Electrical and Electronics Engineering Program

Preamble: The curriculum of B. Tech. (Electrical and Electronics Engineering) program offered by the Department of Electrical And Electronics Engineering under Academic Regulation 2020 is prepared in accordance with the curriculum framework of AICTE, UGC and Andhra Pradesh State Council of Higher Education (APSCHE). Further this Outcome Based Curriculum (OBC) is designed with Choice Based Credit and Semester System (CBCSS) enabling the learners to gain professional competency with multi-disciplinary approach catering the minimum requirement (Program Specific Criteria) of Lead Societies like IEEE and other Professional Bodies as per the Engineering Accreditation Commission (EAC) of ABET and NBA. In addition, the curriculum and syllabi are designed in a structured approach by deploying Feedback Mechanism on Curriculum from various stakeholders viz. Industry, Potential Employers, Alumni, Academia, Professional Bodies, Research Organizations and Parents to capture their voice of the respective stakeholders.

The Curriculum design, delivery, and assessment, the three major pillars of academic system is completely aligned in line with Outcome Based Education (OBE) to assess and evaluate the learning outcomes facilitating the learners to achieve their Professional and Career Accomplishments.

The Vision

To be a hub for imparting knowledge, skills and behaviour for exemplary contributions in the field of Electrical & Electronics Engineering

The Mission

- To impart technical education through the state of the art infrastructural facilities, laboratories and instruction
- To inculcate industry oriented learning through industrial visits, internships, projects at industries, MOUs, to make students technically skilled oriented
- Creating conductive environment for higher education, employment and entrepreneurship through quality education, professional skills and research
- To promote societal commitment among students by inculcating moral and ethical values

Program Educational Objectives (PEOs)

The PEOs are the educational goals that reflect Professional and Career Accomplishments that a graduate should attain after 4 – 5 years of his/her graduation.

The graduates of Electrical and Electronics Engineering of NSRIT will

1. Demonstrate the real-world engineering problem solving skills by applying the fundamental and conceptual engineering knowledge as a practicing Electrical and Electronics engineer or as a member/lead in a multidisciplinary project setting that utilize 21st century skills

2. Provide research-based engineering solutions addressing the triple bottom line of environment and sustainability maintaining the professional standards, ethics and integrity

3. Foster self-directed learning through their professional experience, technology advancements in their relevant field of interest and desiring graduates pursue advanced higher education leading to research

Program Outcomes (POs)

The POs are the transactional statements of graduate attributes (GAs) that each graduating engineer should possess in terms of knowledge, skill and behaviour with a minimum target performance level at the time of graduation as fixed by the program of study seeking continuous improvement year on year.

The graduates of Electrical and Electronics Engineering of NSRIT will be able to demonstrate the following outcomes in terms knowledge, skill and behavioural competencies at the time of graduation with the expected target performance level

1. Apply the knowledge of basic sciences and fundamental engineering concepts in solving engineering problems (Engineering Knowledge)
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences (Problem Analysis)
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations (Design/Development of Solutions)
4. Perform investigations, design and conduct experiments, analyse and interpret the results to provide valid conclusions (Investigation of Complex Problems)
5. Select/develop and apply appropriate techniques and IT tools for the design & analysis of the systems (Modern Tool Usage)
6. Give reasoning and assess societal, health, legal and cultural issues with competency in professional engineering practices (The Engineer and Society)
7. Demonstrate professional skills and contextual reasoning to assess environmental/societal issues for sustainable development (The Environment and Sustainability)
8. Demonstrate Knowledge of professional and ethical practices (Ethics)
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary situations (Individual and Team Work)
10. Communicate effectively among engineering community, being able to comprehend and write effectively reports, presentation and give / receive clears instructions (Communication)

11. Demonstrate and apply engineering & management principles in their own / team projects in multidisciplinary environment (Project Finance and Management)
12. Recognize the need for, and have the ability to engage in independent and lifelong learning (Life Long Learning)

Program Specific Outcomes (PSOs)

1. Analyze, design and simulate diverse problems associated in the field of electrical, electronics and computer based systems by providing sustainable solutions adopting ethical practices
2. Apply appropriate methods and modern components to aid design, analysis and synthesis of solutions

Category-wise Credit Distribution of Courses

	Category	AICTE	APSCHE	NSRIT (A)
HS	Humanities and Social Science	12.0	10.5	10.5
BS	Basic Science	25.0	18.0	21.0
ES	Engineering Science	24.0	22.5	22.5
PC	Professional Core	48.0	55.5	52.5
PE	Professional Elective	18.0	15.0	15.0
OE	Open Elective	18.0	12.0	12.0
	Internship (s), Project & Seminars	15.0	16.5	16.5
SC	Skill Oriented Courses	-	10.0	10.0
	Mandatory Courses	-	-	-
AC	Audit Course	-	-	-
	Total no. of credits	160	160	160

Electrical and Electronics Engineering

Credit requirement for the award of the degree under academic Regulation 2020 – 2021 for the candidates admitted from the academic year 2021 onwards

	Four Years	Three Years
B. Tech. (Regular Degree)	160	121
B. Tech. (Honors Degree)	180	141
B. Tech. (With Minor specialization other than Chosen Branch of Engg. & Tech.)	180	141

Semester I

No.	Code	Course	POs	Contact Hours L	T[1]*	P	C	
01	20HSX01	Communicative English	10	3	0	0	3.0	HS
02	20BSX11	Linear Algebra and Differential Equations	1, 12[1]	3	1	0	3.0	BS
03	20BSX33	Applied Physics	1	3	1	0	3.0	BS
04	20ESX03	Basic Electrical Engineering	1	3	0	0	3.0	ES
05	20ESX02	Programming for Problem Solving Using 'C'	1	3	0	0	3.0	ES
06	20HSX02	Communicative English Lab	10	0	0	3	1.5	HS
07	20BSX34	Applied Physics Lab	1, 4	0	0	3	1.5	BS
08	20ESX07	Programming for Problem Solving Using 'C' Lab	1, 4	0	0	3	1.5	ES
			Sub-total	15	02	09	**19.5**	

Semester II

01	20BSX12	Partial Differential Equations and Vector Calculus	1	3	1	0	3.0	BS
02	20BSX23	Applied Chemistry	1	3	1	0	3.0	BS
03	20CS403	Python Programming	1	3	1	0	3.0	ES
04	20ESX04	Engineering Mechanics	1	3	1	0	3.0	ES
05	20ESX01	Engineering Drawing	1, 5, 10	1	0	4	3.0	ES
06	20BSX24	Applied Chemistry Lab	1, 4	0	0	3	1.5	BS
07	20CS407	Python Programming Lab	1	0	0	3	1.5	ES
08	20ESX06	Engineering Workshop	4	0	0	3	1.5	ES
09	20MCX01	Environmental Science	1	2	0	0	-	MC
			Sub-total	15	04	13	**19.5**	

Semester III

01	20BSX13	Numerical Methods and Transforms	1	3	1	0	3.0	BS
02	20EC302	Electronic Devices and Circuits	1, 3, 10	3	0	0	3.0	PC
03	20EE303	Electrical Circuit Analysis	1, 3, 10, PSO 1	3	1	0	3.0	PC
04	20EE304	DC Machines and Transformers	2,3, PSO 1	3	0	0	3.0	PC
05	20EE305	Power Generation and Transmission	2, 7, 10, PSO 1	3	0	0	3.0	PC
06	20EC306	Electronic Devices and Circuits Lab	4, PSO 1	0	0	3	1.5	PC
07	20EE307	DC Machines and Transformers Lab	4, PSO 1	0	0	3	1.5	PC
08	20EE308	Electrical Circuit Analysis Lab	4, PSO 1	0	0	3	1.5	PC
09	20EES01	MATLAB	5	1	0	2	2.0	SC
10	20MCX02	Constitution of India	-	2	0	0	-	MC
			Sub-total	18	02	11	**21.5**	

*Suggested hours for tutorial

[1]By default all courses are mapped to PO 12 as they are weakly contributing

No.	Code	Course	POs	Contact Hours L	T	P	C	
Semester IV								
01	20HSX03	Managerial Economics and Financial Analysis	11	3	0	0	3.0	HS
02	20BSX15	Probability and Statistics	1	3	1	0	3.0	BS
03	20EE403	Control Systems	3, PSO 1	3	0	0	3.0	PC
04	20EE404	Induction Motors and Synchronous Machines	2, 3, PSO 1	3	1	0	3.0	PC
05	20EE405	Electro Magnetic Field Theory	3, PSO 1	3	0	0	3.0	ES
06	20EE406	Induction Motors and Synchronous Machines Lab	4	0	0	3	1.5	PC
07	20EE407	Industrial Automation for Electrical & Electronics Engg.	4	0	0	3	1.5	PC
08	20EE408	Control Systems Lab	4, PSO 1	0	0	3	1.5	PC
09	20EES02	Programmable Logic Circuits	3, 4	1	0	2	2.0	SC
			Sub-total	16	02	11	**21.5**	
Semester V								
01	20EE501	Power Distribution and Distributed Generation	2, 3, 7, PSO 1	3	0	0	3.0	PC
02	20EE502	Power Electronics	2, 3, PSO 1	3	1	0	3.0	PC
03	20EC305	Digital System Design	1, 3	3	0	0	3.0	PC
04	-	Professional Elective I	-	3	0	0	3.0	PE
05	-	Open Elective I	-	3	0	0	3.0	OE
06	20EC308	Digital System Design Lab	4	0	0	3	1.5	PC
07	20EE507	Power Electronics Lab	4, PSO 1	0	0	3	1.5	PC
08	20EES03	MOOCs	12	0	0	0	2.0	SC
09	20MCX03	Intellectual Property Rights and Patents	-	2	0	0	-	MC
10	-	Summer Internship #1[2]	5, 8, 9, 10, PSO 1	0	0	0	1.5	IN
11	-	Technical Paper Writing	-	0	0	2	-	AC
			Sub-total	17	01	08	**21.5**	
Semester VI								
01	20EC603	Micro Processors and Micro Controllers	3	3	0	0	3.0	PC
02	20EE602	Electrical Measurements and Instrumentation	2, PSO 1	3	0	0	3.0	PC
03	20EE603	Power System Analysis	2, 3, 6, PSO 1	3	1	0	3.0	PC
04	-	Professional Elective II	-	3	0	0	3.0	PE
05	-	Open Elective II	-	3	0	0	3.0	OE
06	20EC606	Micro Processors and Micro Controllers Lab	4, 9	0	0	3	1.5	PC
07	20EE607	Electrical Measurements and Instrumentation Lab	4, PSO1	0	0	3	1.5	PC
08	20EE608	Power Systems and Simulation Lab	4, PSO1	0	0	3	1.5	PC
09	20EES04	P-SPICE	5	1	0	2	2.0	SC
10	20MCX04	Indian Traditional Knowledge	-	2	0	0	-	MC
			Sub-total	18	01	11	**21.5**	
Semester VII								
01	-	Professional Elective III	-	3	0	0	3.0	PE
02	-	Professional Elective IV	-	3	0	0	3.0	PE
03	-	Professional Elective V	-	3	0	0	3.0	PE
04	-	Open Elective III	-	3	0	0	3.0	OE
05	-	Open Elective IV	-	3	0	0	3.0	OE
06	20HSX04	Professional Ethics	8	3	0	0	3.0	HS
07	20EES05	E-CAD	5	1	0	2	2.0	SC
08	-	Summer Internship #2[2]	5, 8, 9, 10, PSO 1	0	0	0	3.0	IN
			Sub-total	19	0	02	**23.0**	
Semester VIII								
01	-	Full Semester Internship[3]	5-10, PSO 1, PSO 2	0	0	0	06	IN
02	-	Capstone Project[3]	5-10, PSO 1, PSO 2	0	0	0	06	PW
			Sub-total	0	0	0	**12.0**	
			Total Credits	-	-	-	**160**	

[2] The work pertaining to Summer Internship #1 and #2 shall be completed at the end of Semesters IV and VI respectively. The assessment shall be carried out during Semesters V and VII

[3] The students opting for FSI in VII Semester should take up the courses of VII Semester in VIII Semester

List of Electives

Professional Elective #1								
1	20EE001	Advanced Power Electronics	-	3	0	0	3.0	PE
2	20EE002	Digital Control Systems	-	3	0	0	3.0	PE
3	20EE003	Utilization of Electrical Energy	-	3	0	0	3.0	PE
4	20EE004	Machine Modelling and Analysis	-	3	0	0	3.0	PE
5	20EE005	Sensors and Transducers	-	3	0	0	3.0	PE
Professional Elective #2								
6	20EE006	Solid State Electric Drives	-	3	0	0	3.0	PE
7	20EE007	Advanced Control Systems	-	3	0	0	3.0	PE
8	20EE008	Reactive Power Compensation and Management	-	3	0	0	3.0	PE
9	20EE009	Basic Industrial Automation	-	3	0	0	3.0	PE
10	20EE010	Process Instrumentation	-	3	0	0	3.0	PE
Professional Elective #3								
11	20EE011	Switchgear Protection	-	3	0	0	3.0	PE
12	20EE012	Digital Signal Processing	-	3	0	0	3.0	PE
13	20EE013	HVDC and FACTS	-	3	0	0	3.0	PE
14	20EE014	Programmable Control Devices and Applications	-	3	0	0	3.0	PE
15	20EE015	Virtual Instrumentation	-	3	0	0	3.0	PE
Professional Elective #4								
16	20EE016	Analysis of Power Converters	-	3	0	0	3.0	PE
17	20EE017	Multivariable Control System	-	3	0	0	3.0	PE
18	20EE018	Power System Operation and Control	-	3	0	0	3.0	PE
19	20EE019	Automotive Electrical Engineering	-	3	0	0	3.0	PE
20	20EE020	Wireless Sensors and Instrument Networks	-	3	0	0	3.0	PE
Professional Elective #5								
The curriculum provides academic flexibility to choose any of the domain specific courses from MOOCs as approved by the respective Board of Studies and Academic Council. The students can take up this course on self- study mode. The course shall be of 45 – 60 hours duration (4-credits) and the assessment shall be as per the academic regulation 2020.								PE
Open Elective #1								
21	20CEO01	Urban Environmental Service	-	3	0	0	3.0	OE
22	20CSO01	Data Structures and Algorithms	-	3	0	0	3.0	OE
23	20AIO01	Machine Learning for Engineers	-	3	0	0	3.0	OE
24	20DSO01	Introduction to Database Management Systems	-	3	0	0	3.0	OE
25	20ECO01	Architectures and Algorithms of IoT	-	3	0	0	3.0	OE
26	20EEO01	Introduction to Renewable Energy Sources	-	3	0	0	3.0	OE
27	20MEO01	Nano Technology	-	3	0	0	3.0	OE
28	20SHO01	Women and Society	-	3	0	0	3.0	OE
Open Elective #2								
29	20CEO02	Ecology, Environment and Resources	-	3	0	0	3.0	OE
30	20CS004	Internet of Things	-	3	0	0	3.0	OE
31	20AIO02	Fundamentals of Deep Learning	-	3	0	0	3.0	OE
32	20DSO02	Introduction to Data Science	-	3	0	0	3.0	OE
33	20ECO02	IoT for Smart Grids	-	3	0	0	3.0	OE
34	20EEO02	Electrical Safety and Management	-	3	0	0	3.0	OE
35	20MEO02	Fundamentals of Automobile Engineering	-	3	0	0	3.0	OE
Open Elective #3								
36	20CEO03	Disaster, Risk Mitigation and Management	-	3	0	0	3.0	OE
37	20CS302	Operating Systems	-	3	0	0	3.0	OE
38	20AIO03	Intelligent Robots and Drone Technology	-	3	0	0	3.0	OE
39	20DSO03	Introduction to Big Data	-	3	0	0	3.0	OE
40	20ECO03	Privacy and Security in IoT	-	3	0	0	3.0	OE
41	20EEO03	Low-cost Automation	-	3	0	0	3.0	OE
42	20MEO03	Industrial Automation	-	3	0	0	3.0	OE
43	20SHO03	Design Thinking	-	3	0	0	3.0	OE
Open Elective #4								

The curriculum provides academic flexibility to choose any of the inter-disciplinary courses from MOOCs as approved by the respective Board of Studies and Academic Council. The students can take up this course on self-study mode. The course shall be of 45 – 60 hours duration and the assessment shall be as per the academic regulation 2020. OE

B. Tech. (Honors)

Category I								
1	20EEH01	Smart Grid	-	4	0	0	4.0	HO
2	20EEH02	Advanced Smart Power Grids	-	4	0	0	4.0	HO
3	20EEH03	Electric Power Quality	-	4	0	0	4.0	HO
Category II								
4	20EEH04	Electric Vehicle Technologies	-	4	0	0	4.0	HO
5	20EEH05	Energy Audit Conversation and Management	-	4	0	0	4.0	HO
6	20EEH06	Electrical Load Estimation	-	4	0	0	4.0	HO
Category III								
7	20EEH07	Electric Vehicle in Smart Grids	-	4	0	0	4.0	HO
8	20EEH08	Optimization Techniques	-	4	0	0	4.0	HO
9	20EEH09	Illumination Engineering	-	4	0	0	4.0	HO
Category IV								
10	20EEH10	Power Electronic Converters for Smart Grids and Electric Vehicles	-	4	0	0	4.0	HO
11	20EEH11	Advanced Power System Protection	-	4	0	0	4.0	HO
12	20EEH12	Power System Stability	-	4	0	0	4.0	HO

B. Tech. (Minor with Specialization)

Category I								
1	20CEM01	Air Pollution	-	3	0	0	3.0	MI
2	20CSM01	E-Commerce	-	3	0	0	3.0	MI
3	20MEM01	Biomaterials	-	3	0	0	3.0	MI
4	20EEM01	Basic Control Systems	-	3	0	0	3.0	MI
5	20ECM01	Fundamentals of Electronics	-	3	0	0	3.0	MI
6	20AIM01	Fundamentals of Neural Networks	-	3	0	0	3.0	MI
7	20DSO03	Introduction to R Programming	-	3	0	0	3.0	MI
Category II								
8	20CEM02	Climate Change Mitigation and Adaptation	-	3	0	0	3.0	MI
9	20CSM02	Knowledge Discovery and Databases	-	3	0	0	3.0	MI
10	20MEM02	Micro Electromechanical Systems	-	3	0	0	3.0	MI
11	20EEM02	Basics of Electrical Machines and Drives	-	3	0	0	3.0	MI
12	20ECM02	Digital Electronics	-	3	0	0	3.0	MI
13	20AIM02	Machine Learning with Python	-	3	0	0	3.0	MI
14	20DSM02	Data Management and Analysis	-	3	0	0	3.0	MI
Category IIII								
15	20CEM03	Sustainability and Pollution Prevention Practices	-	3	0	0	3.0	MI
16	20CSM03	Database Security	-	3	0	0	3.0	MI
17	20MEM03	Surface Engineering	-	3	0	0	3.0	MI
18	20EEM03	Electrical Engineering Material Science	-	3	0	0	3.0	MI
19	20ECM03	Analog Electronic Circuits	-	3	0	0	3.0	MI
20	20AIM03	Interpretable Deep Learning	-	3	0	0	3.0	MI
21	20DSM03	Data Governance	-	3	0	0	3.0	MI

List of Honors offered by Electrical and Electronics Engineering Program

1. Smart Electrical Vehicles
2. Advanced Power Systems
3. Advanced Power Quality

List of Minor with Specialization offered by Electrical and Electronics Engineering Program

1. Basics of Electrical Drives and Control

PC 20EE501 Power Distribution and Distributed Generation 3 0 0 3.0

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

Code	Course Outcomes	Mapping with PO's				DoK
		PO2	PO3	PO7	PSO 1	
20EE501.1	Illustrate various Electrical loads and their characteristics.	2	3	2	2	L1 - L2
20EE501.2	Design Distribution feeders and Identify Substation location	2	3	2	2	L1 - L4
20EE501.3	Outline the importance of Distributed Generations (DGs)	2	3	3	2	L1 - L2
20EE501.4	Summarize the various storage techniques for DGs	2	3	3	2	L1 - L2
20EE501.5	Summarize economic aspects of DG system	2	3	3	2	L1 - L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: General Concepts 12 Hours

Introduction to distribution systems: Load modeling and characteristics. Coincidence factor, contribution factor, loss factor. Relationship between the load factor and loss factor. Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics

Classification of distribution system

Unit II: Substations 12 Hours

Location of Substations: Rating of distribution substation, service area within primary feeders. Benefits derived through optimal location of substations.
Distribution Feeders Design Considerations of Distribution Feeders: Radial and loop types of primary feeders - Voltage levels - Feeder loading - Basic design practice of the secondary distribution system.

11kV Substation layout

Unit III: Need for Distributed Generation 12 Hours

Introduction to Distributed Generation, Need, Importance and Advantages of DGs, Distributed vs, Central station Generation, Traditional power system, Load Curve Analysis and Measuring Load curve data accurately, Distributed Generation Systems: Planning and Comparison

Daily load curve

Unit IV: Energy Storage with distributed generation 12 Hours

Planning Process: Finding best alternative with short term and long-term planning, Energy storage elements –Battery storage, capacitors storage, Mechanical Storage: (flywheels, pumped and Compressed Fluid), Fuel cell powered distributed generators.

