AC-
Item No.

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electrical Engineering

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC:
Item No.

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Final Year of B.E in Electrical Engineering**
2	Eligibility for Admission	**After Passing Third Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	**Under Graduation**
7	Pattern	**Semester**
8	Status	**Revised**
9	To be implemented from Academic Year	**With effect from Academic Year: 2022-2023**

Date:

Dr. S. K. Ukarande
Associate Dean, Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean, Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Fourth Year of Engineering from the academic year 2022-23.

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface by BoS

The outcome based course curriculum for the undergraduate degree in Electrical Engineering in Rev.2019 'C' scheme has been chalked out through the thoughtful discussions and deliberations of academic and industry experts. While devising the syllabus content framework, the correct balance between the fundamental / core topics with appropriate mix of topics from the state of the art technologies in electrical and allied domains is attempted. With the increased Industry-Institute interaction and internship programs, students are encouraged to explore the opportunity to improve communication skills, problem solving skill and good team management. These skills shall surely help them to meet the future challenges in their career.

The new course curriculum will also give ample opportunity to the students to work in cross discipline domains to gain the hands on experience through the project based learning facilitated through the various skill based labs, Mini projects, Course projects , Major projects etc. The increased number of department and institute level electives shall facilitate students with the truly choice based learning and skilling in a particular domains.

On behalf of the Board of Studies (BoS) in Electrical Engineering of the University of Mumbai, we seek the active participation from all the stake holders of the engineering education to meet the set outcomes and objectives for the Undergraduate Program in Electrical Engineering.

Board of Studies in Electrical Engineering

Dr. Sushil Thale : Chairman
Dr. B. R. Patil : Member
Dr. S. R. Deore : Member
Dr. B. B. Pimple : Member
Dr. Nandkishor Kinhekar : Member

Program Structure for Final Year B.E. in Electrical Engineering
(Semester VII & VIII)
University of Mumbai
(With Effect from 2022-2023)
Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
EEC701	Electrical Drives & Control	3	--	3	--	3
EEC702	Electrical Power System III	3	--	3		3
EEDO701X	Department Optional Course – 3	3	--	3	--	3
EEDO702X	Department Optional Course – 4	3	--	3	--	3
EEIO701X	Institute Optional Course – 1	3	--	3	--	3
EEL701	Electrical Drives & Control Lab	--	2	--	1	1
EEL702	Simulation Lab III	--	2	--	1	1
EEL703	Power Electronics Design Lab	--	2	--	1	1
EEP701	Major Project I	--	6#	--	3	3
Total		**15**	**12**	**15**	**6**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
EEC701	Electrical Drives & Control	20	20	20	80	3	--	--	100
EEC702	Electrical Power System III	20	20	20	80	3	--	--	100
EEDO701X	Department Optional Course – 3	20	20	20	80	3	--	--	100
EEDO702X	Department Optional Course – 4	20	20	20	80	3	--	--	100
EEIO701X	Institute Optional Course - 1	20	20	20	80	3	--	--	100
EEL701	Electrical Drives & Control Lab	--	--	--	--	--	25	25	50
EEL702	Simulation Lab III	--	--	--	--	--	25	25	50
EEL703	Power Electronics Design Lab	--	--	--	--	--	25	25	50
EEP701	Major Project I	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**75**	**700**

# indicates work load of Learner (Not Faculty), for Major Project

Department Optional Courses

Course Code	Sem. VII: Department Optional Course- 3		Course Code	Sem. VII: Department Optional Course - 4
EEDO7011:	Digital Control System		EEDO7021:	Microgrid and Smart-grid
EEDO7012:	HVDC Transmission Systems		EEDO7022:	Power System Dynamics and Control
EEDO7013:	Internet of Things		EEDO7023:	Artificial Intelligence and Machine Learning
EEDO7014:	Digital Signal Processors and Applications		EEDO7024:	Electrical Machine Design

Institute Optional Courses

Course Code	Institute Optional Course-I #
EEIO7011	Product Lifecycle Management
EEIO7012	Reliability Engineering
EEIO7013	Management Information System
EEIO7014	Design of Experiments
EEIO7015	Operation Research
EEIO7016	Cyber Security and Laws
EEIO7017	Disaster Management and Mitigation Measures
EEIO7018	Energy Audit and Management
EEIO7019	Development Engineering

 # Common with all branches

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEC701	**Electrical Drives & Control**	Theory	Pract./Tut.	Theory	Pract /Tut.	Total
		3	**--**	**3**	**--**	**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term work	Pract./ Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEC701	**Electrical Drives & Control**	**20**	**20**	**20**	**80**	**03**	**-**	**-**	**100**

Course Objectives	To impart knowledge on 1. the basic concepts of electrical drives 2. the speed and torque control techniques of both DC and AC drives
Course Outcomes	Upon successful completion of this course, the learner will be able: 1. To apply the knowledge of dynamics to solve problems on electrical drives. 2. To select the power rating of a motor based on duty cycle. 3. To illustrate the modes of operation and control schemes (both open and closed loop) of electrical drive. 4. To analyze the speed control of DC drives with waveforms. 5. To analyze various methods of speed control and braking methods used in induction motor drives. 6. To describe the advanced control techniques used in induction motor drives.

