kshemkalyani, Mukesh Singhal , " Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2011.*
4. *Douglas Comer, "The Cloud Computing Book:The Future of Computing Explained", CRC Press, 2021.*

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

Pre-requisite: Machine Learning.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

Neural Networks Review: Feed forward network, Gradient Descent based Back propagation algorithm. Convolutional Neural Networks (CNN). Different layers and functionalities, data augmentation. Cost function, Training, parameters and hyper-parameters. Regularization, Vanishing Gradient, learning algorithms.

Unit 2

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

Unit 3

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

Reference/Textbook

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

23ELC365	BLOCK CHAIN TECHNOLOGY	L-T-P-C: 3-0-0-3

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References

1. *Andreas Antonopoulos, "Mastering Bitcoin", O'Reilly Publishing 2014 978-0691171692.*
2. *Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.*
3. *William Mougayar, "The Buisness Blockchain: Promise, Practice, and Application of the Next Internet Technology" Wiley; 1st Edition, 2016.*

4. *Bitcoin: A Peer-toPeer Electronic Cash System Satoshi Nakamoto Online 2009 https://bitcoin.org/bitcoin.pdf*
5. *Vitalik Buterin Ethereum White Paper Online 2017.*

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

Pre-requisite: Computer Programming

Course Objective

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

Course Outcomes

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

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

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks / References:

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

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

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

Course Objective

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

Course Outcomes

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

CO2: Comprehend mathematical and statistical models for NLP.

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

CO4: Develop probabilistic models in code.

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

CO-PO Mapping

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

Syllabus

Unit-1

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

Unit- 2

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

Unit- 3

Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure. Applications of NLP – Spell-checking, Summarization Information Retrieval – Vector space

model, term weighting, homonymy, polysemy, synonymy, improving user queries. Machine Translation – EM algorithm – Discriminative learning – Deep representation learning – Generative learning.

Textbooks / References

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

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

Course Objective

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

Course Outcomes

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

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

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

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

CO5: Apply range of tools to monitor and design green systems.

CO-PO Mapping

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

Syllabus

Unit-1

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

Unit-2

Virtualizing of IT systems –Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC –Green Data center – Green Grid framework.

Applying Computing towards Sustainability, Smart Buildings and the Smart Grid, sensing, modeling and controlling the energy usage of buildings, as well as new operating systems and software stacks for the smart infrastructure.

Unit-3

Socio-cultural aspects of Green IT –Green Enterprise Transformation Roadmap –Green Compliance: Protocols, Standards, and Audits –Emergent Carbon Issues: Technologies and Future. The Environmentally Responsible Business Strategies (ERBS) –Case Study Scenarios for Trial Runs – calculating the carbon footprint – greening mobile devices - CASE STUDIES –Applying Green IT Strategies and Applications to a Home, Hospital, Packaging Industry and Telecom Sector.

Textbooks / References:

1. *Bhuvan Unhelkar, "Green IT Strategies and Applications-Using Environmental Intelligence", CRC Press, June 2011.*
2. *Woody Leonhard, Katherrine Murray, "Green Home computing for dummies", August 2009*
3. *Alin Gales, Michael Schaefer, Mike Ebbers, "Green Data Center: steps for the Journey", Shoff/IBM rebook, 2011.*
4. *John Lamb, "The Greening of IT", Pearson Education,2009.*
5. *Jason Harris, "Green Computing and Green IT-Best Practices on regulations & industry, Lulu.com", 2008.*
6. *Carl Speshocky, "Empowering Green Initiatives with IT", John Wiley & Sons, 2010.*
7. *Wu Chun Feng (editor)," Green computing: Large Scale energy efficiency", CRC Press, 2012.*

23ELC369	EVOLUTIONARY OPTIMIZATION TECHNIQUES	L-T-P-C: 3-0-0-3

Course Objective

- To classify the problem around us as optimization or modelling or simulation problems and solve using evolutionary algorithms.