Superconducting Magnetic Energy Storage (SMES)

Unit V: Economic aspects of DGs 12 Hours

Economic and financial aspects of distributed generation, Cost, Time value of Money, Decision based cost effectiveness evaluation Market facts, issues and challenges, Reliability evaluation of DG based systems

Cost Analysis of DG

Text Books

1. V. Kamaraju, "Electrical Power Distribution Systems", 2nd Edition, Tata Mc Graw Hill, New Delhi.

2. M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A. Chakrabarti, "A Text Book on Power System Engineering", 6th Edition, Dhanpat Rai & Co. Pvt. Ltd.
3. H. Lee Willis, Walter G. Scott, 'Distributed Power Generation – Planning and Evaluation', Marcel Decker Press, 2000
4. M.Godoy Simoes, Felix A. Farret, 'Renewable Energy Systems – Design and Analysis with Induction Generators', CRC press

Reference Books

1. Anthony J. Pansini "Electrical Distribution Engineering", CRC Press, 2005
2. A. Pabla, "Electric Power Distribution", McGraw-Hill, 2005.
3. Robert Lasseter, Paolo Piagi, 'Micro-grid: A Conceptual Solution', PESC 2004, June 2004
4. F. Katiraei, M.R. Iravani, 'Transients of a Micro-Grid System with Multiple Distributed Energy Resources', International Conference on Power Systems Transients (IPST'05) in Montreal, Canada on June 19-23, 2005

Web References

1. https://nptel.ac.in/courses/108/108/108108034/
2. https://www.youtube.com/watch?v=XgBft337-SU

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	20	20
L2	55	55
L3	25	-
L4	-	25
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Explain the different methods for reduction of Distribution system losses.
2. Explain the factors affecting the feeder voltage level.

L2: Understand

1. How is DG being integrated into national power sector planning
2. How are the objectives of DG efforts being established.

L3: Apply

1. A three phase, 11 KV, 30 MVA generator with X3 = 0.06 PU, X1 = 0.3 PU and X2 = 0.3 PU is grounded through a reactance of 0.28 ohms. Calculate the total fault current for a Single line to Ground fault
2. A 3 phase 400 HP, 50 Hz, 11 KV star connected Induction motor has a full load efficiency of 88% at lagging power factor of 0.78 and is connected to a feeder. If it is desired to correct the power factor of 0.92 lagging load, determine i)the size of the capacitor bank in KVAR ii) the capacitance of each unit if the capacitors are connected in delta as well as in star

L4: Analyze

1. List the factors that need to be considered for selecting an ideal location of Substation.
2. Analyse the coordination among the Protective devices used in Distribution system

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Chairman
Board of Studies (EEE)

PC 20EE502 Power Electronics 3 1 0 3.0

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

Code	Course Outcomes	Mapping with PO's			DoK
		PO 2	PO3	PSO1	
20EE502.1	explain the characteristics of various power semiconductor devices	2	2	2	L2
20EE502.2	explain the operation of single phase full–wave converters and analyze harmonics in theinput current	2	2	2	L2
20EE502.3	explain the operation of three phase full–wave converters	3	2	2	L3
20EE502.4	analyze the operation of different types of DC-DC converters	2	2	2	L2
20EE502.5	explain the operation of inverters and application of PWM techniques for voltage controland harmonic mitigation	3	2	2	L2
1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos					
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge					

Unit I: Power Electronic Devices **12 Hours**

Basic Theory of Operation - Static Characteristics-Two Transistors analogy -Turn on and Turn off Methods - Methods of SCR Triggering - Dynamic & Gate Characteristics of SCR – SeriesandParallel Operation – Snubber circuit - Characteristics of Power MOSFET.

Characteristics of IGBT

Unit II: Single Phase AC-DC Converters **12 Hours**

Single Phase half wave controlled rectifiers - R load and RL load with and without freewheelingdiode - Single Phase fully controlled bridge converter with R load, RL load - Continuous and Discontinuous conduction - Effect of source inductance in 1-phase fullycontrolled bridge rectifier with continuous conduction – Expression for output voltages – Single Phase semi Converter with R load, RL load and RLE load – Continuous and Discontinuous conduction - Numerical Problems.

Single Phase fully controlled bridge converter with RLE load

Unit III: Three Phase AC-DC Converters & AC – AC Converters **12 Hours**

Three Phase half wave Rectifier with R and RL load -Three Phase fully controlled rectifier with R and RL load - Three Phase semi converter with R load - Expression for Output Voltage - - Three Phase Dual Converters - Numerical Problems. AC-AC power control by phase control with R and RL loads - Three Harmonic Analysis phase AC voltage regulator with R load –Numerical Problems

Three Phase semi converter with RL load

Unit IV: DC–DC Converters **12 Hours**

Operation of Basic Chopper - Classification - Control Techniques - Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous ConductionModes (DCM) - Output voltage equations using volt-sec balance in CCM & DCM – Expressionsfor output voltage ripple and inductor current ripple- Numerical Problems.

Analysis of Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous ConductionModes (DCM)

Unit V: DC–AC Converters **12 Hours**

Introduction - Harmonic Analysis -Classification - Single Phase half bridge and full bridge inverters with R and RLloads - Unipolar & Bipolar Switching - Quasi-square wave pulse width modulation - Three Phasesquare wave inverters - 180^0 conduction mode of operation – PWMinverters -NumericalProblems

Three Phase square wave inverters - 1200 conduction mode of operation

Text Books

1. Power Electronics: Converters, Applications and Design by Ned Mohan, Tore MUndeland, William P Robbins, John Wiley & Sons
2. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hallof India, 2nd edition, 1998
3. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009.

Reference Books

1. Elements of Power Electronics–Philip T.Krein.oxford.
2. Power Electronics – by P.S.Bhimbra, Khanna Publishers.
3. Thyristorised Power Controllers – by G. K. Dubey, S. R. Doradla, A. Joshi and R. K.Sinha, New Age International (P) Limited Publishers, 1996.

Web References

1. https://nptel.ac.in/courses/108/102/108102145/
2. https://nptel.ac.in/courses/108/101/108101126/
3. https://www.digimat.in/nptel/courses/video/108101126/L01.html

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	50	50
L3	10	10
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Latching Current
2. List the applications of step up choppers.
3. What is shoot through fault? Explain.
4. Draw the circuit diagram of three phase M-3 controlled converter.

L2: Understand

1. Explain the operation of snubber circuit and also design the parameters of snubber circuit.
2. Draw the two-transistor analogy of a SCR? Explain SCR operation with this analogy
3. Explain the operation of single phase two pulse midpoint converter with relevant voltage and current waveforms and also derive the expression for average output voltage.
4. Explain the working of three-phase half wave uncontrolled rectifier with relevant wave forms for 'R' load.

L3: Apply

1. A single phase semi converter is delivering power to RLE load with R= 5Ω, L= 10 mH and E = 80 V. The ac source voltage is 230 V, 50 Hz. For continuous conduction, find the average value of output current for a firing angle of 500 . If one of the SCR is damaged and open circuited find the new value of average output current on the assumption to continuous conduction. Also sketch the output voltage and current waveforms?
2. A boost regulator has an input voltage of Vs = 5 V. The average output voltage Va = 15 V and the average load current Ia = 0.5 A. The switching frequency is 25 kHz. If L = 150 μH and C = 220 μF, determine (i) the duty cycle, (ii) the ripple current of inductor ΔI, (iii) the critical values of L and C..

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PC 20EC305 Digital System Design 3 0 0 3

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

Code	Course Outcomes	Mapping with Pos		DoK
		PO1	PO3	
20EC305.1	Understand the number systems and its logical operations	3	2	L1, L2
20EC305.2	Apply the properties of Boolean theorems for reducing the logical functions	3	1	L2, L3
20EC305.3	Classify and Design simple combinational logic circuits using logic gates and Design various programmable logic devices	3	2	L2, L3, L4
20EC305.4	Design various Registers and Counters using Flip-Flops and Analyze various Sequential Logic Circuits	3	2	L2, L3, L4
20EC305.5	Learn the IEEE standard Hardware Description Language	2	3	L2, L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

UNIT-I: Digital Systems and Number System **13 Hours**

Digital systems, Number systems, Counting in radix, Conversion of one radix to other, Complements of numbers, Signed binary numbers, Arithmetic addition and subtraction, 4-bit codes: BCD codes, Excess-3, Gray code, r's and r-1's complement, Error detecting & Error correcting codes, Basic logic gates, Universal gates, Ex-OR , Ex-NOR gates.

Logic families, Characteristics of Logic families: CMOS, TTL, ECL families.

UNIT-II: Concept of Boolean Algebra **12 Hours**

Basic Theorems and Properties of Boolean algebra, Boolean Functions, Canonical and Standard Forms, Min-terms and Max-terms, Products of Sum Simplification, Sum of Products Simplification, Gate level Minimization: Map Method, Two-Variable K-Map, Three-Variable K-Map, Four Variable K-Maps, Five Variable K-Maps, Don't – Care Conditions, Quine–McCluskey method, NAND and NOR Implementation, Exclusive-OR function, Code converters.

Six variable K-Map, Hazards

UNIT-III: Combinational Logic Circuits & Programmable Logic Devices **12 Hours**

Introduction, Adder, Subtractor, 4-Bit binary adder, 4-Bit binary Subtractor, BCD adder circuit, Carry look-a-head adder circuit, Decoders, Encoders, Multiplexers, Higher order multiplexing, De-Multiplexers, Priority encoder, Magnitude comparator.

Programmable Logic Devices: PROM, PAL, PLA-Basics structures, Realization of boolean function with PLDs, Programming tables of PLDs, merits & demerits of PROM, PAL, PLA comparison, Realization of Boolean functions using PROM, PAL, PLA, Programming tables of PROM, PAL

Parallel Prefix Adders, Binary Multiplier, Vedic Multiplier. Complex Programmable Logic Devices (CPLD), Field Programmable gate arrays (FPGA).

UNIT -IV: Sequential Logic Circuits & Finite State Machines **12 Hours**

Introduction to sequential circuits, Storage elements: Latches, Flip-flops, RS- Latch using NAND and NOR Gates, RS, JK, T and D Flip Flops, Master Slave JK flip flop, Excitation tables and Characteristic equations, Conversion of flip flops. Registers, Shift registers, Universal shift register, Asynchronous counters, Synchronous counters, Ring counter, Johnson counter.

Master slave RS flip flop, Master slave D flip flop, Registers and Counters using reversible logic gates, Vending machine controller

UNIT –V Introduction to VHDL **12 Hours**

Design flow, Program structure, Levels of abstraction, Elements of VHDL: Data types, Data objects, operators and identifiers. Packages, Libraries and Bindings, Subprograms. VHDL Programming using structural and data flow modelling. HDL implementation of combinational and Sequential Logic Circuits.

Modelling of Combinational ICS Using VHDL, Modelling of Sequential ICS Using VHDL

Textbooks

1. Morris Mano, "Digital Design", 3rd Edition, Prentice Hall of India, 2001
2. Hill and Peterson Mc-Graw Hill, "Switching Theory and Logic Design", 1ST Edition, Tata McGraw-Hill, 2016
3. John F.Wakerly, "Digital Design", 4th Edition, Pearson Prentice Hall, 2008
4. A. Anand Kumar, "Switching theory and logic design", 3rd Edition, Prentice Hall of India, 2016

Reference Books

1. Zvi Kohavi, "Switching & Finite Automata theory", 2nd Edition, Tata McGraw-Hill, 2008
2. R P Jain, "Modern Digital Electronics", 3rd Edition, Tata McGraw-Hill, 2003
3. Charles H. Roth Jr, "Fundamentals of Logic Design", 4th Edition, Jaico Publishers, 1992

Web Resources

1. https://nptel.ac.in/courses/117/105/117105080/
2. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
3. http://webstor.srmist.edu.in/web_assets/srm_mainsite/files/2017/15CS20

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	15	-
L2	40	40
L3	30	30
L4	15	30
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Find the decimal number equivalent of fractional octal number
2. List any two postulates of Boolean algebra
3. What you mean by non-weighted code?
4. Name any two functions of encoders
5. What is Flip flop?
6. Define a finite state machine
7. List the three differences between Synchronous and asynchronous counter
8. What is mean by weighted code?
9. Define VHDL

L2: Understand

1. Explain how combinational logic circuit 4:1 multiplexer works
2. Represent the following Boolean expression to min-terms and max-terms AB+BC'+ABD'+ACD
3. Represent a T flip flop using JK flip flop
4. Explain binary adder
5. Show the logic diagram of SR flip-flop with four NOR gate
6. Explain the operation of D-flip-flop
7. What are the elements of the VHDL

L3: Apply

1. Build the Boolean function F (x, y, z) = $\sum$ m (0, 1, 2, 4, 5, 7) by using 4 to 1 Multiplexer
2. Develop a full adder using half adder
3. Construct a 16:1 multiplexer using 8:1 multiplexer
4. Solve the following Boolean functions, using four-variable maps: F(w, x, y, z) = $\sum$ (1, 4, 5, 6, 12, 14, 15)
5. Develop 4-bit ring counter using D flip-flop
6. Write the VHDL program for Universal Gates

L4: Analyze

1. Distinguish combinational logic circuits and sequential logic circuits.
2. Compare mealy and Moore machine
3. Classify the counters
4. Analyze the characteristics of counters and registers
5. List out the statements of Boolean Theorems

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PC 20EC308 Digital System Design Lab 0 0 3 1.5

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

Code	Course Outcomes	Mapping with POs	
		PO4	PSO1
20EC308.1	Identify and Verify the Logic Gates	3	1
20EC308.2	Design and Verify the Various Combinational Logic Circuits using Basic Logic Gates	3	1
20EC308.3	Design Registers and Counters using Flip-Flops	3	2
20EC308.4	Develop Various Sequential Logic Circuits	3	3
20EC308.5	Simulate and Verify the Combinational and Sequential Logic Circuits	3	3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

List of Experiments

1. Design of Logic Gates
2. Design of Adders and Sub-tractor
3. Design of Binary to Gray and Gray to Binary
4. Design of 3 to 8 Decoder
5. Design of 4-bit Comparator
6. Design of 4-bit multiplier
7. Design of 8 x 1 Multiplexer
8. Design of Decade counter
9. Design of 4-bit Ring and John Son Counter
10. Design of Universal shift registers
11. Design of Mealy and Moore machine

References

1. Lab Manual for Digital System Design Lab, Department of Electronics and Communication Engineering, NSRIT

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PC 20EE507 Power Electronics Lab

0 0 3 1.5

Code	Course Outcomes	Mapping with POs	
		PO4	PSO1
20EE507.1	Study the characteristics of various power electronic devices.	3	3
20EE507.2	Analyze the performance of single–phase and three–phase full–wave bridge converters with both resistive and inductive loads.	3	3
20EE507.3	Understand the operation of single-phase AC voltage regulator with resistive and inductive loads	3	3
20EE507.4	Understand the working of Buck converter, Boost converter	3	3
20EE507.5	Understand the working of single–phase square wave inverter and PWM inverter	3	3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective PO's

List of experiments

1. Characteristics of Thyristor, MOSFET & IGBT (maintenance)
2. Single -Phase semi converter with R & RL loads.
3. Single -Phase full converter with R & RL loads.
4. Three- Phase full converter with R &RL loads.
5. Single -Phase AC Voltage Regulator with R & RL Loads
6. Single Phase step down Cyclo-converter with R & RL Loads
7. Single Phase dual converter in circulating current & non circulating current mode of operation.
8. Boost converter in Continuous Conduction Mode operation.
9. Buck converter in Continuous Conduction Mode operation.
10. Single -Phase square wave bridge inverter with R & RL Loads.
11. Single - Phase PWM inverter

References

1. Lab Manual for Power Electronics Lab, Department of Electrical and Electronics Engineering, NSRIT.
2. P S Bimbhra, "Power Electronics", 2nd Edition Khanna Publishers, 2021.
3. Norman S Nise, "Control Systems Engineering", 3rd Edition John Wiley and sons, 2018.

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MC 20MCX03 Intellectual Property Rights and Patents 2 0 0 0

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

Code	Course Outcomes	Mapping with POs PO11	PO12	DoK
20MCX03.1	Acquire knowledge on intellectual property rights	-	-	L1,L2
20MCX03.2	Know about the acquisition of trademarks.	-	-	L1,L2
20MCX03.3	Identify the importance of copyrights,patents and Transfer of Ownership.	-	--	L1, L2
20MCX03.4	Reciprocate to new developments of intellectual property rights	-	-	L1, L2
20MCX03.5	International overview of IPR	-	-	L1,L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

UnitI: Introduction to Intellectual property: **4 Hours**

Concepts, types of intellectual property,international organizations, agencies and importance of intellectual propertyrights.IndustrialProperty,technologicalResearch,InventionsandInnovations – Important examples of IPR.,IPR in India and Abroad

Unit II: Introduction toTrade Marks: **4 Hours**

Purpose and function of trademarks, acquisition of trade markrights,selecting and evaluating trademark ,trademark registration processes.Trade Secrets and Industrial Design registration in India and Abroad

Unit III: Registration of Copy Rights **4 Hours**

Fundamentals of copy right law,rights of reproduction, rights to perform the work publicly, copy right ownership issues, copyrightregistration, international copyright laws.
Law of patents: Foundation of patent law, patent searching process, ownership rights andtransfer.

Unit IV: Latest development of intellectual property Rights **4 Hours**

New developments in trademark law; copy right law, patent law, intellectual property audits. Infringementof IPRs,Enforcement Measures,Emerging issues–

Unit V:Enforcement Of IPRs **4 Hours**

International overview on intellectual property, international – trade mark law, copy right law, international patent law international development in trade secrets law.

Text Books

1. Intellectualpropertyright,Deborah,E. Bouchoux,cengagelearning.
2. Intellectual property right - Unleashing the knowledge economy, Prabuddha Ganguli,TataMcGraw Hill PublishingCompanyLtd.
3. Cornish,WilliamRodolph&Llewelyn,David.Intellectualproperty:patents,copyright,trademarks andallied rights. Sweet& Maxwell,8/e,2013.

Reference Books

1. Cornish,WilliamRodolph.Casesandmaterialsonintellectualproperty.Sweet&Maxwell, 5/e,2006.
2. Lo,JackandPressman,David.Howtomakepatentdrawings:apatentityourselfcompanio n. Nolo, 5/e 2007.

Web References

1. https://www.investopedia.com/terms/i/intellectualproperty.asp
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3217699/
3. https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	60	60
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What is Industrial property?
2. What are the fundamentals of copy rights
3. Define patents and its approval process
4. Define copy right law.
5. Define transfor of trade marks.

L2: Understand

1. Explain the role trade scerets in company law.
2. Explain the concept owenership rights of patents with suitable examples
3. Explain the international patent law.
4. Distinguish between copy rights and patents.
5. Explain copt right registration.

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IN	**Summer Internship #1**	**0**	**0**	**0**	**1.5**

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

No.	Course Outcomes
1	Demonstrate the theoretical learning outcomes
2	Integrate theory and practice during graduation
3	Comprehend the industry practices in the relevant and allied field of study
4	Develop communication skills in terms of oral, written, and graphical communications
5	Develop problem solving skills
6	Develop work habits and teamwork in a multidisciplinary setting for a successful career after graduation

Note: All the above course outcomes are relatively mapped to all POs as it caters to all program outcomes

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AC Technical Paper Writing

0 0 2 0

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

No.	Course Outcomes
1	Develop searching latest relevant literature pertaining to the topic of interest
2	Develop self-learning ability to become a lifelong independent learner
3	Develop the habit of writing technical manuscript as per the requirement
4	Develop presentation skills and speak with appropriate technical phrases
5	Explore the research topics and develop research interests
6	Comprehend the latest technologies, techniques, tools, and methodologies

Note: All the above course outcomes are relatively mapped to all POs as it caters to all program outcomes

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PC 20EC603 Microprocessors and Microcontrollers 3 1 0 3

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

Code	Course Outcomes	Mapping with POs		DoK
		PO1	PO9	
20EC603.1	Describe the features and architecture of 8086 Microprocessor & the modes of operation	3	3	L1, L2
20EC603.2	Illustrate different instructions, addressing modes and write assembly programs	3	2	L1, L2, L3
20EC603.3	Illustrate how different peripherals are interfaced with Microprocessor	3	3	L1, L2, L3
20EC603.4	Describe the concepts of 8051 microcontroller's architecture, Addressing modes, interfacing and programs	3	3	L1, L2
20EC603.5	Differentiate the various ARM Processor architectures, functions and interfaces	3	2	L1, L2, L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

UNIT I: Introduction to 8086 Microprocessor **11+1 Hours**

Basic Microprocessor architecture, with examples, Microprocessor Unit and Microcontroller Unit, Main features, pin diagram/description, 8086 microprocessor family, internal architecture, Bus interfacing unit, Execution unit, interrupts and interrupt response, 8086 system timing, minimum mode and maximum mode configurations*Diode switching times, PN diode clipping circuits.*

Address bus, Data bus, ALE, Interrupts

UNIT II: 8086 Programming **11+1 Hours**

Instruction set, addressing modes, Assembler directives, writing simple programs with an assembler, assembly language program development tools, Program development steps.

Assembler Directives, Instruction set

UNIT III: 8086 Interfacing **11+1 Hours**

Intel 8255 programmable peripheral interface, Interfacing switches and LEDS, Interfacing seven segment displays, Intel 8251 USART architecture and interfacing, Intel 8237a DMA controller, stepper motor, A/D and D/A converters, Need for 8259 programmable interrupt controllers.

Interfacing, Interrupt priority, Direct Memory Access

UNIT IV: 8051 Microcontrollers **11+1 Hours**

Architecture, Signal Description, Input/output ports and circuits, Memory Organization, Counters/Timers, serial Communication, Interrupts. Assembly language programming: Instructions, addressing modes, simple programs.
Interfacing to 8051: Memory (RAM, ROM), Stepper motor interface, Keyboard, LCD Interfacing A/D and D/A Converters.

Counters, Timers, Data Transfer through Serial Communication

UNIT V: ARM Processors **11+1 Hours**

ARM Architecture, ARM Processors Families, ARM Cortex-M Series Family, ARM Cortex-M3 Processor Functional Description, functions and Interfaces. Modes of operation and execution, Instruction set summary, System address map, write buffer, bit-banding, processor core register summary, exceptions.