Module	Contents	Hours
1	Electrical Drives - Introduction & Dynamics: Introduction, Advantages of Electrical Drives, Parts of Electrical Drives, Choice of Electrical Drives, Status of DC and AC Drives, Fundamental Torque equations, Speed-Torque conventions and Multi-quadrant Operation, Equivalent values of Drive Parameters, Measurement of Moment of Inertia, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization	10
2	Selection of Motor Power Rating: Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating: Continuous duty; Equivalent current, Torque and Power Methods for Fluctuating and Intermittent Loads; Short Time Duty; Intermittent Duty.	05
3	Control of Electrical Drives: Modes of Operation, Speed Transitions during Acceleration and Deceleration, Static and Dynamic Performance Requirement of a Drive. Review of Hysteresis Band Current Control Technique and pulse width modulation (PWM) voltage control techniques. Closed loop control of drives – Torque control, Speed control loop with inner current control loop.	05
4	DC Drives: Review of Basic multi-quadrant speed torque characteristics and equations of DC motors, Three Phase Fully Controlled Converter based Separately Excited DC Motor Drive. Chopper based Separately Excited DC Motor Drive (No Numerical on this Module)	04
5	AC Drives:	08

	Induction Motor Drives: Review of Basic Multi-Quadrant Speed-Torque Characteristics and Equations, Regenerative Braking, Plugging, Speed Transitions during Acceleration and Deceleration, Speed Control: Stator Voltage Control, V/f Control, Soft starting with V/f control. Synchronous Motor Drives: Introduction to Synchronous Motor Variable Speed Drives – V/f Control, Self Control.	
6	**Advanced Control Techniques in Induction Motor Drives** Review of d-q Model of Induction Motor, Principle of Vector Control (also called as Field Oriented Control (FOC)), DC Motor Analogy, Block diagram and Phasor Diagram of Direct Vector Control Scheme, Comparison of Scalar and Vector control, Direct Torque and Flux Control using the Switching Table of Inverter Voltage Vectors (DTFC or DTC).	07

Text Books:

1. Fundamentals of Electrical Drives by G. K. Dubey, Narosa Publication
2. First Course on Electrical Drives by S. K. Pillai, New Age International
3. Modern Power Electronics and AC Drives by B. K. Bose, Prentice Hall PTR
4. Electrical Drives: Concepts and Applications by Vedam Subramanyam, T.M.H

Reference Books:

1. Electric Motor Drives: Modeling, Analysis and Control by Krishnan.R, PHI.
2. Power Electronics by Joseph Vithayathil, Tata McGraw Hill
3. Power Electronics by Muhammad H. Rashid, Pearson

Web Reference /Video Courses

1. **NPTEL Course**: **Fundamentals of Electric Drives** By Prof. Shyama Prasad Das, IIT Kanpur
2. **NPTEL Course**: **Advanced Electric Drives** By Prof. Shyama Prasad Das, IIT Kanpur
3. **NPTEL Course**: **Industrial Drives - Power Electronics**, Prof. K. Gopakumar, IISC Bangalore

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEC702	**Electrical Power System III**	Theory	Pract./Tut.	Theory	Pract /Tut.	Total
		3	**--**	**3**	**--**	**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term work	Pract./ Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEC702	**Electrical Power System III**	**20**	**20**	**20**	**80**	**03**	**--**	**-**	**100**

Course Objectives	Student shall be able 1. to understand concept of Generator operating cost, input-output, Heat rate and IFC curve, Constraints in operation, solve Load scheduling and unit commitment problem 2. to understand concept of out of step falling of synchronous generator, system stability and analysis 3. to apply different numerical techniques to study power system stability 4. to understand concept of load flow studies and solve it by using different numerical techniques 5. to understand concept of load frequency control and voltage control 6. to understand concept of interchange of power and energy
Course outcomes	**Upon successful completion of this course, the learner will be able to** 1. Solve Load scheduling and unit commitment problem 2. Define and classify power system stability 3. Determine critical clearing angle using techniques like equal area criterion 4. Formulate load flow problem and solve it by using different techniques 5. Model single area load frequency control and analyse its steady state and dynamic behavior 6. Understand concept of interchange of power and energy