Course Outcomes

CO1: Understand the structure, components and adaptive parameter settings of evolutionary algorithms.
CO2: Design hybrid, multi-objective, interactive evolutionary algorithms for static/dynamic and constrained/unconstrained optimization problems.
CO3: Apply algorithms for evolutionary learning and neural evolution strategies.
CO4: Analyze the performance of evolutionary algorithms for given toy and real-world problems.

CO-PO Mapping

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

Syllabus

Unit 1

Type of Problems - Introduction to Evolutionary Computation – Evolutionary Algorithms (*EAs*) – Different components of EAs– population representation techniques, mutation and crossover techniques, population management models, parent and survivor selection, fitness, fitness landscape, fitness sharing and crowding – Summary of popular variant of EAs.

Unit 2

Parameter of EAs – parameter control and parameter tuning, Working with EAs – Performance metrics and test problems. Hybridizing EAs – memetic algorithms, Nonstationary and Noisy optimization, Multi-objective EAs – Constraint handling – Interactive EAs.

Unit 3

Special forms of evolution – co-evolution and speciation, ensemble EAs, evolutionary learning, neuroevoluion, design and analysis of EAs – design of experiments, empirical and statistical comparison of EAs, applications of EAs – toy problems (viz., eight-queen problem and knapsack problem) and real-world problems.

Textbooks

1. *A. E. Eiben and J. E. Smith,"An Introduction to Evolutionary Computing", Natural Computing Series, Springer, 2nd Edition 2015.*
2. *Iaroslav Omelianenko, "Hands-on neuroevolution with python: build high-performing artificial neural network architecture using neuroevolution based algorithm", Packt Publishing, 2019.*

References

1. *Slim Bechikh, Rituparna Datta and Abhishek Gupta, "Recent advances in evolutionary multi-objective optimization", Adaptation, learning and optimization book – 20, Springer 2017.*
2. *Hitoshi Iba, "Evolutionary approach to machine learning and deep learning networks: neuro-evolution and*

gene regulatory networks", Springer 2018.

3. *Kenneth A. De Jong," Evolutionary Computation - A Unified Approach",MIT Press, 2006.*
4. *Z. Michaelewicz and David B. Fogel "How to Solve it: Modern Heuristics", Springer,Second Edition, 2004.*
5. *Thomas Bartz-Beielstein, "Experimental Research in Evolutionary Computation: The New Experimentalism", Natural Computing Series, Springer, 2006.*

23ELC370	ARTIFICIAL INTELLIGENCE	L-T-P-C: 3-0-0-3

Pre-requisites: Probability and statistics, matrix algebra.

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbook

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

References

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

23ELC371	OPERATING SYSTEMS	L-T-P-C: 3-0-0-3

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbook

1. *Silberschatz A, Gagne G, Galvin PB. Operating system concepts. Tenth Edition, John Wiley and Sons; 2018.*

References

1. *Deitel HM, Deitel PJ, Choffnes DR. Operating systems. Third Edition, Prentice Hall; 2004.*
2. *Tannenbaum AS. Modern Operating Systems. Fourth Edition, Prentice Hall; 2016.*
3. *Stevens WR, Rago SA. Advanced programming in the UNIX environment. Second Edition, Addison-Wesley; 2008.*
4. *Nutt G. Operating systems. Third Edition, Addison Wesley; 2009.*

23ELC372	DATA STRUCTURES AND ALGORITHMS	L-T-P-C: 3-0-0-3

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbooks

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

References

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

23ELC373	OBJECT ORIENTED PROGRAMMING USING PYTHON	L-T-P-C: 3-0-0-3

Course Objective

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

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Textbook

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

References

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

23ELC374	DATA BASE MANAGEMENT SYSTEMS	L-T-P-C: 3-0-0-3

Course Objective

- To learn fundamentals of database management systems

Course Outcomes

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

CO-PO Mapping

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

Syllabus

Unit 1

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

Unit 2

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

Unit 3

Python and databases: Development tools, drivers, and modules, Design a database within RDBMS and SQLite. Database connectivity with python.

Text Book

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

References

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