ARM Features, Modes of operation

Textbooks

1. Douglas V. Hall, Rao S. S. S. P., "Microprocessors and Interfacing – Programming and Hardware ", Tata Mc Graw Hill Education Private Limited, 3rd Edition,1994
2. Prof Bhurchandi K. M., and Prof Ray A. K., "Advanced Microprocessors and Peripherals: With ARM and an Introduction to Microcontrollers and Interfacing", 3rd Edition, 2010
3. Muhammad Ali Mazidi, Janice Gillespie Mazidi and Rollin D. McKinlay, "The 8051 Microcontrollers and Embedded systems Using Assembly and C", 2nd Edition, Pearson Publications, 2011
4. Joseph Yiu," The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors", 3rd Edition, Newnes, 2013

Reference Books

1. Kenneth J. Ayala," The 8051 Microcontroller", 4th Edition, Tata McGraw Hill Education Private Limited, 1994
2. Dr. Alexander G. Dean," Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach in English", Arm Education Media, 2017

Web Resources

1. https://www.youtube.com/watch?v=GapjjO_8Kuk
2. https://www.tutorialspoint.com/microprocessor/microprocessor_8086_overview.html
3. https://www.javatpoint.com/8086-microprocessor
4. http://www.digimat.in/nptel/courses/video/108105102/L31.html
5. https://nptel.ac.in/courses/117/106/117106111/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	30
L2	40	40
L3	30	30
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Microprocessor
2. Define Bus in Microprocessor
3. What is an Interrupt in Microprocessor?
4. Specify the function of ALE Signal
5. Define Pipeline processing
6. List out any four features of 8086 Microprocessor
7. List out any four features of 8051 Microcontroller
8. Write any four Applications of A/D Converters

L2: Understand

1. Illustrate different operations in Stack
2. Explain the functions of BIU and Execution unit
3. Discuss the addressing modes of 8086 Microprocessor with examples
4. Illustrate different instructions of 8086 Microprocessor
5. Discuss the minimum mode of configuration of 8086 Microprocessor
6. Discuss the memory Segmentation of 8086 Microprocessor
7. Discuss the Register Organization of 8051 Microcontroller
8. Explain Timers and Counters in 8051 Microcontroller
9. Describe the Features of ARM Microprocessors

L3: Apply

1. How to Write simple Assembly level programs?
2. Discuss the procedure of Interfacing A/D Converters to 8086 Microprocessor

3. How to interface stepper motor to 8051 Microcontroller?
4. How to Generate square wave forms using Timer Mode Programming?
5. How to generate quarter second delay in 8051 Microcontroller?

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PC 20EE602 Electrical Measurements and Instrumentation 3 0 0 3.0

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

Code	Course Outcomes	Mapping with PO's		DoK
		PO 2	PSO 1	
20EE602.1	Understand the working principle of basic analog instruments	2	2	L1 - L2
20EE602.2	Illustrate the working of different meters for measurement of Power, Power Factor and Energy	2	2	L1 - L2
20EE602.3	Estimate the values of unknown resistance, inductance and capacitance using bridges.	3	2	L1 - L3
20EE602.4	Explain the working of different Transducers and their applications	2	2	L1 - L2
20EE602.5	Explain the working of different types of digital meters.	3	2	L1 - L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Measuring Instruments — 12 Hours

Classification of measuring instruments, Ammeters and Voltmeters – Basics, range extensions, PMMC
Moving Iron type instruments – expression for the deflecting torque and control torque – errors and compensations, extension of instrument range, Current Transformer construction, theory. ratio and phase angle errors

Potential Transformer constructin, theory,ratio and phase angle errors.

Unit II: Analog Wattmeters and Power Factor Meters — 12 Hours

Electrodynamometer type wattmeter (LPF and UPF), Power factor meters: Dynamometer and M.I type (Single phase and Three phase), construction, theory, torque equation, advantages and disadvantages -Numerical Problems.

Construction,theory,torque equation of M.C. type

Unit III: DC and AC Bridges — 12 Hours

Method of measuring low, medium and high resistance – sensitivity of Wheat stone's bridge, Kelvin's double bridge, Megger – measurement of earth resistance - Numerical Problems
Measurement of inductance – quality factor, Maxwell's bridge, Anderson's bridge, measurement of capacitance and loss angle, Schering Bridge, Wien's bridge- Numerical Problems

Hay's bridge, Desauty's bridge

Unit IV: Transducers — 12 Hours

Definition, Classification, Resistive, Inductive and Capacitive Transducer, LVDT, Strain Gauge, Thermistors, Thermocouples, Piezo electric and Photo Diode Transducers.

Digital shaft encoders, Hall effect sensors

Unit V: Digital Meters — 12 Hours

Digital Voltmeter–Successive approximation, ramp and integrating type - Digital frequency meter–Digital multimeter–Digital Tachometer. Digital energy meter, Measurement of phase difference – Frequency.

Hysteresis loop using lissajious patterns in CRO

Text Books

1. A.K.Sawhney, "Electrical & Electronic Measurement & Instruments", 5th Edition, Dhanpat Rai &Co.Publications, 2021

2. R.K.Rajput, "Electrical and Electronic Measurements and instrumentation", 4th Edition, S.Chand, 2015
3. G.N.Srinivas and S. Narasimha, "Electrical and Electronic Measurements and Instrumentation", 2nd Edition, B S Publications, 2018.

Reference Books

1. E.W. Golding and F. C. Widdis, "Electrical Measurements and Measuring Instruments", 5thEdition, Wheeler Publishers, 2012.
2. W.D. Coopers and Helfrick, "Modern Electronic instrumentation and Measurements Techniques", Pearson / Prentice Hall of India P. Ltd.2003

Web References

1. https://nptel.ac.in/courses/108/105/108105153/
2. https://www.udemy.com/course/complete-course-in-electrical-measurement-instrumentation/?utm_source=adwords&utm_medium=udemyads&utm_campaign=DSA_Catchall_la.EN_cc.INDIA&utm_content=deal4584&utm_term=_._ag_rp1MsBIToN2H4nODEy1jzOZtQ5UZ5ZUQIPk2MiFYm1ACDEaAtyfEALw_wcB

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	50	50
L3	10	10
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What are the errors usually occur in PMMC instruments?
2. What is the basic principle used in potentiometer?
3. What are the advantages and disadvantages of a Maxwell bridge?
4. Write about spring control of an instrument.
5. How are Instrumental Errors different from gross Errors?

L2: Understand

1. Discuss any 2 essential features of indicating instruments.
2. Explain with the help of a neat sketch the construction and operation of a D'Arsonval galvanometer.
3. Explain the working of Successive - approximation type Digital voltmeter with a neat block diagram.
4. Derive the expression for torque equation of a moving iron instrument.
5. Explain the procedure for measuring a low resistance with the help of kelvin's double bridge.

L3: Apply

1. The four arms of an A.C. bridge network are as follows: Arm AB: an unknown capacitance; Arm BC: a standard capacitor C 3 of 1000pF; Arm CD: a non inductive resistor R4 of 100 in parallel with a capacitor C4 of 0.01μF; Arm DA: a non – inductive resistor R2 of 1000 . The A.C. supply is connected across terminals B, D and the supply frequency is 50 Hz. If the bridge is balanced with the above values, determine the components of the unknown impedance, while deriving the balanced conditions.

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PC 20EE603 Power System Analysis 3 1 0 3.0

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

Code	Course Outcomes	Mapping with PO's PO2	PO3	DoK
20EE603.1	Illustrate the per-unit representation for given power system network	2	2	L2
20EE603.2	Solve load flow equations using Gauss-Seidel method and Newton-Raphson's method.	2	2	L2
20EE603.3	Analyze power system stability..	3	2	L3
20EE603.4	Study the concept of the Zbusbuilding algorithm	2	2	L2
20EE603.5	Understand the excitation control.	3	2	L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Circuit Topology & Per-unit Representation 12 Hours

Per-unit System representation of a given power system network, Per-unit equivalent reactance diagram Symmetrical fault Analysis:Symmetrical Component Theory: Symmetrical Component Transformation, Sequence Networks. Unsymmetrical Fault Analysis: LG, LL, LLG faults without fault impedance

Unsymmetrical Fault Analysis: LG, LL, LLG faults with fault impedance

Unit II: Power Flow studies 12 Hours

Power flow problem – significance, classification of buses, Formation of Ybus using direct inspection method, Derivation of Static load flow equations, Load flow solutions using Gauss Seidel Method, Acceleration Factor, Newton Raphson Method in Rectangular and Polar Co-ordinates, Comparison of different load flow methods. (Only derivative approach) problems on 3-bus systems only.

Decoupled and Fast decoupled load flow method

Unit III: Power system stability 12 Hours

Elementary Concepts of Steady State, Dynamic and Transient Stabilities - Description of: Steady State Stability Power Limit, Transfer Reactance, Synchronizing Power Coefficient, Power Angle Curve and Determination of Steady State Stability

Methods to Improve Steady State Stability.

Unit IV: Z-Bus Algorithm & Symmetrical Fault Analysis: 12 Hours

Formation of Zbus: Algorithm for the Modification of Zbus Matrix (without mutual impedance).
Symmetrical Fault Analysis: Reactances of Synchronous Machine – Three Phase Short Circuit Currents - Short circuit MVA calculations for Power Systems.

Algorithm for the Modification of Zbus Matrix (witht mutual impedance).

Unit V: Excitation voltage ans control 12 Hours

Excitation System Control in synchronous generators, Automatic Voltage Regulators. Series and Shunt Compensators.

Facts devices

Text Books

1. C.L. Wadhwa, "Electrical Power Systems", New Age International Publishers, 7th Edition, 2017.
2. 2.. P.Kundur, "Power System Stability and Control", McGraw Hill Inc, 2nd Edition, 2005
3. Allen J Wood, Bruce F Wollenberg, Gerald B Sheble, "Power Generation, Operation and Control", Wiley India, 3rd Edition, 2013.
4. John J Grainger, William D Stevenson Jr."Power system analysis" Tata McGraw-Hill, 2th Edition, 2012.(Unit-I,II,III,IV)

Reference Books

1. I.J. Nagrath & D.P. Kothari, "Modern Power System Analysis", Tata McGraw-Hill, 4th Edition, 2013.
2. M. A. Pai "Computer Techniques in Power System Analysis", Tata McGraw-Hill Publishing Company, 2nd Edition, 2006.

Web References

1. https://www.youtube.com/watch?v=tb3gCr9m0LU&list=PLtcRcIUOKppXWUMEVXGwwULXgzEBygOK-
2. https://www.youtube.com/watch?v=fBm1dr_gRBk&list=PL36A60B630E8C7B56

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	50	50
L3	10	10
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What are the disadvantages of per unit quantities?
2. What are the merits and demerits of Gauss-Seidel method?
3. What are the causes for large disturbances in the power system?
4. What are the methods considered for improving steady state stability?
5. What is the need of slack bus?

L2: Understand

1. How the Zbus is modified when a new branch Zb is added from a new bus P to reference bus 'Ó'.
2. How do you get the short circuit MVA from per unit impedance?
3. Explain the sequence networks of three phase transformer..
4. Explain the selection of reactors.
5. Describe the latest methods for improving the transient stability

L3: Apply

1. Determine the ZBus using building algorithm for a power system whose element data is given in the following table: Element No. Connected between bus Nos. Self reactance (p.u)

Ele.no.	busno.	Self reactance(p.u)
1	1-2	0.3
2	1-3	0.1
3	2-3	0.2

4	1-2	0.1

2. A transformer rated at 75 MVA and having a short circuit reactance of 0.02 p.u is connected to the bus bar of a generating station which is supplied through two 12.6 kV feeders each having an impedance of (1.5+j 4) Ω . One of the feeder is connected to the generating station using generator capacity of 50 MVA connected to its bus bars having a short circuit reactance of 0.2 p.u and other feeder to a generator with 25MVA and having a reactance of 0.35 p.u. Calculate the MVA supplied to the fault in the event of a short circuit occurring between the secondary terminals of the transformer.

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PC 20EC606 Microprocessors and Microcontrollers Lab 0 0 3 1.5

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

Code	Course Outcomes	Mapping with POs	
		PO4	PO9
20EC606.1	Develop assembly language programs to perform arithmetic, logical operations, string operations using TASM and 8086 Microprocessor boards	3	2
20EC606.2	Design interfacing circuits using 8086 Microprocessor	2	3
20EC606.3	Construct different waveforms using 8086 Microprocessor and 8051 Microcontroller	3	3
20EC606.4	Develop and implement assembly language programs to perform real time interfacing using 8051Microcontrollers	3	3
20EC606.5	Implement assembly language programs to perform arithmetic operations using ARM Processors	3	3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

List of Experiments

1. Programs for 16 -bit arithmetic operations using 8086 programs
2. Perform BCD Addition
3. Write an assembly program for finding factorial of a given number
4. Program for sorting an array
5. Interfacing ADC to 8086
6. Interfacing DAC to 8086
7. Interfacing stepper motor to8086
8. Finding number of 1's and number of 0's in a given 8-bit number
9. Program to find Average of n-numbers
10. Interfacing Traffic Light Controller to8051
11. Timer Mode Programming
12. Write an assembly program to multiply of 2 16-bit binary numbers
13. Write an assembly program to find the sum of first 10 integers numbers
14. Write a program to toggle LED every second using timer interrupt

References

1. Lab Manual for Microprocessors and Microcontrollers of Electronics and Communication Engineering, NSRIT

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PC 20EE607 Electrical Measurements and Instrumentation Lab 0 0 3 1.5

Code	Course Outcomes	Mapping with POs	
		PO4	PSO1
20EE607.1	Understand various measurement techniques used in electrical engineering	3	3
20EE607.2	Understand the calibration of DC and AC Potentiometers.	3	3
20EE607.3	Demonstrate the use of sensors and transducers in electrical and nonelectrical measurements.	3	3
20EE607.4	Apply knowledge of virtual instruments in measurement of analysis of electrical parameters	3	3
20EE607.5	Understand and the characteristics of Thermo couples, LVDT.	3	3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective PO's

List of experiments

1. Calibration of dynamometer wattmeter using phantom loading.
2. Crompton D.C. Potentiometer - Calibration of PMMC ammeter and PMMC voltmeter.
3. Kelvin's double Bridge - Measurement of resistance - Determination of tolerance.
4. Capacitance Measurement using Schering Bridge.
5. Inductance Measurement using Anderson Bridge.
6. Calibration of LPF Wattmeter – by direct loading.
7. Measurement of 3 phase power with single watt meter and 2 No's of C.T.
8. Thermocouple – characteristics.
9. LVDT – characteristics.
10. Capacitive transducers characteristics.
11. Piezoelectric transducer characteristics.

References

1. Lab Manual for Control Systems Lab, Department of Electrical and Electronics Engineering, NSRIT
2. A K Sawhney, "Electrical and Electronic measurement and instruments", Dhanpat Rai and Sons Publications, 2002.
3. E W Golding and F C Widdis, "Electrical measurements and measuring instruments", Wheeler publishing, 5th Edition, 2006.

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PC 20EE608 Power Systems and Simulation Lab 0 0 3 1.5

Code	Course Outcomes	Mapping with POs	
		PO4	PSO1
20EE608.1	Obtain Sequence impedances and calculate the dielectric strength of 3 phase Transformer by using hardware lab Equipment	3	3
20EE608.2	Obtain the response of Single area Load frequency control with &without control	3	3
20EE608.3	Understand the Load flow studies using NR method and Gauss- seidel method	3	3
20EE608.4	Analyze and calculate the Power Angle Characteristics of 3phase Alternator with infinite bus bars.	3	3
20EE608.5	Understand Economic load dispatch with & without losses Economic load dispatch with losses.	3	3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective PO's

List of experiments

1. Sequence impedances of 3 phase Transformer.
2. Dielectric strength of Transformer oil.
3. Single area Load frequency control with &without control
4. Double area Load frequency control with & without control
5. Sequence impedances of 3 phase Alternator by Fault Analysis.
6. Sequence impedances of 3 phase Alternator by Direct method.
7. ABCD parameters of Transmission line.
8. Power Angle Characteristics of 3phase Alternator with infinite bus bars.
9. Load flow studies using Gauss- seidel method
10. Load flow studies using N-R method
11. Economic load dispatch with & without losses
12. Economic load dispatch with losses.

References

1. Lab Manual for Power System and Simulation Lab, Department of Electrical and Electronics Engineering, NSRIT

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SC 20EES04 P-SPICE

1 0 2 2.0

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

Code	Course Outcomes	Mapping with POs PO5
20EES04.1	Understand the P-SPICE software	3
20EES04.2	Explain the circuits for various types of loads	3
20EES04.3	Understand the working of single-phase AC voltage controller	3
20EES04.4	Explain working of Buck and Boost converter	3
20EES04.5	Understand the working of single-phase inverter	3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Po's

List of Experiments

1. Introduction to PSPICE software
2. PSPICE Simulation of Series RLC Circuits for Step, Pulse & Sinusoidal Inputs
3. Study VI characteristics of a diode using PSPICE
4. PSPICE Analysis of Single-Phase Full Converter with RL & RLE Loads
5. Single phase AC voltage controller using RL loads
6. PSPICE Simulation of Integrator
7. PSPICE Simulation of Differentiator
8. Introduction to PSPICE modelling
9. Simulation of Boost Converters
10. Simulation of Buck Converters
11. Single Phase Inverter with PWM Control

Text Books

1. Susan A. Riedel, James W.Nilsson, "Introduction to PSpice for Electric Circuits", 6th Edition, Pearson, 2007
2. Franz J. Monssen, "OrCAD PSpice with Circuit Analysis", 4th Edition, Pearson, 2000.

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20MCX04 Indian Traditional Knowledge

2 0 0 0

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

Code	Course Outcomes	Mapping with POs				DoK
		PO1	PO6	PO7	PO12	
20MCX04.1	Identify the concept of Traditional knowledge and its importance	1	3	3	2	L1, L2
20MCX04.2	Explain the need and importance of protecting traditional knowledge	1	2	3	2	L1, L2
20MCX04.3	Illustrate the various enactments related to the protection of traditional knowledge	1	3	3	2	L1, L2
20MCX04.4	Interpret the concepts of Intellectual property to protect the traditional knowledge	1	2	3	2	L1, L2
20MCX04.5	Explain the importance of Traditional knowledge in Agriculture and Medicine	1	3	3	2	L1, L2, L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create

UNIT I: Introduction to traditional knowledge **6 hours**

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge

UNIT 2: Protection of traditional knowledge **6 hours**

The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNIT 3: Legal framework and TK **6 hours**

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

UNIT 4: Traditional knowledge and intellectual property **6 hours**

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge

UNIT 5: Traditional Knowledge in Different Sectors **6 hours**

Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK

Text Books:

1. Amit Jha, "Traditional Knowledge System in India", 2009.

Reference Books:

1. Amit Jha, "Traditional Knowledge System in India", 2002
2. Kapil Kapoor, Michel Danino, "Knowledge Traditions and Practices of India", CBSE, 2012

Web Links:

1.https://www.youtube.com/watch?v=LZP1StpYEPM
2.http://nptel.ac.in/courses/121106003/

PE 20EE001 Advanced Power Electronics 3 0 0 3

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

Code	Course Outcomes	Mapping with Pos			DoK
		PO1	PO2	PSO1	
20EE001.1	Evaluate different dc-dc voltage regulators	2	2	1	L1-L2
20EE001.2	Explain resonant converters	2	2	1	L1-L2
20EE001.3	Understand phase shifting converter for a multi-level converter	2	2	1	L1-L3
20EE001.4	Explain phase shifting converter for a multi-pulse converter	2	2	1	L1-L2
20EE001.5	Understand various multi-level inverter configurations	2	2	1	L1-L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

Unit I: Switching Voltage Regulators **12 Hours**

Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converters and their analysis for continuous and discontinuous mode; Other converter configurations like Flyback converter, Forward converter, Half bridge, Full bridge configurations, Push-pull converter, Cuck converter, Sepic Converter; Design criteria for SMPS;

Multi-output switch mode regulator

Unit II: Resonant Converters **12 Hours**

Introduction, Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zero-voltage switching dc-dc converters, zero current switching dc-dc converters,

clamped voltage topologies

12 Hours

Unit III: Multi-level converters

Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations applications,

carrier based PWM technique for multi-level converters

Unit IV: Multi pulse Converters **12 Hours**

Concept of multi-pulse, Configurations for m-pulse (m=12,18,24 ....) converters, Different phase shifting transformer (Y-Y1, Y-Y2, Y-Z1 and Y-Z2) configurations for multi-pulse converters

Applications of multi pulse converters

Unit V: HVDC Transmission **12 Hours**

Introduction, Operation of 12-pulse converter as receiving and sending terminals of HVDC system, Equipment required for HVDC System and their significance, Comparison of AC and DC transmission

Control of HVDC transmission

Textbooks

1. Ned Mohan, Tore M. Undeland and William P, "Power Electronics – Converters, Applications and Design" 5th edition ,Robbins John Willey & sons,2015
2. Drives Bin Wu John "High Power Converters and AC" 4th edition, John Willey & sons Inc,2013
3. Clean Power Derek, "Power Electronic Converter Harmonics – Multipulse Methods", 3rd edition, IEEEPress

Reference Books

1. P.C.Sen "Modern Power Electronics" 3rd edition S. Chand and Co. Ltd.,2012
2. L. Umanand Wiley " Power Electronics Essentials and Applications" 3rd edition, India Pvt Ltd 2009
3. Vijay K. Sood Kluwer "HVDC and FACTS Controllers Applications of Static Converters in Power System, 5th edition, Academic Publishers, 2008

Web References

1. https://onlinecourses.nptel.ac.in/noc20_ee28/preview
2. http://ieeexplore.ieee.org/document/6493452/
3. https://www.nature.com/articles/s41467-020-16262-0

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	50
L2	40	40
L3	10	10
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1 What is the need of resonant converters?
4. State important advantages, disadvantages and applications of SMPS.
5. Give comparison of HVAC and HVDC transmission.
6. Discuss need of multilevel inverter.