Module	Contents	Hours
1.	Economic Operation of Power System Optimal operation of generators in thermal power station, heat rate curve, input-output curve, IFC curves, optimum generation scheduling neglecting Transmission losses (coordinate equation), optimum generation scheduling considering transmission losses (Exact coordinate equation), Transmission loss formula, Bmn coefficient, Inherent procedure of solving co-ordination equation, optimal unit commitment (Numerical)	10
2.	Power System Stability I Introduction to stability, types of stability, Power angle curve, dynamics of synchronous machine, power angle equation, steady state stability (Numerical)	05
3.	Power System Stability II Swing equation, transient stability, equal area criterion, application of equal area criterion, some techniques for improving transient stability (Numerical)	05
4.	Load Flow Studies Introduction, formation of Y bus using step by step method, Load flow problem, Load flow Equation and methods of solution, Gauss-Seidel method, Newton- Raphson method, Decoupled load flow method, Fast decoupled load flow method, comparison of load flow method (Numerical)	08
5.	Automatic Generation and Voltage control Introduction, Basic control loops in generator, AVR loop, Thermal control, speed governing system and transfer function, steam turbine, and power system transfer	06

	function, Load frequency control (single area), steady state and dynamic response.	
6.	**Power system security and Interchange of power** Power system security: Introduction, System state classification, security analysis, contingency analysis. Interchange of power: Interchange of power between interconnected utilities, types of interchange, capacity and diversity interchange, energy banking, power pools	05

Text Books:-

1. Kothari D.P., Nagrath I.J., Modern power system Analysis, TMH publication, 4e, 2019.
2. Chakrabarti A, Halder S., Power System Analysis-Operation and Control, PHI
3. Allen Wood, Bruce F. Wollenberg, Power Generation operation and control, Willey India
4. B.R. Gupta, Power System Analysis and Design, S. Chand

Reference Books:-

1. Hadi Saadat, Power System Analysis, TMH publications, 2e
2. Soman S.A., Kharpade S.A., and Subha Pandit - Computer Methods for Large Power System Analysis, an object Oriented Approach, Kluwer Academic Publisher New York 2001.

Website Reference/ Video Courses:

1. NPTEL Course: Power System Analysis, Prof. A.K. Sinha, IIT Kharagpur
2. NPTEL Course: Power System Engineering, By Prof. Debapriya Das, IIT Kharagpur
3. NPTEL Course: Power System Protection, By Prof. Ashok Kumar Pradhan, IIT Kharagpur
4. NPTEL Course: Operation and Planning of Power Distribution Systems, By Prof. Sanjib Ganguly, IIT Guwahati
5. NPTEL Course: Power System Dynamics, Dr. M.L. Kothari, IIT Delhi

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEDO7011	**Digital Control System**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**		**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEDO7011	**Digital Control System**	**20**	**20**	**20**	**80**	**3**	**-**	**-**	**100**

Course Objectives	1. To familiarize the student with the concept of discretization 2. Introduction to discrete-time system representations and digital control 3. Learn to design controller for digital systems
Course outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Obtain discrete representation of LTI systems. 2. Analyze stability of open loop and closed loop discrete-time systems. 3. Design and analyze digital controllers. 4. Design state feedback and output feedback controllers.

Module	Contents	Hours
1.	Discrete Representation of Continuous Systems: Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent	05
2.	Discrete System Analysis: Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.	06
3.	Stability of Discrete Time System: Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.	04
4.	State Space Approach for discrete time systems: State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Re-constructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.	10
5.	Design of Digital Control System: Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.	07
6.	Discrete output feedback control: Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.	07

Text Books:-

1. K. Ogata, Discrete-time Control Systems, Ed. 2, Prentice-Hall, 1995
2. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems, Addison-Wesley, 1998.
3. B. C.Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
4. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.

5. K. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.

Web Reference /Video Courses

1. NPTEL Course: Digital Control System by Dr. Indrani Kar and Prof. S. Majhi IIT Guwahati
2. NPTEL Course: Control Systems By Prof. C.S. Shankar Ram, IIT Madras

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEDO7012	**HVDC Transmission Systems**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**		**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEDO7012	**HVDC Transmission Systems**	**20**	**20**	**20**	**80**	**3**	**-**	**-**	**100**

Course Objectives	To impart knowledge on HVDC system, its control, protection along with brief analysis of HVDC converters
Course outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Identify significance of dc over ac transmission systems, types of HVDC link, Components of HVDC system and applications. 2. Analyze multi-pulse converters. 3. Illustrate the basic control of HVDC system and its limitation, features and implementation. 4. Describe the converter firing control schemes for starting and stopping of HVDC link. 5. Understand and analyze faults and protection of HVDC system. 6. Illustrate the harmonics, their causes, effects and use of different filters.

Module	Contents	Hours
1	**Introduction to HVDC transmission:** Early discoveries and applications, Limitation and advantages of AC and DC transmission, Classification of HVDC links, Components HVDC Transmission system, Ground Return Advantages and Problems, Advances in HVDC transmission. HVDC system application in wind power generation	05
2	**Analysis of the Bridge rectifier:** Analysis of six pulse converter with grid control but no overlap, Current and phase relations, Analysis of six pulse converter with grid control and overlap less than 60°, Relation between AC and DC quantities, Analysis with overlap greater than 60°, Rectifier operation output voltage, thyristor voltage waveforms with and without overlap, Inverter operation output voltage waveforms. Equivalent circuit of rectifier and inverter, Multi bridge converter, Numerical from converter circuits and multiple bridge converters.	12
3	**HVDC System Control:** Basic means of control, Limitation of manual control, Constant current verses constant voltage control, Desired features of control, Actual control characteristics, Significance of current margin, Power reversal, Control implementation	06
4	**Converter Control:** Converter Firing Control Schemes (EPC and IPC. Starting and shutting down the HVDC link	04
5	**Faults and protection:** By pass valve, Causes and analysis of arc back, arc through, misfire, current extinction, single commutation failure, double commutation failure, short circuits in converter station Protection against over current, over voltage	08

6	**Harmonics & Filters:** Characteristics Harmonics and Un-Characteristics Harmonics, Causes, Consequences, Trouble Caused by Harmonics, Means of Reducing Harmonics, Filters, AC & DC Filters.	04

Text Books:-

1. Edward Wilson Kimbark, Direct Current Transmission, Wiley publication Interscience
2. K R Padiyar, HVDC power transmission systems, second edition, New Age International Ltd
3. S. Kamkshaiah and V Kamraju, HVDC transmission, Tata McGraw Hill, New Delhi
4. S.N. Singh, Electric Power Generation, Transmission and Distribution, PHI, New Delhi, 2nd edition, 2008

Reference Books:-

1. S. Rao, EHVAC and HVDC Transmission Engineering and Practice, Khanna publication, 1990
2. J. Arrillaga, HVDC Transmission, Wiley publication Inter science
3. C.L. Wadhwa, Electrical Power System (2nd Edition)

Web Reference /Video Courses

1. **NPTEL Course:** High Voltage DC Transmission, by Dr. S.N. Singh, IIT Kanpur

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEDO7013	**Internet of Things**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**		**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEDO7013	**Internet of Things**	**20**	**20**	**20**	**80**	**3**	**-**	**-**	**100**

Course Objectives	To provide overview of internet-of-things technologies, hardware, operating systems, networking, security and databases aspects.
Course outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Understand the concept of IOT 2. Illustrate IOT architecture and applications in various fields 3. Demonstrate use Devices, Gateways and Data Management in IoT. 4. Describe the security and privacy issues in IOT. 5. Understand emerging technological options, platforms and case studies of IoT implementation in home & city automation.

Module	Contents	Hours
1	**Introduction to IoT:** Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT; Sensing, Actuation, Basics of Networking; Software Architectures and Software Interoperability, Privacy and Security	06
2	**IoT Architecture:** Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints, Data representation and visualization, Interaction and remote control.	06
3	**Hardware Platforms:** Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases. IOT Physical Devices & Endpoints:	06
4	**Networking and Communication Protocols:** Cloud based IoT platforms, Zigbee and Zwave, advantage of low power mesh networking. Long distance Zigbee; Bluetooth/BLE: Low power vs high power, speed of detection, class of BLE. Wireless protocols such as Piconet and packet structure for BLE and Zigbee. Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and WebSockets (Publish –Subscribe),MQTT, AMQP, CoAP Protocols	10
5	**Introduction to Mobile App platform for IoT:** Protocol stack of Mobile app for IoT, Mobile to server integration.	04
6	**IoT Applications:** Fog Computing, eHealth, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid; Industrial IoT: Case Study: Agriculture, Healthcare, Activity Monitoring.	07

	Introduction to Programming and Integration of Sensors / Actuators with IoT platform using Arduino, Raspberry Pi.	