L2: Understand

1. Explain in brief Static VAR Compensator (SVC). Compare it with STATCOM.
2. Explain concept of multilevel inverter.
3. Discuss principle of series compensation. Explain operation of static synchronous series compensator (SSSC).
4. Draw block diagram of HVDC transmission system. Mention equipment required for HVDC system.

L3:Apply

1. Compare 12 pulse and 18 pulse converter based on its harmonic analysis.
2. Discuss principle of shunt compensation. Explain operation of fixed capacitor- thyristors controlled reactor.

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PE 20EE002 Digital Control Systems 3 0 0 3.0

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

Code	Course Outcomes	Mapping with PO's PO1	PO6	DoK
20EE002.1	Explain the concept of sample and hold operation and apply Z-transforms to Digital systems	2	2	L1 - L2
20EE002.2	Understand the theory of z–transformations and application for the mathematical analysis of digital control systems.	2	2	L1 - L2
20EE002.3	Explain the stability of digital controlsystems	3	2	L1 - L3
20EE002.4	Ubderstand the concept of state space to test the performance of digital controlsystems	2	2	L1 - L3
20EE002.5	Study the design of state feedback control by "the pole placement method.	3	2	L1 - L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Introduction and Signal processing — 12 Hours

Introduction to analog and digital control systems – Advantages of digital systems sample and hold operations, Sampling theorem, Reconstruction of original sampled signal to continuous-time signal, A/D and D/A conversion, applications of A/D and D/A conversion

Frequency domain characteristics of zero order hold.

Unit II: Review of Z-transforms — 12 Hours

Z-Transform method for solving difference equations; Pulse transfer function, block diagram analysis ofsampled – data systems, mapping between s-plane and z-plane: Primary strips

Complementary Strips.

Unit III: Stability analysis — 12 Hours

Mapping between the s–Plane and the z–Plane – Primary strips and Complementary strips – Stability criterion – Modified Routh's stability criterion and Jury's stability test

Stability analysis using Liapunov theorems.

Unit IV: State space representation — 12 Hours

State Space Representation of discrete time systems, solving discrete time state space equations, State transitionmatrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuoustime state – space equations. Concepts of Controllability and Observability, Testsfor controllability and Observability

Duality between Controllability and Observability

Unit V: State feedback controllers — 12 Hours

Design of state feedback controller through pole placement – Necessary and sufficient conditions – Ackerman's formula. Applications of state feedback controllers

Advanced feedback controllers.

Text Books

1. Discrete–Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition
2. B.C. Kuo, "DigitalControlSystems", 2 nd Edition, Oxford University Press, Feb 2012. (Units - 2, 3)

3. M. Gopal, "Digital Control Engineering", 2 nd Edition-New Age International Publications, 2014.

Reference Books

1. Karl J Astrom& B. Wittenmark, "Computer controlled systems, Theory and & Design", 3 rd Edition, Prentice Hall Information Sciences & System sciences series,1997.
2. M.Gopal, "Digital Control and State Variable Methods", 4 th Edition, TMH, April-2012.

Web References

1. http://mtc-m18.sid.inpe.br/col/sid.inpe.br/mtc m18@80/2008/03.17.15.17.24/doc/mirrorget.cgi?languagebutton=pt-BR&metadatarepository=sid.inpe.br/mtc-m18@80/2009/02.09.14.45.33&index=0&choice=full
2. http://portal.acm.org/author_page.cfm?id=81100182444&coll=GUIDE&dl=GUIDE&trk=0&CFID=27536832&CFTOKEN=71744014

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	50	50
L3	10	10
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What State Transition Matrix?
2. Write about Discretization of continuous time state – space equations?
3. Define stability of digital control systems
4. What is meant by sampling and hold operations?
5. What are digital compensators?
6. State the sampling theorem

L2: Understand

1. Write about a) State Transition Matrix b) Pulse Transfer Function Matrix c) Discretization of continuous time state – space equations.
2. Explain the shifting and scaling operator with suitable examples.
3. Describe the linear time invariant and casual systems.
4. What is State transition matrix? state its Properties. Also explain any two methods for Computation of State Transition Matrix.
5. Discuss the design procedure of state feedback controller through pole placement technique.

L3: Apply

1. Prove that the discrete-time control system defined by x[(k+1)T] = G x(kT), y(kT) = C x(kT) is complete observable.

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PE 20EE003 Utilization Of Electrical Energy 3 0 0 3.0

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

Code	Course Outcomes	Mapping with PO's PO1	PO2	PO3	DoK
20EE003.1	Identify a suitable motor for electric drives and industrial applications	3	1	2	L1-L2
20EE003.2	Identify most appropriate heating or welding techniques for suitable applications	3	1	2	L1-L2
20EE003.3	Understand various levels of illuminosity produced by different illuminating sources.	3	1	2	L1-L3
20EE003.4	Design different lighting systems by taking inputs and constraints in view for different layouts.	3	1	2	L1-L3
20EE003.5	Understand the speed/time characteristics of different types of traction motors.	3	1	2	L1-L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: 12 Hours

Illumination fundamentals

Introduction, terms used in illumination–Laws of illumination–Polar curves–Integrating sphere–Lux meter–Sources of light

Various Illumination Methods

Discharge lamps, MV and SV lamps–Basic principles of light control–Types and design of Indoor lighting and Outdoor lighting–LED lighting, Energy conservation.

Comparison between tungsten filament lamps and LED lamps

Unit II: 12 Hours

Electric Heating

Advantages and methods of electric heating–Resistance heating induction heating and dielectric heating.

Electric Welding

Electric welding–Resistance and arc welding–Electric welding equipment

Comparison between AC and DC Welding, Applications of Electric Heating and Electric Welding

Unit III: Selection of Motor 12 Hours

Choice of motor, type of electric drives, starting and running characteristics–Speed control–Temperature rise—Types of industrial loads–continuous–Intermittent and variable loads–Load equalization, Introduction to energy efficient motors.

Applications of electric drives

Unit IV: Electric Traction - I 12 Hours

System of electric traction and track electrification–Special features of traction motor– Mechanics of train movement–Speed–time curves for different services – Trapezoidal and quadrilateral speed time curves.

Review of existing electric traction systems in India

Unit V: Electric Traction - II 12 Hours

Calculations of tractive effort–power–Specific energy consumption for given run–Effect of varying acceleration and braking retardation–Adhesive weight and braking retardation adhesive weight and coefficient of adhesion

Principles of energy efficient motors

Text Books

1. Partab, "Art & Science of Utilization of electrical Energy", 5th edition, Dhanpat Rai & Sons, 2014.

2. C.L. Wadhwa , "Generation, Distribution and Utilization of electrical Energy" 2nd Edition, New Age International (P) Limited, Publishers,1997

Reference Books

1. N V Suryanarayana, "Utilization of Electrical Power including Electric drives and Electric Traction", 2nd editionNew age International (P) Limited, publishers, 1996.

Web References

1. https://nptel.ac.in/courses/108/105/108105060/
2. https://youtu.be/ftr5QB91LDw

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	30
L2	40	30
L3	30	40
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What are different types of Motor control?
2. What is Adhesive weight:
3. List out the electrical characteristics of DC Shunt motors.

L2: Understand

1. Explain the Operating Characteristics of a DC series motor using the Curves.
2. Explain the operation of Ajax Wyatt Furnace.
3. Discuss about the Speed-Time curves in Traction

L3: Apply

1. For a three-phase induction motor, maximum torque is thrice the full-load torque and starting torque is 1.9 times the full-load torque. In order to get a full-load slip of 6%, calculate the percentage reduction in rotor circuit resistance neglect stator impedance.
2. The rotor of a six-pole, 50-Hz, and 3-φ induction motor has a resistance of 0.3Ω per phase and sums at 960 rpm. If the load torque remains unchanged, calculate the additional rotor resistance that will reduce the speed by 20%.
3. A 4.5-kW, 200-V, and 1-φ resistance oven is to have nichrome wire heating elements. If the wire temperature is to be 1,000°C and that of the charge 500°C. Estimate the diameter and length of the wire. The resistivity of the nichrome alloy is 42.5 μΩ-m. Assume the radiating efficiency and the emissivity of the element as 1.0 and 0.9, respectively.

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PE 20EE004 Machine Modelling and Analysis 3 0 0 3.0

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

Code	Course Outcomes	Mapping with PO's PO3	PSO 1	DoK
20EE004.1	Explain the basic concepts of AC/ DC machine modeling.	2	1	L1 - L2
20EE004.2	Understand the dynamic modeling and phase transformation	2	1	L1 - L2
20EE004.3	Explain various methodologies in small signal machine modeling.	2	1	L1 - L2
20EE004.4	Understand the modeling of synchronous machine modeling	2	1	L1 - L2
20EE004.5	Explain the performance and dynamic modeling of synchronous machines	2	1	L1

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Basic concepts of Modelling 12 Hours

Basic Two - pole Machine representation of Commutator machines, 3 phase synchronous machine with and without damper bars and 3 - phase induction machine.DC Machine modeling: Mathematical model of separately excited D.C motor –Steady State analysis - Transient State analysis - Sudden application of Inertia Load - Transfer function of Separately excited D.C Motor - Mathematical model of D.C Series motor, Shunt motor - Linearization Techniques for small perturbations

Theory of DC Machines

Unit II: Reference Frame Theory 12 Hours

Reference frame theory Real time model of a two phase induction machine-Transformation to obtain constant matrices - three phase to two phase transformation - Power equivalence. Dynamic modeling of three phase Induction Machine Generalized model in arbitrary reference frame - Electromagnetic torque - Derivation of commonly used Induction machine models - Stator reference frame model - Rotor reference frame model Synchronously rotating reference frame model - Equations in flux linkages - per unit model

Theory of Induction Machines

Unit III: Small Signal Modeling 12 Hours

Small Signal Modeling of Three Phase Induction Machine Small signal equations of Induction machine – derivation - DQ flux linkage model derivation - control principle of Induction machine.Single phase induction motor - Cross field theory of single - phase induction machine.

Single phase induction motor

Unit IV: Modeling of Synchronous Machine 12 Hours

Synchronous machine inductances – voltage equations in the rotor's dq0 reference frame - electromagnetic torque - current in terms of flux linkages - simulation of three phase synchronous machine- modeling of PM Synchronous motor.

Theory of synchronous Machines

Unit V: Dynamic analysis of Synchronous Machine 12 Hours

Dynamic performance of synchronous machine, three -phase fault, comparison of actual and approximate transient torque

characteristics, Equal area criteria.

Synchronous machine torque equation

Text Books

1. R. Krishnan, "Electric Motor Drives - Modeling, Analysis& control", First edition, Pearson Publications, 2002.
2. P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive systems", Second Edition, IEEE Press.
3. Dynamic Simulation of Electric Machinery using MATLAB by ONG, Chee-Mun - Prentice Hall PTR

Reference Books

1. P.S.Bimbra, "Generalized Theory of Electrical Machines", Fifth edition, Khanna publications, - 1995.
2. Chee Mun Ong –"Dynamic simulation of Electric machinery using MATLAB / Simulink", Prentice Hall of India Publications.

Web References

1. http://nptel.ac.in/courses/108106023/
2. https://nptel.ac.in/courses/108/106/108106023/#
3. http://www.infocobuild.com/education/audio-video-courses/electronics/AnalysisOfElectricMachines-IIT-Madras/lecture-09.html

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	60
L2	50	40
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Why damper bars are used?
2. What are the commonly used induction machine models?
3. What meant by reference frame theory?
4. State electro magnetic torque in induction motor
5. Define and write relation for stored magnetic energy

L2: Understand

1. Draw the basic circuit model for a 3-phase induction motor for stator as well as rotor currents
2. Derive the dynamic model of a 3-phase induction motor in synchronizing rotating reference frame
3. Discuss in detail about phase transformation and active transformation
4. Explain the generalized mathematical model of the series motor. List out the assumptions pertaining to the use of generalized mathematical model of dc machines.
5. Explain the transfer function analysis of a separately excited DC motor.

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PE 20EE005 Sensors and Transducers 3 0 0 3.0

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

Code	Course Outcomes	Mapping with PO's PO1	PO5	DoK
20EE005.1	Understand basic operation of sensors.	2	2	L1 - L2
20EE005.2	Explain different types of sensors	2	2	L1 - L2
20EE005.3	Understand basic operation of transducer	2	2	L1 - L2
20EE005.4	Explain different types of amplifiers	2	2	L1 - L2
20EE005.5	Explain various types of electric quantities	2	2	L1 - L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Introduction to Sensors — 12 Hours

Definition, principle of sensing & transduction, classification. Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity. Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics.

Stretched diaphragm type: microphone, response characteristics

Unit II: Thermal and Magnetic Sensors — 12 Hours

Material expansion type: solid, liquid, gas & vapor. Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermister material, shape, ranges and accuracy specification. Thermo emf sensor: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type. Radiation sensors: types, characteristics and comparison. Pyroelectric type. Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics.

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Wiedemann effect for yoke coil sensors, Thomson effect.

Unit III: Introduction to Transducers — 12 Hours

Stain Gages, Load Cells, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchros and Resolvers.

Induction Potentiometers, Micro Electromechanical Systems

Unit IV: Signal Condition — 12 Hours

Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Electrical and electronic Amplifiers.
Data Acquisition Systems and Conversion:Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems,.

Optical Amplifiers, Data Conversion

Unit V: Data Transmission and Telemetry — 12 Hours

Data/Signal Transmission, Telemetry. Measurement of Non – Electrical Quantities:Pressure Measurement.

Modified maxwell equation

Text Books

1. Patranabis D, "Sensors and Transducers", 5th Edition, Prentice Hall India Learning Private Limited, 2003
2. Murty D.V.S, "Transducers and Instrumentation", 2nd Edition, Prentice Hall India Learning Private Limited, 2008
3. Ian Sinclair., "Sensors And Transducers", 2nd Edition, Elsevier, 2011

Reference Books

1. S. Vijayachitra., "Transducers Engineering", 4th Edition, Prentice Hall of India Pvt. Ltd., 2010

Web References

1. https://nptel.ac.in/courses/108/104/108104087/
2. https://ocw.mit.edu/courses/physics/8-311-electromagnetic-theory-spring-2004/syllabus/
3. https://www.edx.org/course/electricity-and-magnetism-maxwells-equations

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	60
L2	50	40
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What is principle of transduction?
2. What is the functions of Signal Conditioning Equipment?
3. What is proximity sensor?
4. What is the tactile sensor?
5. What are the configurations of Data Acquisition System?

L2: Understand

1. Explain the basic parameters that are to be possessed by a sensor.
2. Differentiate between Electrical and electronic Amplifiers.
3. Determine the objectives of Data Acquisition System.
4. Explain Variable Differential Transformer.
5. Explain the characterisitcs of Fiber Optic Transducers.

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PE 20EE006 Solid State Electric Drives 3 0 0 3.0

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

Code	Course Outcomes	Mapping with PO's		DoK
		PO 1	PO 5	
20EE006.1	Explain the fundamentals of electric drive	2	2	L1 - L2
20EE006.2	Analyze the operation of controlled converter dc motors and four quadrant operation of dc motors using dual converters.	2	2	L1 – L3
20EE006.3	Explain the converter control of dc motors in various quadrants.	3	2	L1 – L2
20EE006.4	Explain the concept of speed control of induction motor by using AC voltage controllers and voltage source inverters. various slip power recovery schemes.	2	2	L1 - L2
20EE006.5	Explain the speed control mechanism of synchronous motors	3	2	L1 - L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Fundamentals of Electric Drives 12 Hours

Electric drive – Block diagram of electic drive- Dynamics of electric Drive - Equivalent Drive Paramaeters– Load torque components — Steady state stability – Load equalization.

Nature and classification of load torques Active load and passive loads

Unit II: Multi Quadrant & Dual converter operation of DC drives

Four quadrant operation of drive (hoist control) -Braking methods: Dynamic braking – Plugging braking methods. Principal of operation of 1-phase half and fully controlled converter fed DC motor drive- Principle of operation of dual converters and dual converter fed DC motor drives -Numerical problems.

Regenerative braking method

Unit III: Control of DC Motor Drives 12 Hours

1-phase half and fully controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics.
Single quadrant – Two quadrant and four quadrant chopper fed separately excited and series excited motors – Continuous current operation– Output voltage and current waveforms – Speed–torque expressions – Speed–torque characteristics

Four quadrant operations

Unit IV: Stator side control of 3-phase Induction motor Drive: 12 Hours

Stator voltage control using 3-phase AC voltage regulators – Waveforms– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop v/f control of induction motor drives (qualitative treatment only).
–Speed torque characteristics of 3-phase Induction motor

Unit V: Rotor side control of 3-phase Induction motor Drive 12 Hours

Rotor side control of 3-phase Induction motor Drive - Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics – Advantages –Applications.
- Introduction to permanent magnet synchronous motors - principal of operatin and types of Control techniques of PMSM –block diagram of Cloased loop control of PMSM Drive.
Advantages –Applications of Slip power recovery schemes

Text Books

1. Fundamentals of Electric Drives – by G K Dubey Narosa Publications
2. Power Semiconductor Drives, by S.B. Dewan, G.R.Slemon, A.Straughen, Wiley-India Edition.
3. Power Electronics handbook by Muhammad H.Rashid, Elsevier.

Reference Books

1. Electric Motors and Drives Fundamentals, Types and Apllications, by Austin Hughes and Bill Drury, Newnes.
2. Thyristor Control of Electric drives – Vedam Subramanyam Tata McGraw Hill Publications.
3 Power Electronic Circuits, Devices and applications by M.H. Rashid, PHI.

Web References

1. https://nptel.ac.in/courses/108/105/108105153/
2. https://www.youtube.com/watch?v=g8l3Ckx4AIQ&list=PLQLdKyBqWCjpHeitTB8UlkuYsmhbRnb2V&ab_channel=ElectricalandElectronicsEngineering

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	50	50
L3	10	10
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What are the converters used for the speed control of induction motor below the rated frequency?
2. What are the disadvantages of rotor resistance control?
3. Draw the schematic diagram of two quadrant chopper
4. How the variable frequency control is used for synchronous motor speed control?

L2: Understand

1. Explain the different types of load torques and enlist different motors to suit these torques.
2. Explain the operation of a dc series motor supplied from single phase full converter with free-wheeling diode.
3. Describe type-D chopper fed two-quadrant drive operation with necessary equivalent circuits and waveforms.
4. Describe the closed loop self control of synchronous motor with VSI.

L3: Apply

1. A three phase, 440 V, 4-pole 50 Hz induction motor is driving a constant torque load of 80 Nm. The parameters of the motor are: r1 = 0.4 Ω, r2= 0.1 Ω, xeq = 4 Ω and N1/N2 = 2. Calculate the magnitude of the injected voltage that would reduce the motor speed to 1000 rpm. Also calculate the power received by the source of the injected voltage.
2. A three phase, 480 V, 4-pole 60 Hz Y-connected induction motor has inductive reactance of 4 Ω and stator resistance of 0.6 Ω, the rotor resistance referred to stator is 0.8 Ω. The motor is driving constant load torque of 60 Nm at a speed of 3500 rpm. Calculate motor speed and starting current if the frequency is reduced to 50 Hz

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PE 20EE007Advanced Control Systems 3 0 0 3

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

Code	Course Outcomes	Mapping with Po's PO3	Mapping with Po's PSO1	DoK
20ESX03.1	State space representation of control system and formulation of different state models are reviewed.	-	3	L1 – L3
20ESX03.2	Understand the design of control system using the pole placement technique.	-	3	L1 – L3
20ESX03.3	Analyze nonlinear systems using the describing function technique	2	1	L1 - L3
20ESX03.4	Understand the stability analysis using phase plane analysis.	3	1	L1 – L3
20ESX03.5	Understand the stability analysis using Lyapunov method.	3	3	L1 – L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

Unit I: State space analysis — 12 Hours

State Space Representation – Solution of state equation – State transition matrix, –Canonical forms – Controllable canonical form – Observable canonical form, Jordan Canonical Form.

The concept of state – State Equations for Dynamic systems

Unit II: Controllability, observability and design of pole placement — 12 Hours

Controllability, observability and design of pole placement
Tests for controllability and observability for continuous time systems – Time varying case –Minimum energy control – Time invariant case – Principle of duality – Controllability and observability form Jordan canonical form and other canonical forms – Effect of state feedback on controllability and observability – Design of state feedback control through pole placement.

Controllable Companion Form, Observable Companion Form (For Siso and Mimo Systems)

Unit III: Non-Linear Systems — 12 Hours

Introduction – Non-Linear Systems – Types of Non – Linearities – Saturation – Dead Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear systems, properties of Non-Linear Systems – Describing function – describing function analysis of nonlinear systems.

Applications of frequency response analysis, transfer function

Unit IV: Stability of Non-Linear Systems — 12 Hours

Stability analysis of Non-Linear systems through describing functions Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

Graphical Representation of Stability, Optimum Switching Curve and applications

Unit V: Stability Analysis — 12 Hours

Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

Asymptotic Stability and Instability; Sign-Definiteness of Scalar Function

Textbooks

1. Nagarath I.J. and .Gopal M, "Control Systems Engineering", 2nd Edition, New age International Publications,2018.
2. Benjamin C.Kuo, "Automatic control systems", 8th Edition, John Wiley and sons, 2014.
3. Norman S Nise, "Control Systems Engineering", 3rd Edition, John Wiley and sons, 2018.

Reference Books

1. Katsuhiko Ogata, "Modern Control Engineering", 3rd Edition, Prentice Hall of India Pvt. Ltd, , 2015.
2. Nagoorkani A, "Control Systems", 3rd Edition, RBA publications, 2017.

Web References

1. https://www.youtube.com/watch?v=W2jzxNeEAPU&list=PLooDK0dmOTDb-9czkkO_b13evBJqE9BaL
2. https://www.youtube.com/watch?v=bbm79UcNN0&list=PLbMVogVj5nJTNkhtkCEKQHhPOr2bpS3za

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	40	40
L3	20	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define state
2. Define state variable
3. Define controllability
4. Define observability
5. What is saturation?