Text /Reference Books:-

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
2. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 2020.
3. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0. CRC Press. 2020.
4. Adrian McEwen, Hakim Cassimally Designing the Internet of Things , John Wiley, 2014
5. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
6. CunoPfister, "Getting Started with the Internet of Things", OReilly Media, 2011
7. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
8. Samuel Greenguard, "Internet of Things", MIT Press, 2015.
9. Mandler, B., Barja, J., Mitre Campista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing
10. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley-Blackwell.
11. Internet of things (IoT): Technologies, Applications, Challenges, and Solutions Edited by B.K. Tripathy J. Anuradha, CRC Press, 2018

Web Reference /Video Courses

1. **NPTEL Course:** Introduction to Internet of Things By Prof. Sudip Misra, IIT Kharagpur

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEDO7014	**Digital Signal Processors and Applications**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**		**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEDO7014	**Digital Signal Processors and Applications**	**20**	**20**	**20**	**80**	**3**	**-**	**-**	**100**

Course Objectives	1. To introduce digital signal processors (DSP) architecture, its specifications, functionalities and programming for simple applications. 2. To introduce the numerical integration techniques and its use in implementation of digital compensator 3. To introduce various applications of DSPs in power system and power electronics and their practical design aspects.
Course outcomes	**Upon successful completion of this course, the learner will be able to:** 1. To identify and describe DSP/DSC architecture and its features along with number representation used. 2. To write a program code for DSP for simple applications 3. To compare and evaluate various numerical integration methods used for digital control implementation. 4. To model, analyze and design various compensators for converter/ inverter control 5. To understand various applications of DSP in power electronics and power systems 6. To design solar PV systems for various modes of operation.

Module	Contents	Hours
1	Introduction Digital signal processors (DSP) and digital signal controller (DSC) architectures; Fixed and floating-point processors, Fixed point and floating point number representations. Review of commonly used DSPs/DSCs in power and control applications, Introductions to TMS320C2000 processors	05
2	DSP/DSC Architecture, Peripherals and Programming: DSP/DSC Architecture, peripherals Overview of TMS320C2000 DSC family – Features, Architecture, Memory map, Clock system- Digital I/O -CPU Timers, Analog to Digital Converter (ADC), Pulse Width Modulator (PWM) Capture Module, Quadrature Encoder Pulse Module and communication ports. Programming: assembler, linker processes, code structure, Code Composer Studio (CCS), Programming for: generation of PWM, Sine PWM, measurement of AC/ DC voltage/ currents, use of CPU timers and Digital I/Os	08
3	Mathematical tools for Real Time DSP implementation: Review of numerical integration: Euler's implicit and explicit method, Heun's Method, Trapezoidal Method. Implementation of digital filters and transformations	05
4	Digital Controller Design: Modeling buck, boost converter and 3 phase inverter with LC filter, Design of compensators voltage and current mode, control for their closed loop applications. Design of PI, Type II and Type III controllers.	07

5	**Applications in Power Systems and Power Electronics:** Implementation of Active filters in DSP/DSC under balanced and unbalanced condition, harmonic oscillator and 3 phase lock loop, Static VAR Compensator, Speed control of Induction motor.	10
6	**DSP based System Design:** Design of a DSP controlled Solar PV based Converter/Inverter system for standalone and grid connected modes.	04

Reference Books:-

1. Digital Signal Processing in Power Electronics Control Circuits By Krzysztof Sozanski, Springer
2. Digital Signal Processing in Power System Protection and Control By Waldemar Rebizant, Janusz Szafran, and Andrzej Wiszniewski, Springer.
3. Digital Power Electronics and Applications By Fang Lin Luo, Hong Ye and Muhammad Rashid, Elsevier Academic Press.
4. Digital Signal Processing in Power Electronics Control Circuits By Krzysztof Sozanski, Springer
5. Power Electronics, Converters, Applications & Design by N.Mohan, T.M.Undeland, W.P Robbins, Wiley India Pvt. Ltd.
6. Modern Power Electronics and AC Drives by B. K Bose, Pearson Education
7. DSP Based Electromechanical Motion Control by Hamid Toliyat and Steven Campbell, CRC Press

Web Reference /Video Courses

Texas Instruments Website:

1. https://www.ti.com/microcontrollers-mcus-processors/microcontrollers/c2000-real-time-control-mcus/overview.html
2. https://training.ti.com/c2000-workshops

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEDO7021	**Microgrid and Smart-grid**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**		**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEDO7021	**Microgrid and Smart-grid**	**20**	**20**	**20**	**80**	**3**	**-**	**-**	**100**

Course Objectives	1. To introduce the fundamental concept, various power architectures and control of distributed generation and microgrids. 2. To review various regulatory standards and state of the art of microgrids 3. To understand the microgrid and Smart Grid deployments for large scale integration of clean energy sources, various technologies, automation and ICT infrastructure requirements.
Course outcomes	**Upon successful completion of this course, the learner will be able to:** 1. To identify and describe the impact of renewable energy integration for mitigating energy crises and sustainable future. 2. To identify and describe the concept of Microgrid and its various topologies, modes of operation control and communication architecture. 3. To identify and describe the concept of Smart Grid, its features and the state of the art. 4. To understand various Smart Grid technologies, automation, resiliency and its adoption in current power system**.**