L2: Understand

1. Explain the concept of state? Write the observable canonical form?
2. Describe the controllability tests for continuous time systems.
3. State and explain the Lyapunov's instability theorem

L3: Apply

1. Convert the following state model into the Jordan canonical form and there from comment on controllability and observability

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -1 & 1 \end{bmatrix} u(t), \quad y(t) = \begin{bmatrix} 0 & 1 & -1 \\ 1 & 2 & 1 \end{bmatrix} x(t)$$

2. Draw a phase plane portrait of the following system

$$\ddot{\theta} + \dot{\theta} + sin\theta = 0.$$

3. Find a Lyapunov's function for the following system

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 1 \\ 2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

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PE 20EE008 Reactive Power Compensation and Management 3 0 0 3.0

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

Code	Course Outcomes	Mapping with PO's PO3	PSO 1	DoK
20EE008.1	Understand objectives specifications of load compensation	2	1	L1 - L2
20EE008.2	Understand steady state reactive power compensation in transmission system	2	1	L1 - L2
20EE008.3	Understand reactive power coordination	2	1	L1 - L2
20EE008.4	Understand importance of user reactive power management	2	1	L1 - L2
20EE008.5	Understand power management in electric traction systems and arc furnaces	2	1	L1

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Load Compensation 12 Hours

Objectives and specification: Reactive power characteristics, inductive and capacitive approximate biasing, load compensator as a voltage regulator, phase balancing and power factor correction of unsymmetrical loads examples.

Reactive power, Voltage regulator, power factor

Unit II: Steadystate Reactive Power Compensation In Transmission System 12 Hours

Uncompensated line: Types of compensation, passive shunt and series and dynamic shunt compensation, examples transient state reactive power compensation in transmission systems: Characteristic time periods, passive shunt compensation, static compensations, series capacitor compensation, compensation using synchronous condensers, examples.

Types of compensation, Synchoronous condensors

Unit III: Reactive Power Coordination 12 Hours

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

Quality of power supply, Hormonics.

Unit IV: User Side Reactive Power Management 12 Hours

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

KVAR, Basics of capacitors.

Unit V: Reactive Power Management in electric traction systems and arc furnaces 12 Hours

Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace.

Traction systems, Arc furnace.

Text Books

1. D M Tagare, "Reactive power Management", 1st Edition, Tata McGraw Hill, , 2004
2. TJE Miller, "Reactive power control in Electric power systems", 1st Edition, Wiely Publication, 1982.

Reference Books

1. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just "Reactive Power Compensation: A Practical Guide", Wiely publication, 4th Edition, 2012.

Web References

1. https://www.accessscience.com/content/reactive-power-compensation-technologies/YB084380
2. http://een.iust.ac.ir/profs/Arabkhabouri/Electrical%20Drives/Books/
3. https://ktu.edu.in/eu/att/attachments.htm?download=file&id=156232

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	60
L2	50	40
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. what are different methods of load shaping
2. Define reactive power control?
3. What are the different Types of compensation?
4. State shunt compensation?
5. What are the objectives of reactive power planning

L2: Understand

1. Describe Reactive Power Management
2. Draw the reactive power characteristics and also explain with neat figures and circuit diagrams
3. Discuss how Reactive Power Management or Planning is found by means of mathematical modelling
4. How power factor correction and voltage regulation can be achieved by means of compensation
5. Discuss how a Load Compensator works as a voltage regulator

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PE 20EE009 Basic Industrial Automation 3 0 0 3.0

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

Code	Course Outcomes	Mapping with PO's			DoK
		PO2	PO3	PSO 1	
20EE009.1	Understand different types of amplifiers and their characteristics	2	3	2	L1,L2
20EE009.2	Analyzing the performance of Electronic Controlled DC motors	2	3	2	L4
20EE009.3	Distinguish between various types of Industrial Heating methods	2	3	2	L4
20EE009.4	Illustrate the understanding of various industrial timing circuits	3	3	2	L1,L2
20EE009.5	Understand PLC functions to timing and counting applications	3	3	2	L1,L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Analysis And Design of Small Signal Low Frequency BJT Amplifiers 12 hours

Review of transistor biasing, Classification of Amplifiers – Distortion in amplifiers, Analysis of CE, CC, and CB Amplifiers and CE Amplifier with emitter resistance, low frequency response of BJT Amplifiers, effect of coupling and bypass capacitors, Design of single stage RC coupled amplifier Different coupling schemes used in amplifiers, Analysis of Cascaded RC Coupled amplifiers,.

Cascode amplifier, Darlington pair

Unit II: Regulators For Voltage And Motor Speed 12 hours

Voltage compensator – Solid state DC voltage regulation – DC shunt motor – Armature control and field control of motor speed – Electronic control of DC motor – Speed regulator action – Full wave motor speed regulation by one SCR.

Switched Mode voltage regulator

Unit III: Industrial Heating 12 hours

Induction heating – Principles- Theory – Merits – Applications – High frequency power source for induction heating, Dielectric heating –Theory – Electrodes used in dielectric heating – Method of coupling of electrodes to RF generator – Thermal losses in dielectric heating.

Electrical Heating

Unit IV: Industrial Timing Circuits 12 hours

Constituents of industrial timing circuits – Timers – Classification of timers – Thermal timers –Electromechanical timers – Electronic timers – Classification of electronic timers – Digital timing element –Digital counters – SCR delay timer – IC electronic timer

Fridge Timer

Unit V: Programmable Logic Controllers 12 hours

Number system and codes – Basics of PLC programming – Timer and counter instructions – Data manipulation instructions.

Shaft register and sequence instructions

Text Books

1. Frank D. Petruzella, Industrial Electronics , McGraw Hill International Editions, 1996.
2. G.K. Mithal, Ravi Mithal, Industrial Electronics, Khanna Publishers, Delhi, 1995
3. Gopal. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 28th edition, 2011.

Reference Books

1. M. H. Rashid, " Power Electronics: Circuits, Devices and Applications" , Prentice Hall of India 3rd Edition, 2014.
2. Ned Mohan, Tore M. Undeland, " Power Electronics – Converters, Applications and Design ",Wiley India Edition, 3rd Edition, 2012.
3. Biswanath Paul " Industrial Electronics and Control " by PHI publications, 3rd Edition, 2014.
4. John W. Webb & Ronald A.Reiss," Programmable Logic Controllers-Principles and Applications ", 5th Edition, PHI, 2009.

Web References

1. https://nptel.ac.in/courses/108/108/108108077/
2. https://www.youtube.com/watch?v=VilOmXnoEC0&t=10s

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	45
L2	30	45
L4	40	10
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Explain VI characteristics of SCR.
2. Explain about triggering of TRIAC in different modes.
3. Write about the 3-terminal IC voltage regulators

L2: Understand

1. Discuss the principle and operation of ARC welding with neat sketch.
2. Draw the circuit diagram and waveforms of input current and output voltage of a single phase full wave ac voltage controller with resistive load.
3. Understanding the behaviour, turn on and turn off methods of SCR

L4: Analyze

1. Evaluate the characteristics of TRIAC circuit.
2. Evaluate the speed regulation of motor by SCR.
3. Classify the different types Industrial Timing Circuits

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PE 20EE010 Process Instrumentation 3 0 0 3

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

Code	Course Outcomes	Mapping with POs			DoK
		PO1	PO2	PO3	
20EE010.1	Understand the instrumentation for heat exchangers and dryers	3	1	2	L1-L2
20EE010.2	Explain instrumentation for evaporators & crystallizer	3	1	2	L1-L2
20EE010.3	Examine the instrumentation for distillation columns.	3	1	2	L1-L2
20EE010.4	Analyze the operation of Boiler Instrumentation	3	1	2	L1-L2
20EE010.5	Describe the instrumentation for pumps and compressors.	3	1	2	L1-L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

Unit I: Instrumentation for heat exchangers and dryers 12 Hour

Operation of heat exchanger, controlled and manipulated variables in heat exchanger control problem, instrumentation for feedback, feed-forward, cascade control strategies for heat exchanger, controlled and manipulated variables in dryer control problem, instrumentation for feedback and feed-forward control of various types of dryers.
Selection of devices required in instrumentation.

Types and operation of dryers

Unit II: Instrumentation for evaporators & crystallizer 12 Hour

Types and operation of evaporators, Controlled and manipulated variables in evaporator control problem, instrumentation for feedback, feed-forward, cascade control strategies for evaporators, controlled and manipulated variables in crystallizer control problem, instrumentation for control of various types of crystallizers.
Selection of devices required in instrumentation.

Types and operation of crystallizers

Unit III: Instrumentation for distillation columns 12 Hour

Operation of distillation column, manipulated and controlled variables in distillation column control, instrumentation for flow control of distillate, reflux ratio control, pressure control schemes.
Material and energy balance of distillation column.

Top and bottom composition control

Unit IV: Boiler Instrumentation 12 Hour

Operation of boiler, manipulated and controlled variables in boiler control, safety interlocks and burner management system, instrumentation for boiler pressure controls, boiler drum level controls, steam temperature control, optimization of boiler efficiency, operation and types of reactors, instrumentation for temperature, pressure control in CSTRs.
Continuous / regulatory functions related to batch processes.

Air to fuel ratio controls

Unit V: Instrumentation for pumps and compressors 12 Hour

Types and operation of pumps, manipulated and controlled variables in pump control problem, pump control methods and instrumentation for pump control, capacity control methods of compressors, instrumentation for control of different

variables in centrifugal, rotary and reciprocating compressors including surge and anti-surge control. Methods to increase performance of pump and compressor.

Types and operation of compressors

Textbooks:

1. "Chemical Process Control", Stephanopoulos George, Prentice Hall of India.
2. "Boiler Control System", D. Lindsey, McGraw Hill Publishing Company.

Reference Books:

1. "Process Control, Instrument Engineering Hand book", B.G. Liptak, Chilton Book Company.
2. "Hand book of Process Instrumentation", Considine McGraw Hill Publishing company.

Web References:

1. https://nptel.ac.in/courses/108/105/108105064/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	60	60
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. List out the types of dryers.
2. List out cascade control strategies for evaporators.
3. Define Feed – forward control.

L2: Understand

1. Explain the pump control methods and instrumentation for pump control.
2. Discuss about the cascade control strategies for evaporators.
3. Describe the Operation of distillation column.

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OE 20CEO01 Urban Environment and Health 3 0 0 3

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

Code	Course Outcomes	Mapping with POs	DoK
20CEO01.1	Identify urban – health relationships		L1, L2
20CEO01.2	Demonstrates the connection between urban built form and healthoutcomes		L1, L2
20CEO01.3	Discuss the distribution of health risks of urban transportation grid		L1, L2
20CEO01.4	Assess and plan for community needs in health-care infrastructure		L1, L2
20CEO01.5	Identify preliminary opportunities for advancing urban health outcomes		L1, L2

1: Weakly Contributing | 2: Moderately Contributing | 3: Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

Unit I: Health and Planning 9 Hours

Introduction: The Historical Link, Dividing Health and Planning, Urban Health – Basic Conceptions in the Literature, Urban Form,Physical Activity.

Health Promotion

Unit II: Built Urban Form and Health 9 Hours

Renewing the Health-Urban Link, the Urban Form, the Metropolitan Sprawl Index, Using Measured Urban Forms to Assess Health Effects, Environmental Factors and Physical Activity

Alternatives to Metropolitan Sprawl Index

Unit III: Transportation Systems 9 Hours

Transport Planning, Private Motor Vehicles as Health Risks, Private Motor Vehicles and Obesity, Public Transport, Mixed-use Medium-density and Pedestrians Travel, Proximity and Individual Factors.

Residential and Travel Preferences

Unit IV: Spatial Access to Health Services 9 Hours

Introduction, The Concept of Access, Dimensions of Spatial Access, Primary Care Supply and Access, Spatial Access and Travel Behavior, Access andMortality.

Access to health care Aligned with Transport

Unit V: Challenges and Opportunities 9 Hours

Introduction, Challenges, Conceptual Frameworks, Investigative Methods and Data Collection, Limited Policy Capacity, Fragmented Initiatives, Opportunities, Interdisciplinary Engagement, Major Conceptual Programs, Priorities for future Research.

Promotion of physical activity in daily routines

Text Books

1. Erach Bharucha, "Textbook of Environmental Studies for Undergraduate Courses", 3rd Edition, University Grants Commission, 2021
2. George Luber and Jay Lemery, "Global Climate Change and Human Health", 1st Edition Jossey-Bass, 2015

Reference Books

1. Pataki, Diane E., et al. "Coupling biogeochemical cycles in urban environments: ecosystem services, green solutions, andmisconceptions" Frontiers in Ecology and the Environment, 2011
2. Frank, L., Engelke, P., and Schmid, T., "Health and Community Design: The Impact of The Built Environment on Physical Activity", Island Press, Washington, D.C., 2003
3. Eiichi Taniguchi, Tien Fang Fwa and Russell G Thompson, "Urban Transportation and Logistics", CRC Press, 2014

Web References

1. https://www.oecd.org/health/health-systems/32006565.pdf
2. https://www.pdfdrive.com/urban-environment-proceedings-of-the-10th-urban-environment-symposium-e157051203.html

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	50
L2	50	50
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. How is natural environment different from urban environment?
2. How does the urban environment affect health and well-being?
3. How can urban areas improve health?

L2: Understand

1. Explain the most important problem related to health in urban area
2. Describe the differences between physical activity for transportation and physical activity for recreation
3. Consider a study that evaluates the health of people in two communities, one with sidewalks and one without. The studyauthors find that the rate of lung cancer is higher in the community without sidewalks, and conclude that sidewalks protect against lung cancer. What concerns would you have about accepting this conclusion?

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OE 20CSO01 Data Structures and Algorithms 3 0 0 3.0

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

Code	Course Outcomes	Mapping with POs	DoK
20CSO01.1	Understand the advanced data structures and algorithms	-	L1, L2, L3
20CSO01.2	Demonstrate through abstract properties of various data structures such as stacks, queues and lists to implement efficient programs using data structures.	-	L1, L2, L3
20CSO01.3	Demonstrate through various searching & sorting techniques	-	L1, L2, L3
20CSO01.4	Apply data structures and algorithms to solve real world problems.	-	L1, L2, L3
20CSO01.5	Apply algorithm analysis techniques to evaluate the performance of an algorithm.	-	L1, L2, L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit I: Introduction to Data Structures & Algorithms **9 hours**

Introduction to Data Structure, Data Organization, Abstract Data Types, Elementary data types; Basic concepts of data Structures; performance measures for data structures, Time and Space Complexity. Introduction to Algorithms, Asymptotic notations and common functions. Algorithm Specifications: Performance Analysis and Measurement

Efficiency of an Algorithm

Unit II: Arrays and Linked Lists **9 hours**

Arrays- Definition, Different types of Arrays, Application of arrays, Sparse Matrices and their representations. Linked lists- Definition, Implementation of Singly Linked Lists, Doubly Linked List, Operations on a Linked List. Insertion, Deletion and Traversal. Stack-Basic Concept of Stack, Stack as an ADT and operations in stack. Queue-Basic Concept of Queue, Queue as an ADT and Operations in Queue

Generalized Linked List, Applications of Stack and Queue

9 hours

Unit III: Trees and Graphs

Trees- Basic concept of Binary tree, Operations in Binary Tree, Tree Height, Level and Depth, Binary Search Tree, Insertion, Deletion, Traversals, Search in BST, 2-4 trees. Graph-Matrix Representation Of Graphs, Elementary Graph operations(Breadth First Search, Depth First Search, Spanning Trees, Shortest path, Minimal spanning tree)

Applications of Tress and Graph

Unit IV: Algorithm Design Techniques I **9 hours**

Divide and Conquer-General method, Merge sort, Quick sort. Brute force- approach, bubble sort, Linear Search techniques.

Preferences of Merge and quick sort techniques.

Unit V: Algorithm Design Techniques II **9 hours**

Greedy Technique, General method, Knapsack problem, Job sequencing with deadlines, Minimal cost spanning tree algorithms (Prim's and Kruskal's), Dynamic Programming: General method, 0/1 knapsack problem, All pair shortest path algorithm

Usages of Greedy algorithms.

Text Books

1. Reema Thareja, "Data Structures Using C", Second Edition, Oxford, 2014
2. Horowitz, Sahni and Anderson Freed, "Fundamentals of Data Structures in C", Second Edition, 2008
3. Mark Allen Weis , "Data Structures and Algorithm Analysis in C", Second edition, Pearson, 1997

Reference Books

1. Salaria R.S., "Data Structures and Algorithms using C", Fifth Edition, Khanna Publishing, 2018
2. Richard F Gilberg, "Data Structures: A PseudoCode Approach With C++" Fifth edition, Thomson Press(India), 2004
3. Amitava Nag and Jyothi Prakash Singh, "Data Structures and Algorithms Using C", Second Edition, Vikas Publishing, 2009

Web References

1. https://www.springboard.com/library/software-engineering/data-structures-and-algorithms/
2. https://www.geeksforgeeks.org/data-structures/
3. https://www.programiz.com/dsa

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	20
L2	40	40
L3	20	40
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Describe Data Structure and Algorithm
2. Illustrate some applications of stack
3. Describe about a Queue
4. List two applications of Data Structures

L2: Understand

1. Classify data structures
2. Explain about asymptotic notations
3. Differentiate Linked List, Stack and Queue
4. Explain about different sorting algorithms

L3: Apply

1. Implement the append method, which should add a new element onto the tail of the linked list
2. Implement stack using arrays and linked lists
3. Implement Queue using arrays and Linked Lists
4. Illustrate the importance of recursion

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OE 20AIO01 Machine Learning for Engineers

3 0 0 3

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

Code	Course Outcomes	Mapping with POs	DoK
20AIO01.1	Describe different types of learning's		L1, L2
20AIO01.2	Explain different supervised learning algorithms		L1, L2
20AIO01.3	Explain different unsupervised learning algorithms	-	L1, L2
20AIO01.4	Describe various types of machine learning models		L1, L2
20AIO01.5	Choose appropriate machine learning model and algorithm for given task		L1, L2

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit I: Introduction to learning **9 hours**

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – LinearSeparability – Linear Regression

Examples of regression

Unit II: Linear Models **9 hours**

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice –Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines

Applications of perceptron

Unit III: Trees and Probabilistic Models **9 hours**

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbour Methods – Unsupervised Learning – K means Algorithms – Vector Quantization

Self-Organizing Feature Map

Unit IV: Dimensionality Reduction and Evolutionary Models **9 hours**

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Geneticalgorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms

Markov decision process

Unit V: Graphical Models **9 hours**

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models

Tracking Methods

Text Books

1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, "Machine Learning", 1st Edition, McGraw Hill Education, 2013

Reference Books

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", 1st Edition, Cambridge University Press, 2012.
2. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", 1st Edition, Wiley, 2014

3. Ethem Alpaydin, "Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)", 3rd Edition, MIT Press, 2014

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	50
L2	50	50
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels L1: Remember

1. Define Machine Learning.
2. List the types of Machine Learning.
3. State Bayes Theorem.
4. What is Regularization?

L2: Understand

1. Demonstrate Linear Regression.
2. Explain Back Propagation Algorithm.
3. Illustrate Decision Tree Induction process
4. Explain Genetic Operations with examples

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OE 20DSO01 Introduction to Database Management Systems

3 0 0 3

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

Code	Course Outcomes	Mapping withPos	DoK
20DSO01.1	Describe the basic concepts of DBMS And different data models		L1,L2
20DSO01.2	Apply Constrains on relations		L2,L2,L3
20DSO01.3	Apply SQL commands on relations	-	L1,L3
20DSO01.4	Understand PL/SQL operations		L1,L2,L3
20DSO01.5	Understand the principles of database normalization andTransaction management system.		L1,L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing. for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create DoK: Depth of Knowledge

Unit I: Introduction to Databases **9 Hours**

Overview of Data Base Systems, Database System Applications, File System VS Database System, Data Abstraction, Levels of Abstraction, Data Independence Instances and Schemas, Different Data Models, Database Languages, Data Base Users and Administrator, Database System Structure, N-tier Architecture, Database design and ER diagrams, Design Entities, Attributes and Entity sets, Relationships and Relationship Sets, Advanced Features of ER Model

History of DBMS

Unit II: Relational Model, Relational Algebra and Relational calculus **9 Hours**

Relational Model: Introduction to the Relational Model, Integrity Constraint and key constraints over relations, Logical data base Design, Views, Destroying / Altering Tables and Views - Relational Algebra: Selection and Projection, Set Operations, Aggregate Operations, Renaming, Joins, Division, Additional Relational Algebraic operations - Relational calculus: Tuple Relational Calculus, Domain Relational Calculus

Expressive Power of Algebra and Calculus

Unit III: Structured Query Language **9 Hours**

SQL: Concept of different Database Languages over SQL - DDL, DML, DCL., Set operations, SQL Commands, Nested queries, Aggregate Functions, Null Value, Referential Integrity Constraints, views.

Compare all Database Languages

Unit IV: Schema Refinement and Normalization **9 Hours**

Understand PL/SQL block, components of PL/SQL block, Control statements and conditional statements in PL/SQL Embedded SQL, Triggers, Cursors,Stored procedures packages

Compare all Normal Forms

Unit V: Normalization **9 Hours**

Understand the principles for Relational Database Design, Functional Dependencies, Trivial and Nontrivial Dependencies, Closure Set of Functional Dependencies, Closure Set of Attributes. - Normalization: 1NF, 2NF, 3NF, BCNF, Lossless Join and Dependency Preserving decomposition, 4NF and 5N.

Transaction Concept, ACID Properties, States of Transaction, Implementation of Atomicity & Durability, Schedules,

Concurrency Control without Locking

Text Books

1. Abraham Silber Schatz, Henry F Korth, S Sudarshan, "Database System Concepts", 6th Edition, McGraw-Hill International Edition, 2013
2. Date CJ, Kannan A, Swamynathan S, "An Introduction to Database Systems", 8th Edition, PearsonEducation, 2006
3. Raghurama Krishnan, Johannes Gehrke, "Data base Management Systems", 3rd Edition, TATA McGraw Hill, 2008

Reference Books

1. Elmasri Navrate, "Fundamentals of Database Systems", 7th Edition, Pearson Education, 2016
2. Peter Rob & Carlos Coronel, "Data base Systems design, Implementation, and Management", 10th Edition,Pearson Education, 2013

Web References

1. https://www.javatpoint.com/dbms-tutorial
2. https://www.geeksforgeeks.org/introduction-of-dbms-database-management-system-set-1/?ref=lbp

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	30
L2	30	40
L3	40	30
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. List types of database users
2. List out all types of data models present
3. Give syntaxes to Create and Alter a table
4. What is Redundancy?
5. List out the properties of transactions

L2: Understand

1. Compare the database system with conventional file system
2. Demonstrate the use of DISTINCT keyword in SQL select statement
3. Explain the following SQL constructs with examples:
   (1) Order by (2) group by and having (3) as select (4) schema
4. Explain the difference among Entity, Entity Type & Entity Set
5. Illustrate ACID properities

L3: Apply

1. Choose a relation R with 5 attributes ABCDE and the following FDs: A ->B, BC->E, and ED ->A. Is R in 3NF? Justify?
2. Apply Normalization technique for the following relation up to 3NF:
   Bank (acno, cust_name, ac_type, bal, int_rate, cust_city, branchId, branch_nm, br_city)
3. Construct a transaction state diagram and describe each state that a transaction goes through during its execution?
4. Demonstrate serializability concept

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OE 20ECO01 Architectures and Algorithms of IoT

3 0 0 3

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

Code	Course Outcomes	Mapping with POs	DoK
20ECO01.1	Demonstrate the Architecture and applications of IoT		L1, L2
20ECO01.2	Explain the protocol concept and data bases of IoT		L1, L2, L3
20ECO01.3	Construct the IoT device design space and Platform design		L1, L2, L3
20ECO01.4	Explain the IoT network model and Eventanalysis	-	L1, L2, L3
20ECO01.5	Demonstrate the Industrial Internet of Thingsand its Architecture		L1, L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit I: The IoT Landscape **09 Hours**

What Is IoT?, Applications , Architectures , Wireless Networks, Devices, Security and Privacy , Event-Driven Systems.

Ethernet

Unit II: IoT System Architectures **09 Hours**

Introduction, Protocols Concepts, IoT-Oriented Protocols, Databases, Time Bases, Security.

Message Queuing Telemetritransport (MQTT)

Unit III: IoT Devices **09 Hours**

The IoT Device Design Space, Cost of Ownership and Power Consumption, Cost per Transistor and Chip Size, Duty Cycle andPower Consumption.

Platform Design

Unit IV: Event-Driven System Analysis **09 Hours**

IoT Network Model - Events, Networks, Devices and Hubs, Single-Hub Networks, Multi-hub Networks, Network Models andPhysical Networks, IoT Event Analysis - Event Populations, Stochastic Event Populations, Environmental Interaction Modeling.

Event Transport and Migration

Unit V: Industrial Internet of Things **09 Hours**

Introduction, Industrie 4.0, Industrial Internet of Things (IIoT), IioT Architecture, Basic Technologies, Applications and Challenges.

Integrated IIoT

Textbooks

1. Dimitrios Serpanos and Marilyn Wolf, "Internet-of-Things (IoT) Systems Architectures, Algorithms,Methodologies", Springer, Cham, 2018
2. Vijay Madisetti and Arshdeep Bahga, " Internet of Things (A Hands-on Approach)", Universities Press, 2015

Reference Books

1. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons Ltd, UK, 2014
2. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", John Wiley and Sons Ltd., UK, 2012

Web Resources

1. https://books.google.co.in/books?isbn=1119969093
2. https://books.google.co.in/books?isbn=135123093X

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	30
L2	35	35
L3	35	35
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What is IoT?
2. List any three applications of IoT
3. Define protocol concept of IoT
4. Define data base
5. What is Duty cycle?

L2: Understand

1. Explain the Architecture of IoT
2. Explain the Security and privacy of IoT
3. Illustrate the Protocol Concept of IoT
4. Explain the Date bases of IoT
5. Demonstrate the IoT Device Design Space

L3: Apply

1. Identify the Wireless Networks for IoT
2. Model the Event-Driven Systems for IoT
3. Construct the IoT-Oriented Protocols
4. Construct the Platform Design for IoT

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OE 20EEO01 Introduction to Renewable Energy Sources 3 0 0 3

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

Code	Course Outcomes	Mapping with PO's	DoK
20EEO01.1	Understand the significance of solar energy		L1, L2
20EEO01.2	Provide the importance of Wind Energy		L1, L2
20EEO01.3	Understand the role of ocean energy in the Energy Generation		L1, L2
20EEO01.4	Explain the utilization of Biogas plants and geothermal energy		L1, L2
20EEO01.5	Explain the concept of energy Conservation		L1, L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK:Depth of Knowledge

Unit I: Solar Energy **09 Hours**

Solar Radiation, Measurements of Solar Radiation, Flat Plate And Concentrating Collectors, Solar Direct Thermal Applications, Solar Thermal Power Generation, Fundamentals of Solar , Photo Voltaic Conversion, PV Characteristics Solar Cells, Solar PV Power Generation, Solar PV Applications.

Thermal analysis of flat plate collectors

Unit II: Wind Energy **09 Hours**

Wind Energy Estimation, Types of Wind Energy Systems, Performance, Site Selection, Wind Turbine Generator

Betz Criteria

Unit III: Ocean Energy **09 Hours**

Ocean Thermal Energy Conversion (OTEC), Principle of operation, development of OTEC plants, Tidal and wave energy, Potential and conversion techniques, mini-hydel power plants

Open and closed OTEC Cycle

Unit IV: Bio Mass **09 Hours**

Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gasdigesters, gas yield, combustion characteristics of bio-gas, utilization for cooking.

I.C Engine Operation

Unit V: Geo Thermal Energy and Energy Conservation **09 Hours**

Resources, types of wells, methods of harnessing the energy, scope in India. Principles of energy conservation, the different energy conservation appliances, cooking stoves, Benefits of improved cooking stoves over the traditional cooking stoves

Hydro Thermal, Geo-pressured, Hot dry rocks

Text Books

1. R K Gupta and S C Bhatia "Renewable Energy" Woodhead publishing India Pvt. Ltd.,2019
2. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", Second Edition, IEEE Press, Wiley,2013
3. Ranjan Rakesh, Kothari D. P.& Singal K. C., "Renewable Energy Sources And Emerging Technologies", 2 nd Edition, PHI, 2013
4. Mukund R. Patel, "Wind and Solar Power Systems – Design, Analysis and Operation", 2nd Edition, Taylor &Francis, 2006

Reference Books

1. S Sukhatme, J Nayak, "Solar Energy: Principles of Thermal Collection and Storage", 3rd Edition, Tata Mcgraw Hill , 2003.
2. Tiwari and Ghosal, "Renewable energy resources", 2nd edition, Narosa Publishing house, 2001
3. B H Khan, "Non conventional energy resources", 2 nd Edition, Tata Mcgraw Hill, 2001

Web References

1. https://nptel.ac.in/courses/121/106/121106014/
2. https://www.edx.org/learn/renewable-energy
3. https://www.coursera.org/learn/renewable-energy-resources-and-technologies

Internal Assessment Pattern

CognitiveLevel	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	40	30
L2	60	70
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. What is meant by Solar Thermal Energy?
2. Give the classification of small hydro power stations.
3. What are the various losses occurring in the fuel cell?
4. List various Biomass resources.
5. What is the basic principle of Tidal Power?

L2: Understand

1. Explain in detail about flat plate collectors and give its advantage and disadvantages.
2. Explain the principle of working of a H2 - O2 fuel cell.
3. Explain about Dry, Wet and Hot water Geo thermal systems.
4. Compare between Geo thermal power plant and Conventional thermal power plant.
5. Explain about the site requirements to construct a Tidal Power Plant.

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OE 20MEO01 Nano Technology

3 0 0 3

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

Code	Course Outcomes	Mapping with PO's	DoK
20MEO01.1	*Describe* the fundamental science of nano materials		L2
20MEO01.2	Demonstrate the preparation of nano materials		L1,L2
20MEO01.3	Explain of the challenges on safe nano technology	-	L1,L2
20MEO01.4	Develop knowledge in characteristic nano material		L1,L2,L3
20MEO01.5	Apply Nano science for industrial applications		L1,L2,L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit I: Introduction — 09 Hours

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nano structured materials- nano particles-quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.

Introduction to properties and motivation for study (qualitative only)

Unit II: General Methods Of Preparation — 09 Hours

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly,Vapour phase deposition, MOCVD, Sputtering, Evaporation.

Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE

Unit III: Nano materials — 09 Hours

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)-methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays- functionalization and applications-Quantum wires.

Quantum dots-preparation, properties and applications

Unit IV: Characterization Techniques — 09 Hours

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy includinghigh-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA.

SIMS-Nano-indentation

Unit V: Applications — 09 Hours

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)-Nanosensors, nano crystalline silver for bacterial inhibition.

Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery

TEXT BOOKS:

1. Edelstein A.S and Cammearata R.C, Eds., "Nanomaterials: Synthesis, Properties And Applications", Institute OfPhysics Publishing, Bristol And Philadelphia, 1996.
2. John Dinardo N, "Nanoscale Characterization Of Surfaces & Interfaces", 2nd Edition, Weinheim Cambridge, Wiley- VCH, 2000
3. Murthy B.S and Shankar P, " Nanoscience and NanoTechnology" , 1st Edition, Springer Publications,2013
4. Louis Hornyak and Tibbals H F, " Introduction to Nanoscience and NanoTechnology" , 1stEdition,Tailor Francis CRC Press,2008

REFERENCE BOOKS:

1. Timp G, "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations".Prentice-Hall of India (P) Ltd, New Delhi, 2007.

Web references:

1.http://www.nano.gov
2.http://mrsec.wisc.edu/edetc/IPSE/links.html
3.http://nptel.ac.in/courses/112105182/9
4.IOPSCIENCE—Nanotechnology

Internal Assessment Pattern

CognitiveLevel	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	40	20
L2	60	40
L3		40
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. What is Nano technology?
2. How does Nano Technology Works?
3. 3.What are Nano Materials?
4. Who is Developing Nano technology?

L 2: Understand

1. What Are Some Of The Most Interesting Nanoparticles Found In Nature (Not Manufactured In The Lab)?
2. Given The Nano-Size Of The Particles, Are There Any Effective Respirator Filters To Guard Against Inhalation?
3. What Do You Feel The Repercussions Are For Extended Life Through Utilization Of Nanotechnology?
4. What Is The Risk Of Not Developing Nanotech (In Health Care, Environmental Protection, And Economic Development)?

L 3: Applying

1. How are safety tests carried out in nano tech?
2. Seems that (nano)tech is moving fast. Is there a risk that results of safety testing will be out-of-date as soon as printed? How to keep up pace?
3. Discuss about targeted drug delivery using nanoparticles.

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OE 20CEO02 Ecology, Environment and Resource Management 3 0 0 3

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

Code	Course Outcomes	Mapping with POs	DoK
20CEO02.1	Discuss the role that humans play in affecting the characteristics ofthe environment		L1, L2
20CEO02.2	Understand the interrelationships between land, sea, theatmosphere and the living things that occupy these environments		L1, L2
20CEO02.3	Distinguish between economic growth and economic developmentand outline the nature of a sustainable economy		L1, L2
20CEO02.4	Identify the environmental attributes to be considered for the EIAstudy	-	L1, L2
20CEO02.5	Develop a thorough understanding of Environmental Policies andlegislationspracticed in India		L1, L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit I: Introduction 9 Hours

Meaning, scope and evolution of ecology. Man, environment and ecosystem. Components of nature, Structure and Function, Flow of material, Ecological Succession, Tropic levels, Food chain, Food web, Ecological pyramids.

Adaptation, Environmental Zones

Unit II: Ecosystem and its relevance to Environment 9 Hours

Resources and human settlements impact of advanced agricultural methods, Impact of urbanization and industrialization on nature. Urban ecosystem approach evolution and significance .Settlement planning.

Energy Conservation

Unit III: Resource Management and Sustainable Development 9 Hours

Sustainable Development, Fundamentals concerning Environment and Sustainable Development, Economy, Poverty, Human Settlement Issues, Land Resources, Forests, Mountains, Agriculture, Biodiversity, Protection of Oceans, Industry and Business.

Planning for environmentally sensitive areas

Unit IV: Environmental Impact Assessment 9 Hours

Meaning, Significance and framework. Methodologies, Checklist, Matrices, Network and social cost-benefit analysis. Sources andacquisition of environmental information. Environment impact studies of development projects.

EIA Case Studies

Unit V: Environmental Policies and Legislations in India 9 Hours

Major environment policies and legislations in India - The Ministry of Environment & Forests, The Central Pollution Control Board. Policies to protect environment in India – Environment Protection Act, 1986, National Conservation Strategy and Policy Statementon Environment and Development, 1992, Policy Statement for the abatement of Pollution, 1992, National Environment Policy, 2006, Vision Statement on Environment and Health. Legislations and Rules for the protection of Environment in India.

Five year plans in relation to environmental aspects

Text Books

1. Erach Bharucha, "Textbook of Environmental Studies for Undergraduate Courses", 3rd Edition, University Grants Commission, 2021
2. Walter E. Westman, "Ecology, Impact Assessment and Environmental Planning", John Wiley & Sons, 1985
3. Chadwick A., "Introduction to Environmental Impact Assessment", Taylor & Francis, 2007

Reference Books

1. Charles H. Southwick D., "Ecology and the Quality of Our Environment", Van No strand Co New York, 1976
2. Barthwal, R.R., "Environmental Impact Assessment", New Age International, New Delhi, 2002

Web References

1. http://iced.cag.gov.in/?page_id=256
2. http://econdse.org/wp-content/uploads/2016/07/chapter-1-gupta.pdf
3. https://www.researchgate.net/publication/341521590_Chapter_5_Environmental_Polic y_in_India
4. https://www.preventionweb.net/files/15417_nationalenvironmentpolicyandstrateg.pdf

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	50
L2	50	50
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. What is Ecology?
2. List any three ways in which humans directly influence environmental conditions
3. What is the goal of sustainable development?
4. List the three sequential phases of EIA
5. Enlist any four principles of National Environmental Policy of India

L2: Understand

1. Explain the key principles of the ecosystem approach to conserving natural resources
2. Explain the impact of urbanization on nature
3. How does sustainable development make economic sense for society?
4. Discuss the importance of EIA activities for developing countries
5. Discuss the objectives and founding principles of India's National Environmental Policy

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Board of Studies

OE 20CSO02 Designing the Internet of Things 3 0 0 3.0

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

Code	Course Outcomes	Mapping with POs	DoK
20CSO02.1	Illustrate the IoT in different contexts		L1, L2
20CSO02.2	Outline the Design Principles for Connected Devices		L1, L2
20CSO02.3	Explain the Internet Principles & Application Layer Protocols	-	L1, L2
20CSO02.4	Apply the Prototyping concepts in IoT		L1, L2
20CSO02.5	Analyse the Prototyping Embedded Devices		L1, L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit I: Overview of Internet of Things **9 hours**

The flavour of the Internet of Things, The "Internet" of "Things", Technology of IoT, Enhanced Objects, Who is making theInternet of things.

Applications of IoT

Unit II: : Design Principles for Connected Devices **9 hours**

Calm & Ambient Technology, Magic as Metaphor, Privacy: Keeping secrets, Web Thinking for Connected Devices

Examples of Connected Devices

Unit III: : Internet Principles **9 hours**

Internet Communications-IP,TCP, The IP protocol suite(TCP/IP), UDP, IP Addresses-DNS, static IP Address assignment,Dynamic IP Address assignment, IPV6, MAC Addresses, TCP & UDP Ports, Application Layer Protocols

HTTPS: Encrypted HTTP

Unit IV: Thinking About Prototyping **9 hours**

Sketching, Familiarity, Costs versus Ease of prototyping, Prototypes & Production, Open Source versus Closed Source

Embedded Platforms

Unit V: Prototyping Embedded Devices **9 hours**

Electronics, Embedded Computing Basics, Arduino, Raspberry Pi, BeagleBone Black, Electric Imp

Aurdino Components

Textbooks

1. Adrian, McEwen & Hakim Casimally, "Designing The Internet of Things", John Wiley and Sons, 2014
2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", Wiley, 2019

Reference Books

1. Rajkumar Buyya, Amir Vahid Dastjerdi, "Internet of Things Principles and Paradigms", Morgan Kaufmann,2016
2. Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, Mahendra Swain, "Internet Of things With Raspberry Pi And Arduino", CRC Press/Taylor & Francis Group, 2019

Web Resources

1. https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set-1/
2. https://tutorialspoint.dev/computer-science/computer-network-tutorials/the-new-internet-internet-of- everything
3. https://www.javatpoint.com/iot-internet-of-things

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	20
L2	30	40
Total (%)	100	100

L1: Remembering

1. Define IoT
2. What are the Enhanced objects for IoT?
3. What is a Prototype?
4. Define Sketching
5. Define DNS

L2: Understanding

1. Explain the following terms related to Protocols: UDP, TCP
2. Discuss in detail about MAC Addresses
3. Define Prototyping? Describe the Embedded Computing Basics
4. Explain Application Layer Protocols
5. Discuss the Costs versus Ease of prototyping

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OE 20AIO02 Fundamentals of Deep Learning

3 0 0 3

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

Code	Course Outcomes	Mapping with POs	DoK
20AIO02.1	Describe the fundamental concept of artificial neural networks	-	L1, L2
20AIO02.2	Describe the function of different deep neural networks		L1, L2
20AIO02.3	Explain different deep learning algorithms		L1, L2
20AIO02.4	Describe the functioning of convolution and recurrent neural networks		L1, L2
20AIO02.5	Choose appropriate deep neural network for given application		L1, L2

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit 1: Introduction to Deep Learning **9 hours**

Basics: Biological Neuron, Idea of computational units, McCulloch– Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.

Logic gates with perceptron

Unit 2: Feedforward Networks **9 hours**

Feedforward Networks: Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization – Regularization, autoencoders

Applications of multilayer perceptron

Unit 3: Convolution Networks **9 hours**

Convolutional Networks: The Convolution Operation - Variants of the Basic Convolution Function - Structured Outputs – Data Types - Efficient Convolution Algorithms - Random or Unsupervised Features- LeNet, AlexNet

Applications of CNN

Unit 4: Recurrent Neural Networks **9 hours**

Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks Recursive Neural Networks –The Long Short-Term Memory

Applications of RNN

Unit 5: Applications of Deep Neural Networks **9 hours**

Applications: Large-Scale Deep Learning - Computer - Speech Recognition - Natural Language Processing

Healthcare applications

Text Books

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, UK, 2017
2. Antonio Gulli and Sujit Pal, "Deep Learning with Keras ", Packt Publishing Ltd, Birmingham, UK, 2017

Reference Books

1. Deng & Yu, "Deep Learning: Methods and Applications", Now Publishers, 2013.
2. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

Web References

1. https://www.coursera.org/specializations/deep-learning

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	50
L2	50	50
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels L1: Remember

1. List any 4 benefits of artificial neural networks
2. List any 4 features of ANN
3. What are deep neural networks?
4. Define supervised and unsupervised learning
5. Define generalization

L2: Understand

1. Explain the design parameters of deep neural networks
2. Describe the dimensionality reduction techniques
3. Explain backpropagation algorithm
4. Describe any 2 applications of deep networks for image processing
5. Write about any 5 applications of deep networks

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OE 20DSO02Introduction to Data Science 3 0 0 3

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

Code	Course Outcomes	Mapping with POs	DoK
20DSO02.1	Understand Fundamentals of Data Science Terminology.		L1, L2
20DSO02.2	Demonstrate different computing tools involved in data handling.		L1, L2
20DSO02.3	Understand Knime Tool.	-	L1, L2
20DSO02.4	Understand Machine Learning Concepts		L1, L2
20DSO02.5	Apply domain expertise to solve real world problems using data science		L1, L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

Unit I: Introduction to Data Science **9 Hours**

Analysing the Pieces of the Data Science Puzzle, Exploring the Data Science Solution Alternatives, Defining Big Data by the ThreeVs, Grasping the Difference between Data Science and Data Engineering, Making Sense of Data in Hadoop, Identifying Alternative Big Data Solutions, Converting Raw Data into Actionable Insights with Data Analytics, Distinguishing between Business Intelligence and Data Science, Defining Business-Centric Data Science

Identifying Data Science Users; Data Engineering in Action: A Case Study

Unit II: Computing for Data Science - 1 **9 Hours**

Using Python for Data Science, Using Open Source R for Data Science.

Sorting Out the Python Data Types; R's Basic Vocabulary

Unit III: Computing for Data Science - 2 **9 Hours**

Using SQL in Data Science, Doing Data Science with Excel and Knime

Basic SQL Commands; Knime Basics

Unit IV Machine Learning, Probability and Statistical Modelling **9 Hours**

Defining Machine Learning and Its Processes, Considering Learning Styles, Seeing What You Can Do, Exploring Probability and Inferential Statistic, Quantifying Correlation, Reducing Data Dimensionality with Linear Algebra, Modeling Decisions with Multi-Criteria Decision Making, Introducing Regression Methods

Linear Regression

Unit V Applying Domain Expertise to Solve Real-World Problems Using Data Science **9 Hours**

Data Science in Journalism,Delving into Environmental Data Science, Data Science for Driving Growth in E-Commerce, Using Data Science to Describe and Predict Criminal Activity

Applying statistical modeling to natural resources in the raw; Deploying web analytics to drive growthh

Text Books

1. Lillian Pierson and Jake Porway,"Data Science For Dummies", 2nd Edition,For Dummies, 2017

Reference Books

1. Joel Grus, "Data Science from Scratch", 2nd Edition, O'Reilly Media, 2015
2. Chirag Shah, "A Hands-On Introduction to Data Science", Cambridge University Press, 2020

Web Resources

1. https://www.simplilearn.com/tutorials/data-science-tutorial/
2. https://www.w3schools.com/datascience/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	50
L2	50	50

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. What is data science? Identify three areas or domains in which data science is being used
2. Give three examples of structured data formats
3. Name three measures of centrality and describe how they differ
4. What is supervised learning? Give two examples of data problems where you would use Supervised learning

L2: Understand

1. How do data analysis and data analytics differ?
2. Relate likelihood of a model given data, and probability of data given a model. Are these two the same? Different? How?