Module	Contents	Hours
1	**Introduction:** Energy crises and sustainable alternatives, review of conventional and non-conventional energy sources and power generation; Comparison of renewable technologies: Solar Photovoltaics, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources. Impact of grid integration of renewable energy resources on existing power system: reliability, stability and power quality issues	05
2	**Distributed Generations (DG) and Microgrids:** . DG topologies, regulatory standards/ framework: IEEE 1547 series, Limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues; Concept of microgrid, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC Microgrids; Control architectures of microgrids: Centralised, decentralised and hierarchical control. Local and system level control functionalities; basics of Power sharing and coordinated control of microgrids	08
3	**Power Conditioning Units (PCUs) for Microgrid Sources:** PCUs in DC and AC microgrids, modes of operation and control of PCUs: Voltage mode control, current mode control. Microgrid functions: black-start and grid synchronisation.	05
4	**Microgrid operations and islanding:** Grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques. Role of energy Storage in Microgrid operations and stability	07
5	**Introduction to Smart-Grid:** Concept of Smart-Grid, Definitions, Need of Smart-Grid, Functions of Smart-Grid, Opportunities & Barriers of Smart Grid, Concept of Resilient & Self-Healing Grid, Microgrids role in smart-grid scenario.	07

	Review of Smart Grid Technologies: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), EV (Vehicle to Grid).	
6	**Smart Grid Operations and Automation:** Smart Substations, Substation Automation, Feeder Automation. Intelligent Electronic Devices(IED) & their application for monitoring & protection, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU) *Communication Network for Microgrids & Smart Grid:* Home Area Network (HAN), Wide Area Network (WAN), Bluetooth, ZigBee, , Wireless Mesh Network, Cyber Security for Smart Grid.	07

Text Books :

1. Microgrids architectures and control Edited by Nikos Hatziargyriou, Wiley, IEEE Press, 2014
2. A. Keyhani, M. N. Marwali, M. Dai, Integration of Green and Renewable Energy in Electric Power Systems, Wiley, 2009
3. Antonio Carlos Zambroni de Souza, Miguel Castilla, Microgrids Design and Implementation, Springer 2019

Reference Books:-

1. Yezdani, and Reza Iravani, Voltage Source Converters in Power Systems: Modeling, Control and Applications, John Wiley Publications, 2010
2. Dorin Neacsu, Power Switching Converters: Medium and High Power, CRC Press, 2006
3. B. M. Buchholz and Z. Styczynski, Smart Grids – Fundamentals and Technologies in Electricity Networks, Springer, 2014
4. C. W. Gellings, The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press, 2009
5. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, Smart Grid: Technology and Applications, Wiley, 2012
6. J. C. Sabonnadière and N. Hadjsaïd, Smart Grids, John Wiley & Sons and ISTE, 2012
7. IEEE standards —IEEE-1547-2003: IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems IEEE standards 2003
8. IEEE standards —IEEE 1547-4-2011: IEEE Guide for Design Operation & Integration of Distributed Resources Island System with Electric Power System,
9. Consortium for Electric Reliability Technology Solutions (CERTS) white paper on Integration of Distributed Energy Resources: The CERTS Microgrid Concept' 2002

Web Reference /Video Courses

1. **NPTEL Course:** DC Microgrid and Control System, Prof. Avik Bhattacharya, IIT Roorkee
2. **NPTEL Course:** Introduction to Smart Grid, By Prof. N. P. Padhy & Prof. Premalata Jena, IIT Roorkee

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name6	Teaching scheme (Contact Hours)		Credits Assigned		
EEDO7022	**Power System Dynamics and Control**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**		**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEDO7022	**Power System Dynamics and Control**	**20**	**20**	**20**	**80**	**3**	**-**	**-**	**100**

Course Objectives	1. To understand fundamental concepts & classification of power system stability. 2. To analyze theory and practice of modelling main power system components, such as synchronous machines, excitation systems. 3. Analyze the performance of the system with small signal analysis. 4. To explore voltage stability concepts in power stability studies.
Course outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Explain the dynamic models of power system components. 2. Analyze the performance of the system with small signal analysis. 3. Choose the fundamental dynamic behavior and controls of power systems to perform basic stability analysis. 4. Select the appropriate model depending on the analysis to be done.

Module	Contents	Hours
1	**Introduction to Power System Stability Problem:** Rotor angle stability, voltage stability, voltage collapse, Mid- term and Long- term stability, classification of stability	03
2	**Synchronous Machine Modeling and Representation:** Basic equations of synchronous machine, dqo transformation, Per unit- voltage- flux- torque- power equations and reactance, Equivalent circuit d-q axis, Voltage current flux linkage relation- phasor representation- rotor angle-steady state equivalent circuit. Three phase short circuit, Magnetic saturation and representation Simplifications for large scale studies, Constant flux linkage model.	12
3	**Excitation System:** Excitation system requirement, Elements of excitation system, Types of excitation system, Dynamic performance measures, Control and protective functions in modern excitation control system.	04
4	**Small Signal Stability:** Fundamental concept of stability of dynamic system, Eigen properties of state matrix, SSS of single machine infinite bus system, Effect of AVR on synchronizing and damping torque, Power system stabilizer.	12
5	**Voltage Stability:** Basic concepts, Voltage collapse, Voltage stability analysis, Prevention of voltage collapse.	04
6	**Method of Improving Stability:** Transient system enhancement methods, Small signal stability enhancement method	04

Text Books/ Reference Books:-

1. Prabha Kundur , Power System Stability and Control , TMH Publication,2008
2. K. R. PADIYAR," Power system dynamics "- B.S. Publications
3. P.M. Anderson and A. A. Fouad, "Power system control and stability", IEEE Press
4. Kimbark E W, Power System Stability, Volume I, III, Wiley publication.
5. Anderson P.M, Fouad A.A, Power System Control and Stability, Wiley Inter-Science, 2008 Edition

Web Reference /Video Courses

1. **NPTEL Course:** Power System Dynamics and Control, Dr. A.M. Kulkarni, IIT Bombay
2. **NPTEL Course:** Power System Dynamics, Control and Monitoring, By Prof. Debapriya Das, IIT Kharagpur
3. **NPTEL Course:** Power System Dynamics, Dr. M.L. Kothari, IIT Delhi

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEDO7023	**Artificial Intelligence and Machine Learning**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**		**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEDO7023	**Artificial Intelligence and Machine Learning**	**20**	**20**	**20**	**80**	**3**	**-**	**-**	**100**

Course Objectives	1. To learn the ability of selecting suitable artificial intelligence and machine learning techniques for data handling and to gain knowledge from it. 2. To evaluate the performance of algorithms and to provide solutions for various real-world applications.
Course outcomes	**Upon successful completion of this course, the learner will be able to:** 1. To develop a basic understanding of artificial intelligence building blocks and analyze whether a problem can be solved using artificial intelligence techniques 2. To understand the fundamental concepts of neural networks, different neural network architectures, algorithms, applications and their limitations. 3. To formulate and identify machine learning techniques suitable for a given problem 4. To develop and apply regression algorithms for finding relationships between data variables. 5. To develop and apply pattern classification algorithms to classify multivariate data and demonstrate the usefulness of reinforcement learning and deep learning for controlling complex systems. 6. To create solutions to real-world electrical engineering problems using artificial intelligence and machine learning.

Module	Contents	Hours
1	Introduction to Artificial Intelligence: Introduction to artificial intelligence; Application areas of artificial intelligence; State space search: Depth first search, Breadth first search; Heuristic search: Best first search, Hill Climbing, Beam Search.	4
2	Artificial Neural Networks: Biological Neurons and Biological Neural Networks, Artificial Neural Networks Models, Activation Functions, Perceptrons, Representation Power, Training Rule, Gradient Descent, and the Delta Rule, Multilayer networks and the Back Propagation algorithm, Convergence and Local Minima, Feedforward networks, Inductive Bias, Hidden Layer, Generalization, Overfitting, and Stopping Criterion	8
3	Introduction to Machine Learning: Towards Intelligent Machines, Machine Learning Problems, Data Representation, Diversity of Data: Structured/Unstructured, Forms of Learning, Machine Learning and Data Mining, Basic Linear Algebra in Machine Learning Techniques	3
4	Supervised and Statistical Learning: Bias and Variance, Metrics for Assessing Regression (Numeric Prediction) Accuracy, Metrics for Assessing Classification (Pattern Recognition) Accuracy, Descriptive Statistics in Learning Techniques, Bayesian Reasoning: A Probabilistic Approach to Inference, k-Nearest Neighbor	10