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Board of Studies (CSE)

OE 20ECO02 IoT for Smart Grids

3 0 0 3

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

Code	Course Outcomes	Mapping with POs	DoK
20ECO02.1	Demonstrate the Smart Grid concept ,Need for smart grid		L1, L2
20ECO02.2	Explain the Energy Management system functions		L1, L2, L3
20ECO02.3	Describe how modern power distribution system functions	-	L1, L2
20ECO02.4	Explain the Advanced metering infrastructureand AMI protocols		L1, L2, L3
20ECO02.5	Identify suitable communication networks forSmart Grid applications		L1, L2, L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit I: Introduction to Smart Grid **09 Hours**

Introduction - Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid – Functions – Opportunities – Benefits and challenges, Difference between conventional & Smart Grid.

Technology Drivers

Unit II: Energy Management System **09 Hours**

Energy Management System (EMS) - Smart substations - Substation Automation – Feeder Automation, SCADA – Remote Terminal Unit – Intelligent Electronic Devices – Protocols, Phasor Measurement Unit – Wide area monitoring protection and control, Smart integration of energy resources – Renewable, intermittent power sources.

Energy Storage

Unit III: Distribution Management System **09 Hours**

Distribution Management System (DMS) – Volt / VAR control – Fault Detection, Isolation and Service Restoration, Outage management System, Customer Information System, Geographical Information System, Effect of Plug in Hybrid Electric Vehicles.

Network Reconfiguration

Unit IV: Smart Meters **09 Hours**

Introduction to Smart Meters – Advanced Metering infrastructure (AMI), AMI protocols – Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing.

Peak Time Pricing

Unit V: Communication Networks & IoT **09 Hours**

Elements of communication and networking – architectures, standards, PLC, Zigbee, GSM, BPL, Local Area Network (LAN) - House Area Network (HAN) - Wide Area Network (WAN) – Broadband over Power line (BPL) - IP based Protocols - Basics of Web Service and CLOUD Computing.

Cyber Security for Smart Grid

Textbooks

1. Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", CRC Press, 2012
2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu and Akihiko Yokoyama, "Smart Grid:Technology and Applications", Wiley, 2012

Reference Books

1. Mini S. Thomas and John D McDonald, "Power System SCADA and Smart Grids", CRC Press, 2015
2. Kenneth C. Budka, Jayant G. Deshpande and Marina Thottan, "Communication Networks for Smart Grids",Springer, 2014

Web Resources

1. https://books.google.co.in/books?isbn=1119969093
2. https://books.google.co.in/books?isbn=135123093X

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	30
L2	35	35
L3	35	35
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define a Smart grid
2. List any three Benefits of Smart grid
3. What is SCADA?
4. List any three Intelligent Electronic Devices
5. Define a Fault Detection

L2: Understand

1. Explain the need of Smart Grid
2. Demonstrate the Smart Grid Concept
3. Explain the Energy Management System (EMS)
4. Classify and explain the Smart integration of energy resources
5. Illustrate Effect of Plug in Hybrid Electric Vehicles

L3: Apply

1. Identify the Outage management System
2. How to utilize the Distribution Management System (DMS)? explain

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Board of Studies (ECE)

OE 20EEO02 Electrical Safety and Management 3 0 0 3

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

Code	Course Outcomes	Mapping with PO's	DoK
20EEO02.1	Understand the Indian electricity rules and their significance		L1, L2
20EEO02.2	Explain the safety standard in residential, commercial, and agricultural		L1, L2
20EEO02.3	Learn about electrical safety installation, testing and commission	-	L1, L2
20EEO02.4	Understand about electrical safety in distribution system		L1, L2
20EEO02.5	Explain flash-overs and corona discharge		L1, L2

1: Weakly Contributing | 2: Moderately Contributing | 3: Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Indian Electricity Regulations and Acts and their Significance 09 Hours

Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage – earthing of system neutral – Rules regarding first aid and fire fighting facility.

The Electricity Act2003 (Part 1,2,3,4 & 5) and Control Authority Safety Regulations

Unit II: Electrical Safety in Residential, Commercial and Agriculture Installations 09 Hours

Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.

System grounding and Equipment grounding

Unit III: Safety During Installation, Testing and Commissioning, Operation and Maintenance 09 Hours

Preliminary preparations – safe sequence – risk of plant and equipment –safety documentation – field quality and safety - personal protective equipment – safety clearance notice – safety precautions – safeguards for operators – safety

Magnetic Hot sticks, protective clothing and industrial clothing

Unit IV: Electrical Safety in Hazardous Areas 09 Hours

Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipments for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours.

Hazards associated with currents and voltages

Unit V: Electrical Safety Shocks and their Prevention 09 Hours

Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

Objectives of Safety and Security Measures

Text Books

1. Rao, S. and Saluja, H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 1988.
2. Pradeep Chaturvedi, "Energy Management Policy, Planning and Utilization", Concept Publishing Company,1997
3. John M Madden, "Electrical Safety and Law, Planning and Utilization", 5th Edition, Routledge, 2017

Reference Books

1. Nagrath, I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1998.
2. Martha J Boss and Gayle Nicoll, "Electrical Safety", 1st Edition, CRC Press, 2014
3. Gupta, B.R., "Electrical Safety", 1st Edition, American Technical Publishers, 2018

Web References

1. https://nptel.ac.in/courses/108/104/108104087/
2. https://ocw.mit.edu/courses/physics/8-311-electromagnetic-theory-spring-2004/syllabus/
3. https://www.edx.org/course/electricity-and-magnetism-maxwells-equations

Internal Assessment Pattern

CognitiveLevel	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	40
L2	70	60
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. Give the classification of electrical installations.
2. State the disadvantages of low power factor.
3. What is safety documentation system?
4. State preliminary preparations before commencing the installation.

L2: Understand

1. Write the objectives and scope of Indian Electricity Act and Indian Electricity Rule.
2. Explain the importance of earthing system neutral.
3. Write a note on Do's and Don't for safety in the use of domestic electrical appliances.
4. Explain the classification of equipment/enclosure for hazardous locations.

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Board of Studies (EEE)

OE 20MEO02 Fundamentals of Automobile Engineering 3 0 0 3

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

Code	Course Outcomes	Mapping with PO's	DoK
20ME302.1	Introduction to fundamentals of automobiles, lubrication, Tires and safety.		L1, L2
20ME302.2	Classify and identify the steering system		L2, L3
20ME302.3	Classify and identify the Transmission system	-	L2, L3
20ME302.4	Define and compare the suspension, breaking and electrical system.		L2,L4
20ME302.5	Identify and Interpret the specifications and safety precautions..		L2, L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

Unit I: Introduction 09 Hours

Componentsoffourwheelerautomobile–chassisandbody–powerunit–typesofautomobileengines,engineconstruction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps–crank case ventilation–. Types – wheels and tyres. Safety Introduction, safety systems-seat belt, airbags, bumper, anti lock brake system(ABS),windshield, suspension sensors, traction control, mirrors, central locking and electric.

windows, speed control.

Unit II: TRANSMISSION SYSTEM 09 Hours

Power transmission–rear wheel drive, front wheeldrive,4wheeldrive Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, construct mesh, synchromesh gear boxes, epicyclic gear box, over drive torque converter. propeller shaft – Hotch – Kiss drive.

Torque tube drive, universal joint, differential rear axles.

Unit III: STEERING SYSTEM 09 Hours

Steering geometry – camber, castor, king pin rake, combined angle toein, center point steering. types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism ,steering gears, –types *steeringlinkages.*

Unit IV: SUSPENSION, BREAKING AND ELECTRICAL SYSTEM 09 Hours

SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber,Independent suspension system.
BRAKINGSYSTEM:Mechanicalbrakesystem,hydraulicbrakesystem,mastercylinder,wheelcylindertandemmastercylinderrequire ment of brake fluid
ELECTRICAL SYSTEM: Charging circuit, generator, current – voltage regulator – starting system, bendixdrivemechanismsolenoidswitch,lightingsystems,horn,wiper,fuelgauge–oilpressuregauge,enginetemperatureindicatoretc.

pneumaticandvacuumbrakes.

Unit V: ENGINESPECIFICATION AND MAINTENANCE 09 Hours

Introduction-engine specifications with regard to power, speed, torque, no.of cylinders and arrangement, lubrication and cooling etc. engine service, reboring, decarburization ,Nitriding of crankshaft. service details of engine cylinder head, valves and valve mechanism, piston-connecting rod assembly, cylinder block, crank shaft and main bearings, engine reassembly-precautions.Types of pollutants, mechanism of formation, concentrationmeasurement,methodsofcontrolling-enginemodification,exhaustgastreatment-thermalandcatalyticconverters-useof alternative fuels for emission control

NationalandInternationalpollutionstandards.

Text Books

1. AutomotiveMechanics–Vol.1&Vol.2/KirpalSingh/standardpublishers
2. AutomobileEngineering/WilliamCrouse/TMHDistributors
3. AutomobileEngineering/P.SGill/S.K.Kataria&Sons/NewDelhi.
4. AutomobileEngineering/CSrinivasan/McGrawHill

Reference Books

1. Automotive EnginesTheoryandServicing/JamesD.HaldermanandChaseD.MitchellJr.,/Pearso neducationinc.
2. Automotive Engineering/KNewton,W.Steeds&TKGarrett/SAE
3. Automotive Mechanics: PrinciplesandPractices/ JosephHeitner/VanNostrandReinhold

Web References

1. https://nptel.ac.in/noc

Internal Assessment Pattern

CognitiveLevel	InternalAssessment#1(%)	InternalAssessment#2(%)
L2	40	30
L3	40	30
L4	20	40
Total(%)	100	100

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. What are the differences between two and four stroke engines.
2. Define the Octane number & Cetane number
3. Explain the significance of governor in automobiles?
4. What is an automotive differential and how does it work?
5. Why are car steering wheels round?
6. Why entropy decreases with the increase in temperature?

L2: Understand

1. Describe the Atkinson cycle..
2. Explain the flywheel with neat sketch.
3. What is an injector pressure in heavy vehicles? Why it is used?
4. Discuss the service the piston – connecting rod assembly with neat sketch.
5. Discuss the magneto ignition.
6. What is 3-way converter?

L3: Classify

1. .Name the different cooling methods with neat sketches.
2. Describe with P-V diagrams the two used cycles for internal combustion engines.

L4: Interpret

1. In a 4-stroke, 4-stroke cylinder diesel engine running 5000 r.p.m., how many times the fuel will be injected per second.
2. Name the car with engine having 4-valves and 5- valves per cylinder.gas at a pressure of 1.5Mpa ,the gas expands according to the process. Which represented by a straight line on a pressure volume. The final pressure is 0.15MPa. Calculate the work done on a gas by the piston

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Board of Studies (ME)

HO 20EEH01 SMART GRID

4 0 0 4

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

Code	Course Outcomes	Mapping with PO's PO1	PO2	PO3	DoK
20EEH01.1	Get acquainted with different smart devices and smart meters	3	1	2	L1-L2
20EE H01.2	Describe how modern power distribution system functions	3	1	2	L1-L2
20EE H01.3	Identify suitable communication networks for Smart Grid applications	3	1	2	L1-L2
20EE H01.4	Identify suitable smart meters for Smart Grid applications	3	1	2	L1-L2
20EE H01.5	Describe basics of Communication Networks & IOT	3	1	2	L1-L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

Unit I: Introduction to Smart Grid — 12 Hours

Introduction - Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid – Functions – Opportunities – Benefits and challenges, Technology Drivers

Difference between conventional & Smart Grid

Unit II: Energy Management System — 12 Hours

Energy Management System (EMS) - Smart substations - Substation Automation - Feeder Automation, SCADA – Remote Terminal Unit – Protocols, Phasor Measurement Unit – Wide area monitoring protection and control, Smart integration of energy resources – Renewable, intermittent power sources – Energy Storage.

Intelligent Electronic Devices

Unit III: Distribution Management System — 12 Hours

Distribution Management System (DMS) – Volt / VAR control – Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, Geographical Information System, Effect of Plug in Hybrid Electric Vehicles.

Customer Information System

Unit IV: SMART METERS — 12 Hours

Introduction to Smart Meters – Advanced Metering infrastructure (AMI), AMI protocols – Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use,

Real Time Pricing, Peak Time Pricing.

Unit V: Communication Networks & IOT — 12 Hours

Elements of communication and networking – architectures, standards, PLC, Zigbee, GSM, BPL, Local Area Network (LAN) - House Area Network (HAN) - Wide Area Network (WAN) - Broadband over Power line (BPL) - IP based Protocols - Basics of Web Service and CLOUD Computing,

Cyber Security for Smart Grid.

Textbooks:

1. Stuart Borlase, "Smart Grid: Infrastructure", Technology and Solutions, CRC Press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley, 2012.

Reference Books:

1. Mini S. Thomas, John D McDonald, "Power System SCADA and Smart Grids", CRC Press, 2015
2. Kenneth C. Budka, Jayant G. Deshpande, Marina Thottan, "Communication Networks for Smart Grids", Springer, 2014.

Web References:

1. https://nptel.ac.in/courses/108/107/108107113/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	50
L2	50	50
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define smart grid concept and explain its necessity.
2. Compare micro grid and smart grid.
3. Compare conventional metering and smart metering.

L2: Understand

1. Explain IED application for monitoring and protection.
2. Explain how the automatic meter reading can make the system smarter.
3. Explain the smart substation.

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HO 20EEH02 Advanced Smart Power Grids 4 0 0 4.0

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

Code	Course Outcomes	Mapping with PO's PO 2	Mapping with PO's PSO 1	DoK
20EEH02.1	Understand smart grids and analyze the smart grid policies and developments in smart grids.	2	2	L1 - L2
20EEH02.2	Develop concepts of smart grid technologies in hybrid electrical vehicles	2	2	L1 - L2
20EEH02.3	Understand smart substations, feeder automation, GIS.	3	2	L1 - L3
20EEH02.4	Analyze micro grids and distributed generation systems	2	2	L1 - L2
20EEH02.5	Analyze the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.	3	2	L1 - L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Introduction to Smart Grid 12 Hours

Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self-Healing Grid.

Present development & International policies on Smart Grid

Unit II: Smart Grid Technologies Part 1 12 Hours

Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors,

Home & Building Automation, Phase Shifting Transformers.

Unit III: Smart Grid Technologies Part 2 12 Hours

Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage.

Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

Unit IV: Micro grids and Distributed Energy Resources 12Hours

Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, microturbines.

Captive power plants, Integration of renewable energy sources

Unit V: Power Quality Management in Smart Grid: 12Hours

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN).

Wide Area Network (WAN).

Text Books

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and DemandResponse", CRC Press
3. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010

Reference Books

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley
2. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
3. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
4. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press
5. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving

Web References

1. https://www.google.com/aclk?sa=l&ai=DChcSEwi965uQ7-r1AhXEwJYKHYCJDkQYABAAGgJ0bA&ae=2&sig=AOD64_0RNc3a64DXk7r07Vbp47On1IZgCA&q&nis=1&adurl&ved=2ahUKEwjA7pKQ7-r1AhWgsIYBHUwNCqAQ0Qx6BAgDEAM
2. https://www.smartgrid.gov/the_smart_grid/smart_grid.html
3. https://nptel.ac.in/courses/108/107/108107113/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	50	50
L3	10	10
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define smart grid concept
2. Compare micro grid and smart grid.
3. State the issues of interconnecting the micro grid with the utility grid.
4. What is power quality control technologies?
5. How the power quality can be improved in smart grid
6.

L2: Understand

1. Explain the role of HAN in smart grid
2. Draw the flow chart of procedure for monitoring power quality and issues of power quality monitoring
3. Explain Bluetooth, Wi-Fi and GPS
4. Explain Wi-Max based communication and wireless mesh network.

L3: Apply

1. Explain the power quality issues in power grid related to renewable energy sources
2. Describe the significance of electromagnetic compatability in power system with power grid

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HO 20EEH03 Electric Power Quality 4 0 0 4

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

Code	Course Outcomes	Mapping with Po's			DoK
		PO1	PO6	PSO1	
20EEH03.1	Differentiate different types of power quality problems.	3	2	1	L1-L2
20EEH03.2	Explain the sources of voltage sag, voltage swell, interruptions, transients, long duration over voltages in a power system.	3	2	1	L1-L2
20EEH03.3	Explain the principle of voltage regulation and power factor improvement methods.	3	2	1	L1-L3
20EEH03.4	Explain the harmonics in a power system.	3	2	1	L1-L2
20EEH03.5	Demonstrate the relationship between distributed generation and power quality.	3	2	1	L1-L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

Unit I: Introduction 12 Hours

Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations –Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations.

Understanding of transmission lines, Different types of losses and conditions

Unit II: Voltage imperfections in power systems 12 Hours

Power quality terms – Voltage sags – Voltage swells and interruptions – Sources of voltage sag, swell and interruptions – Nonlinear loads – IEEE and IEC standards. Source of transient over voltages – Principles of over voltage protection – Devices for over voltage protection – Utility capacitor switching transients.

Causes and Effects of Transient Voltages

Unit III: Voltage Regulation and power factor improvement 12 Hours

Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End–user capacitor application – Regulating utility voltage with distributed resources – Flicker – Power factor penalty – Static VAR compensations for power factor improvement.

Capacitor Banks, Synchronous Condenser, Phase Advancers.

Unit IV: Harmonic distortion and solutions 12 Hours

Voltage distortion vs. Current distortion – Harmonics vs. Transients – Harmonic indices – Sources of harmonics – Effect of harmonic distortion – Impact of capacitors, transformers, motors and meters – Point of common coupling – Passive and active filtering – Numerical problems

The Effects of Harmonics on Power Quality and Energy Efficiency

Unit V: Distributed Generation, Power Quality and Monitoring 12 Hours

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks. Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data – Application of intelligent systems – PQ monitoring standards.

various real time monitoring of power quality

Textbooks

1. Dugan R.C., McGranaghan M.F., Santoso S., and Beaty H.W., "Electrical Power Systems Quality", Second Edition, McGraw–Hill, 2012, 3rd edition.
2. Bollen M.H.J., "Electric power quality problems", IEEE series-Wiley India publications,2011.

Reference Books

1. Primer, Kennedy B.W., "Power Quality", First Edition, McGraw–Hill, 2000.
2. Bollen M.H.J., "Understanding Power Quality Problems: Voltage Sags and Interruptions", First Edition, IEEE Press; 2000.
3. Arrillaga J. and Watson N.R., "Power System Harmonics", Second Edition, John Wiley & Sons, 2003.
4. Kazibwe W.E. and Sendaula M.H., Van Nostrad Reinhold, "Electric Power Quality control Techniques", New York.

Web References

1. http://www.gcebargur.ac.in/sites/gcebargur.ac.in/files/lectures_desk/electrical_power_systems_quality.pdf
2. http://nptel.ac.in/courses/108106025/Power%20quality_in_power_distribution_systems.pdf
3. https://www.accessengineeringlibrary.com/browse/power-quality-in-electrical-systems#

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	40
L2	40	40
L3	20	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. What are the causes for interruptions?
2. Write the remedies to improve power quality?
3. Distinguish power quality and voltage quality
4. Write different types of DG technologies
5. Write standards of power quality monitoring
6. Write different types of non linear loads

L2: Understand

1. Explain different types of transients
2. Explain about various solutions for over voltage protection
3. Explain about long duration and short duration voltage variations

L3: Apply

1. Draw block diagram of advanced power quality monitoring systems and explain
2. Explain impact of DG on low voltage distribution networks
3. Explain Static VAR compensation for power factor improvement

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20CEM01 Air Pollution

3 0 0 3

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

Code	Course Outcomes	Mapping withPOs	DoK
20CEM01.1	Identify different types of pollution and their sources		L1,L2
20CEM01.2	Identify the meteorological components		L1,L2
20CEM01.3	Outline the impact on local and global effects of air pollution on human, materials, properties and vegetation	-	L1,L2
20CEM01.4	Explain various types of air pollution control equipment and their working principles		L1,L2
20CEM01.5	Understand sampling methods and monitoring of air pollution		L1,L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit I: Introduction — 9 H Hours

Definition of air pollution, Sources and causes of air pollution, Types and classification of air pollution - Natural contaminants,Particulate, Gases and Vapors, Primary and secondary air pollutants

Unit II: Meteorology — 9 Hours

General atmospheric circulation, Atmospheric stability, Effect of meteorology on Plume dispersion, Inversion, Wind profiles andstack plume patterns

Unit III: Effects of Air Pollution — 9 Hours

Effects of air pollution on human beings, plants and animals and properties. Global effects-Green house effect, Ozone depletion,heat island, dust storms, Automobile pollution sources and control, Photochemical smog

Unit IV: Air Pollution Control — 9 Hours

Particulate matter and gaseous pollutants - Settling chambers, Cyclone separators, Scrubbers, Filters & Electrostatic precipitator

Unit V: Air Quality Sampling and Monitoring — 9 Hours

Sampling of particulate and gaseous pollutants (Stack, Ambient & indoor air pollution), Monitoring and analysis of air pollutants

Text Books

1. Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, "Environmental Engineering", Mc Graw Hill, International Edition, 2017
2. Rao M. N., Rao H. V. N., "Air Pollution", 1st Edition, Mc Graw Hill, 2004

Reference Books

1. Martin, Crawford, "Air Pollution Control Theory", Tata McGraw Hill, New Delhi, 1986
2. Bulkeley, H., "Cities and Climate Change", Routledge, London, 2013
3. Rao C. S., "Environmental Pollution Control Engineering," Wiley Eastern Limited, New Delhi, 1992
4. Gurjar, B. R., Molina, L., Ojha, C. S. P., "Air Pollution: Health and Environmental Impacts", CRC Press, 2010

Web References

1. http://www.epa.gov
2. http://www.indiaenvironmentportal.org.in
3. http://nptel.iitm.ac.in
4. http://www.filtersource.com
5. https://dgserver.dgsnd.gov

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)

L1	50	50
L2	50	50
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Mention various sources of air pollution.
2. Define Atmospheric stability
3. Write a note on Ozone depletion
4. What are Filters & Electrostatic precipitators?

L2: Understand

1. What are Primary and secondary air pollutants?
2. Write the effect of effect of meteorology on Plume dispersion
3. Explain briefly about effects of air pollution on human beings, plants and animals and properties

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Board of Studies (CE)

MI 20CSM01 E-Commerce 3 0 0 3.0

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

Code	Course Outcomes	Mapping withPOs	DoK
20CSM01.1	Explain the role of new internet economy in E-Commerce		L1,L2
20CSM01.2	Explain the architecture of World Wide Web		L1,L2
20CSM01.3	Describe the E-Commerce process models and E-Payment System	-	L1,L2
20CSM01.4	Illustrate the network models in customization and internal commerce		L1,L2
20CSM01.5	Explain the E-commerce models in advertising and marketing of business		L1,L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit I:Introduction **9 hours**

Electronic Commerce- Architectural Frame work, anatomy of E-commerce applications, E-Commerce consumer applications, E-commerce organization applications

E-Commerce and media convergence

Unit II: World Wide Web & Network security **9 hours**

Client-Server Network security, World Wide Web(WWW) as the architecture, Web background: Hypertext Publishing, Technologybehind the web, Security and the web

Emerging Client-Server Security Threats

Unit III: E-Payment Systems **9 hours**

Consumer Oriented Electronic Commerce- Mercantile Process models, E-Payment systems- Digital Token-Based, smart cards, credit cards, risk and E-Payment systems.

Designing E-Payment Systems

Unit IV:EDI Implementation and Intraorganizational E-Commerce **9 hours**

Standardization and EDI, EDI Software implementation, Value added networks, Intra organizational E -Commerce- Workflow Automation and Coordination, Customization and Internal Commerce, Supply chain management (SCM).

EDI Envelope for Message Transport

Unit V: Advertising and Marketing on the Internet **9 hours**

Corporate Digital Library- Document Library, digital document types, corporate data warehouses, Advertising and marketing-Information based marketing, Advertising on Internet, online marketing process, market research.

Charting the Online Marketing Process

Text Books

1. Ravi Kalakota and Andrew B. Whinston., "Frontiers of electronic commerce", First Edition, Pearson Education ,2011
2. Jaiswal S.," E-Commerce", Second Edition,Galgotia,2010

Reference Books

1. Dave Chaffey., "E-business & E- commerece management- strategy, implementation and Practice", Fifth edition, Pearson Education, 2015.
2. Kenneth C, "E-Commerce: Business.Technology.Society", First Edition, Pearson Education, 2008

Web References

1. https://www.techopedia.com/definition/18226/corporate-data-warehouse-cdw
2. http://ecmrce.blogspot.com
3. http://data.conferenceworld.in

Internal Assessment Pattern

CognitiveLevel	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	50	50
L2	50	50
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. Write any four important E-Commerce organization Applications
2. Write about any four requirements of EDI
3. Write short notes on Risks in E-Payment systems
4. Write short notes on Market research
5. What are the factors for design of electronic payment system?

L2: Understand

1. How enterprise resource planning and supply chain management software differs in their goals and implementations
2. How product or service customization is adopted in intraorganizational commerce?
3. Explain Merchantile's model from the Merchant's perceptive
4. Explain in detail about E-Payment systems
5. Discuss about mercantile transaction using credit cards

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VII 20MEM01 Biomaterials **3 0 0 3**

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

Code	Course Outcomes	Mapping withPOs	DoK
20MEM01.1	Classify various biomaterials		L1,L2
20MEM01.2	Identify the Metallic implant materials		L1,L2, L3
20MEM01.3	Describe the failure modes of implant materials	-	L1,L2
20MEM01.4	Apply Ceramic implant materials		L1,L2, L3
20MEM01.5	Develop the Biocompatibility & Toxicological properties in of biomaterials		L1,L2, L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

Unit I: Introduction **09 Hours**

Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra- vascular system). Surface properties of materials.

physical properties of materials, mechanical properties.

Unit II: Metallic implant materials **09 Hours**

Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants.

Vascular implants, Heart valve implants-Tailor made composite in medium.

Unit III: Polymeric implant materials **09 Hours**

Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. (Classification according to thermo sets, thermoplastics and elastomers).Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems.

Synthetic polymeric membranes and their biological applications.

Unit IV: Ceramic implant materials **09 Hours**

Definition of bio ceramics. Common types of bio-ceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).

Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out).

Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

Unit V: Biocompatibility & Toxicological screening of biomaterials **09 Hours**

Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situimplantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization.

carcinogenicity, mutagenicity and special tests.

Text Books

1. Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press, San Diego, 1996.
2. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
3. J B Park, Biomaterials – Science and Engineering, Plenum Press, 1984.
4. Comprehensive structural interity, Vol.9: Bioengineering Editors: Mithe, Ritchie and Karihalo, Elsevier Academic Press, 2003.

Reference Text books

1. Biomaterials Science: An introduction to Materials in Medicine, Edited by Ratner, Hoffman, Schoet and Lemons, Second Edition: Elsevier Academic Press, 2004.

Web References

1. https://nptel.ac.in/content/syllabus_pdf/113104009.pdf
2. RBM603 BIOMATERIALS Syllabus free download
3. UP Technical University BE BM Syllabus
4. RBM603 Syllabus, BM Unit-wise Syllabus – BE 6th Semester

Internal Assessment Pattern

CognitiveLevel	InternalAssessment#1(%)	InternalAssessment#2(%)
L1	10	10
L2	30	30
L3	60	60
Total(%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Write about classification of biomaterials?
2. State the applications of biomaterials?
3. List the advantages and disadvantages biomaterials?
4. Write about Effects of physiological fluid on the properties of biomaterials?
5. Define Importance of stress-corrosion cracking?

L2: Understand

1. Surface properties of materials
2. Comparison of properties of some common biomaterials
3. Corrosion behavior and the importance of passive films for tissue adhesion
4. Visco elastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity

L3: Apply

1. Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions

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Board of Studies(ME)

MI 20EEM01 Basic Control Systems 3 0 0 3

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

Code	Course Outcomes	Mapping with PO's	DoK
20EEM01.1	Determine time response specifications of second order systems		L1-L2
20EEM01.2	Determine error Constants for different types of input signals		L1-L2
20EEM01.3	Understand various levels of illuminosity produced by differentilluminating sources.		L1-L3
20EEM01.4	Design different lighting systems by taking inputs and constraints in view for different layouts.		L1-L3
20EEM01.5	Understand the speed/time characteristics of different types oftraction motors.		L1-L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

Unit I: Introduction to Control Systems 09 Hours

Classification of control systems, open loop and closed loop control systems and their differences, Feedback characteristics, transfer function of linear system, differential equations of electrical networks, translational and rotational mechanical systems

Differences between Closed loop and Open Loop Control Systems

Unit II: Time Response Analysis 09 Hours

Standard test signals time response of first and second order systems time domain specifications, steady state errors and error constants

Definitions of Time domain Specifications

Unit III: Stability 09 Hours

The concept of stability, Routh's stability criteria – Limitations of Routh's stability, effect of addition of poles and zeros, introduction to root locus.

Basics of Routh's Criteria

Unit IV: Frequency response 09 Hours

Introduction to frequency domain specifications, basics of bode plot, Phase margin, Gain Margin. Introduction to Polar plots, its phase margin and gain margin. Introduction to Nyquist stability criteria

Definitions of Frequency domain Specifications

Unit V: State Space Analysis 09 Hours

Concepts of state, state variables and state model, state space representation of transfer function, diagonalization, solving the time invariant state equations, State Transition Matrix and its Properties, concepts of controllability and observability.

Basics of Matrix operations

Text Books

1. I.J.Nagarath and M.Gopal, "Control Systems Engineering", Newage International Publications, 5th Edition, 2014.
2. Kotsuhiko Ogata, Modern Control Engineering, Prentice Hall of India, 5th edition, 2014

Reference Books

1. S.Palani, "Control Systems Engineering", Tata Mc Graw Hill Publications, 3rd Edition, 2012.

Web References

1. https://nptel.ac.in/courses/107/106/107106081/
2. https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	30
L2	40	30
L3	30	40
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. What are the various standard test signals?
2. Define concept of observability.
3. What is state transition matrix? Write its properties.

L2: Understand

1. Explain how Routh Hurwitz criterion can be used to determine the absolute stability of a system
2. Explain about feedback characteristics.
3. Describe the effect of addition of poles and zeros.

L3: Apply

1. The characteristic polynomial of a system is.$s^5+2s^6+3s^5+s^4+5s^3+2s^2+s+7=0$. Determine the the stability of thesystem using Routh's stability criteria.
2. Determine range of K for stability of unit feedback system whose open loop transfer function is G(s) = K/s(s+1)(s+2).
3. For a system having G(s) = 25/s(s+10) and units negative feedback, find its time response specifications.

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MI 20ECM01 Semiconductor Devices and Circuits 3 0 0 3

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

Code	Course Outcomes	Mapping with POs	DoK
20ECM01.1	Classify different types of semiconductors with energy band diagrams		L1, L2
20ECM01.2	Explain the operation and characteristics of PN junction diode and special diodes		L1, L2
20ECM01.3	Classify and Analyze different types of rectifiers		L1, L2, L3
20ECM01.4	Demonstrate the flow of current in different configurations of the transistor & the concept of DC biasing and transistor stabilization		L1, L2, L3
20ECM01.5	Analyze and Design the small signal low frequency amplifiers		L1, L2, L3

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

Unit I: Semiconductor Physics — 09 Hours

Atomic structure, Neil Bohr's atomic theory, definition of conductors, insulators and semiconductors, energy level diagrams. Semiconductors: Classification and types, intrinsic and extrinsic, P-type and N-type semiconductors, majority and minority carriers, recombination, effect of temperature.

Fermi Level, Charge Densities in Semiconductors

Unit II: Semiconductor Diodes and Special Diodes — 09 Hours

Formation of depletion region, barrier potential, reverse breakdowns, PN junction as diode, symbol, biasing modes, V-I characteristics, diode current equation, effect of temperature on diode current, ideal diode. Special Diodes: Zener diode, Photo Diode, LED - Working, characteristics and applications.

Diode Switching times, Varactor diode, Tunnel Diode

Unit III: Rectifiers and Filters — 09 Hours

Half wave Rectifier, Full wave rectifier, Bridge Rectifier - Operation, Input and output wave forms. Filters: Inductor filter, Capacitor filter, π filter, Comparison of various filter circuits in terms of ripple factors.

LC filter, Multi section π filter

Unit IV: Transistors and Biasing Techniques — 09 Hours

Junction transistor, Transistor current components, Transistor configurations, Transistor as an amplifier, characteristics of transistor in CB and CE configurations. Need for biasing, operating point, Load line analysis, fixed bias and self bias, Stabilization against variations in VBE, Ic, and β, Stability factor, Thermistor and Sensistor bias compensation techniques, Thermal runaway.

Ebers-Moll model of a transistor, Punch through/reach through, Thermal stability

Unit V: Small Signal Low Frequency Transistor Amplifier Models — 09 Hours

BJT: Two port network, Transistor hybrid model, Determination of h-parameters, Generalized analysis of transistor amplifier model using h-parameters, Exact and approximate analysis of CB and CE amplifiers, Comparison of transistor amplifiers.

Effects of emitter bypass capacitor (C_e) on low frequency response

Textbooks

1. Lal Kishore K., "Electronic Devices and Circuits", 4th Edition, Bright Sky Publications, 2016
2. Millman J. and Christos C. Halkias, "Electronic Devices and Circuits", 4th Edition, Tata Mc-Graw Hill, 2010
3. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2009
4. Boylestad R. L. and Louis Nashelsky, "Electronic Devices and Circuits", 10th Edition, Pearson Publications,2009

Reference Books

1. Salivahanan S., Suresh Kumar and Vallavaraj N. A., "Electronic Devices and Circuits", 2nd Edition, Tata Mc-Graw Hill, 2012
2. Donald A. Neamen, "Electronic Circuit Analysis and Design", 3rd Edition, Tata McGraw Hill, 2010
3. Millman J. and Halkias C., "Integrated Electronics", 2nd Edition, Tata Mc-Graw Hill, 2009
4. Singh B. P. and Rekha, "Electronic Devices and Integrated Circuits", 3rd Edition, Pearson publications, 2009
5. Mittal G. K., "Electronic Devices and Circuits", 3rd Edition, Khannan Publishers, 2008

Web Resources

1. www.elprocus.com/p-n-junction-diode-theory-and-working/
2. http://fourier.eng.hmc.edu/e84/lectures/ch4/node3.html
3. http://nptel.ac.in/courses/117103063/11

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	35
L2	40	35
L3	20	30
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Semiconductor
2. What is ideal diode?
3. List any three applications of Zener diode
4. What is rectifier?
5. Define ripple factor
6. What is BJT?
7. What is thermal runaway?
8. Define stability

L2: Understand

1. Describe the formation of P type semiconductor
2. Draw and explain V-I characteristics of PN junction diode
3. Describe the construction and operation of Photo diode
4. With neat circuit diagram describe the operation of bridge rectifier
5. Explain, why Zener diode is used in reverse bias with the help of characteristics
6. Draw and explain the input and output Characteristics of Common base configuration
7. With neat sketches explain the V-I characteristics of NPN transistor in common emitter configuration
8. Write a short note on Thermal Runaway
9. Explain thermister compensation technique

L3: Apply

1. Show that the efficiency of half wave rectifier is 40.6%
2. Show that the efficiency of full wave rectifier is 81.2%
3. Obtain an expression of stability factor for fixed bias
4. With suitable expressions explain self bias of BJT
5. Obtain the expressions for voltage gain and current gain of small signal low frequency common emitter amplifier

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VI 20AIM01 Fundamentals of Neural Networks 3 0 0 3

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

Code	Course Outcomes	Mapping with POs	DoK
20AIM01.1	Describe the concepts of artificial neural networks	-	L1, L2
20AIM01.2	Compare functions of biological and artificial neural networks		L1, L2
20AIM01.3	Explain the architecture and functioning of Single Layer feed forward networks		L1, L2
20AIM01.4	Describe architecture and functioning of Multi-layer networks		L1, L2
20AIM01.5	Explain associative memory networks		L1, L2

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Unit 1: Introduction to Neural Networks **9 hours**

Introduction - Humans and Computers - Organization of the Brain – Biological Neuron - Biological and Artificial Neuron Models - Characteristics of ANN - McCulloch-Pitts Model - Historical Developments - Potential Applications of ANN

Unit 2: Essentials of ANN **9 hours**

Artificial Neuron Model - Operations of Artificial Neuron - Types of Neuron Activation Function - ANN Architectures - Classification Taxonomy of ANN – Connectivity - Learning Strategy (Supervised, Unsupervised, Reinforcement) - Learning Rules

Unit 3: Single Layer Feedforward Networks **9 hours**

Introduction - Perceptron Models: Discrete - Continuous and Multi-Category - Training Algorithms: Discrete and ContinuousPerceptron Networks – Limitations of the Perceptron Model

Unit 4: Multi - Layer Feedforward Networks **9 hours**

Generalized Delta Rule - Derivation of Backpropagation (BP) Training - Summary of Backpropagation Algorithm - Kolmogorov Theorem, Learning Difficulties and Improvements

Unit 5: Associative Memory Networks **9 hours**

Paradigms of Associative Memory - Pattern Mathematics - Hebbian Learning - General Concepts of Associative Memory - Bidirectional Associative Memory (BAM) Architecture - BAM Training Algorithms: Storage and Recall Algorithm - BAM Energy Function

Text Books

1. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Networks Using MATLAB 6.0", Tata McGraw-HillCompanies, 2006
2. Simon Haykin, "Neural Networks: A Comprehensive Foundation", Second Edition, Pearson Education, Asia
3. James A. Freeman, David M. Skapura, "Neural Networks: Algorithms, Applications, and Programming Techniques", Addison-Wesley Publishing Company

Reference Books

1. B. YagnaNarayana, "Artificial Neural Networks", Prentice Hall India, 2013
2. Satish Kumar, "Neural Networks: A classroom approach", Tata McGraw Hill, 2004.
3. Laurene Fausett, "Fundamentals of Neural Networks", Pearson Education

Web Resources

1. https://www.tutorialspoint.com/artificial_neural_network/index.html

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	50
L2	50	50
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

5. Define Neural Computing
6. Define ANN and Neural Computing
7. List any 4 design parameters in the design of Artificial Neural Network
8. What kinds of transfer functions can be used in each layer?
9. Define Pattern Association
10. What is Adaline Model?
11. What are the types of Learning?
12. What is simple artificial neuron?
13. List any 4 applications of Artificial Neural Network
14. Define Delta Learning rule

L2: Understand

4. Describe on the process of assigning and updating weights in a artificial neural network
5. What are the design steps to be followed for using ANN for your problem?
6. Describe least square algorithm with example
7. Why XOR Problem cannot be solved by a single layer perceptron? Write an alternative solution for it
8. Explain Back Propagation Network with necessary diagrams and equations
9. Write the differences between Hetero Associative Memories and Interpolative Associative Memories

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MI **20DSO03 Introduction to R Programming** **3 0 0 3.0**

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

Code	Course Outcomes	Mapping with POs	DoK
20DSO03.1	Understand the basic concepts of R programming		L1, L2
20DSO03.2	Understand about Scalars and Vectors		L1, L2,
20DSO03.3	Implement Lists and data Frames	-	L1, L2, L3
20DSO03.4	Implement Tables and Statistical Distributions		L1, L2 , L3
20DSO03.5	Implement Functions in R programming		L1, L2

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create DoK: Depth of Knowledge

Unit I: Introduction **9 Hours**

Overview of R, R data types and objects, reading and writing data, sub setting R Objects, Essentials of the R Language, Installing R, Running R, Packages in R, Calculations, Complex numbers in R, Rounding, Arithmetic, Modulo and integer quotients, Variable names and assignment, Operators, Integers, Factors, Logical operations

Variable Scope & Default Arguments

Unit II: Control Structures And Vectors **9 Hours**

Control structures, functions, scoping rules, dates and times, Introduction to Functions, preview of Some Important R Data Structures, Vectors, Character Strings, Matrices, Lists, Data Frames, Classes

Vectors: Generating sequences, Vectors and subscripts, Extracting elements of a vector using subscrip ts, Working with logical subscripts, Scalars, Vectors, Arrays, and Matrices, Adding and Deleting Vector Elements, Obtaining the Length of a Vector, Matrices and Arrays as Vectors Vector Arithmetic and Logical Operations, Vector Indexing, Common Vector Operations

Higher-Dimensional Arrays

Unit III: Lists **9 Hours**

Lists: Creating Lists, General List Operations, List Indexing Adding and Deleting List Elements, Getting the Size of a List, Extended Example: Text Concordance Accessing List Components and Values Applying Functions to Lists, Data Frames, Creating Data Frames, Accessing Data Frames, Other Matrix-Like Operations

Merging Data Frames

Unit IV: Factors and Tables **9 Hours**

Factors and Levels, Common Functions Used with Factors, Working with Tables, Matrix/Array-Like Operations on Tables

, Extracting a Sub table, Finding the Largest Cells in a Table, Math Functions, Calculating a Probability, Cumulative Sums and Products, Minima and Maxima, Calculus, Functions for Statistical Distributions

Aaggregate () Function, Set Operations

Unit V: Functions **9 Hours**

Scripts to Functions, Making the Script, Transforming the Script, Using the Function, Reduce the number of Lines, Adding more Arguments, Dots, Using Functions as Arguments, Crossing the Boarders, Choices with If-Else Statements, vectorizing Choices, Looping Through Values

Coping and Scoping of Functions

Text Books

1. Norman Matloff, " The Art of R Programming- A Tour of Statistical Software Design ", 2011
2. Roger D. Peng, " R Programming for Data Science " , 2012

Reference Books

1. Garrett Grolemund, Hadley Wickham, "Hands-On Programming with R: Write Your Own Functions andSimulations", 1st Edition, 2014
2. Andrie de Vries, Joris Meys, "R For Dummies", 2nd Edition, 2015

Web References

1. https://swayam.gov.in/nd1_noc19_ma33/preview
2. https://data-flair.training/blogs/object-oriented-programming-in-r/
3. http://www.r-tutor.com/elementary-statistics
4. https://www.tutorialspoint.com/r/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	20
L2	30	40
L3	40	40
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember

1. Write about vectors in R
2. Write any three type conversions in R
3. What is a data structure in R?
4. Write any two Boolean operators in R
5. Write any two linear vector algebra operations

L2: Understand

1. Explain the importance of data frame
2. How to apply same functions to all rows and columns of a matrix? Explain with example
3. Explain about Finding Stationary Distributions of Markov Chains
4. Describe R functions for Reading a Matrix or Data Frame from a File
5. Explain different matrix operation function in R

L3: Apply

1. Implement binary search tree with R
2. Write R script to create a line graph
3. Create a R language code to generate first n terms of a Fibonacci series
4. Apply R program to implement quicksort
5. Apply R code to the function by using if else commandf(x) = x if
   x<1/2
   = (1-x) if 1/2<x<1
   = 0 otherwise

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