	(k-NN) Classifier, Discriminant Functions and Regression Functions, Linear Regression with Least Square Error Criterion, Logistic Regression for Classification Tasks, Regression by Support Vector Machines, Decision Trees, Overfitting and Regularization	
5	**Data Clustering and Data Transformations:** Unsupervised Learning, Overview of Basic Clustering Methods, K-Means Clustering, Data Cleansing, Derived Attributes, Discretizing Numeric Attributes, Attribute Reduction Techniques, Principal Components Analysis (PCA) for Attribute Reduction **Introduction to Advance Machine Learning:** Introduction, Need and Model of Reinforcement Learning and Deep Learning	8
6	**Application of Artificial Intelligence in Electrical Engineering:** Voltage control, Protection System, Static Security Assessment, Condition Monitoring, Schedule Maintenance of Electrical Power Transmission Networks **Application of Machine Learning in Electrical Engineering:** Load forecasting, Voltage stability assessment, Demand Side Management, Predicting User Preference, Load Pattern Classification, Wind speed forecasting.	6

Text Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education
2. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI.
3. M. Gopal, Applied Machine Learning, McGraw Hill
4. Kevin Warwick, Arthur O. Ekwue, Raj Aggarwal, Artificial Intelligence Techniques in Power Systems, Institution of Electrical Engineers, 1997
5. Morteza, Somayeh, Mohammadi, Moloud, Milad, Application of Machine Learning and Deep Learning Methods to Power System Problems, Springer, 2022

Reference Books:

1. J. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House
2. Tom Mitchell, Machine Learning, TMH
3. Harrington, Peter. Machine learning in action. Simon and Schuster, 2012.
4. Bishop, Christopher M., and Nasser M. Nasrabadi. Pattern recognition and machine learning. Vol. 4, no. 4. New York: springer, 2006.
5. Athem Ealpaydin, Introduction to Machine Learning, PHI
6. C. Bishop, Neural Networks for Pattern Recognition, Oxford University Press.
7. Ajay Kumar Vyas, Harsh S. Dhiman, Kamal Kant Hiran, S. Balamurugan, Artificial Intelligence for Renewable Energy Systems, WIley, 2022

Web Reference /Video Courses

1. **NPTEL Course: Artificial Intelligence: Search Methods for Problem Solving, Prof. Deepak Khemani, IIT Madras**
2. **NPTEL Course: Introduction to Machine Learning, Prof. S. Sarkar, IIT Kharagpur**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEDO7024	**Electrical Machine Design**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**		**3**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEDO7024	**Electrical Machine Design**	**20**	**20**	**20**	**80**	**3**	**-**	**-**	**100**

Course Objectives	1. To explore the design philosophies adopted in design of electrics machines and transformers 2. To introduce software tools used in design of electrics machines and transformers
Course outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Understand the construction and performance characteristics of electrical machines. 2. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines 3. Understand the principles of electrical machine design and carry out a basic design of an ac machine. 4. Use software tools to do electrical machine design calculations.

Module	Contents	Hours
1	Introduction: Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.	04
2	Transformers: Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers	07
3	Induction Motors: Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly-phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics	10
4	Synchronous Machines: Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.	10
5	Machines for special Applications: Introduction to structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines; Sizing of motors for Electric Vehicles, design of EV grade Induction motor.	04
6	Computer aided Design (CAD): Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design.	04

Text/ Reference Books:-

1. A. K. Sawhney, A Course in Electrical Machine Design, Dhanpat Rai and Sons, 1970.
2. M.G. Say, Theory & Performance & Design of A.C. Machines, ELBS London.
3. S. K. Sen, Principles of Electrical Machine Design with computer programmes, Oxford and IBH Publishing, 2006.
4. K. L. Narang, A Text Book of Electrical Engineering Drawings, Satya Prakashan, 1969.
5. Shanmugasundaram, G. Gangadharan and R. Palani, Electrical Machine Design Data Book, New Age International, 1979.
6. K. M. V. Murthy, Computer Aided Design of Electrical Machines, B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

Web Reference /Video Courses

1. NPTEL Course: Modelling and Analysis of Electric Machines, Dr. Krishna Vasudevan, IIT Madras
2. NPTEL Course: Electrical Equipment and Machines: Finite Element Analysis By Prof. S. V. Kulkarni, IIT Bombay

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO7011	**Product Life Cycle Management**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEIO7011	**Product Life Cycle Management**	**20**	**20**	**20**	**80**	3	**--**	**--**	**100**

Course Objectives	1.To familiarize the students with the need, benefits and components of PLM 2.To acquaint students with Product Data Management & PLM strategies 3.To give insights into new product development program and guidelines for designing and developing a product 4.To familiarize the students with Virtual Product Development
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. 2. Illustrate various approaches and techniques for designing and developing products. 3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. 4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Contents	Hours
1	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM	10
2	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09

3	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
4	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
5	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
6	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

References:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Assessment:

Internal Assessment for 20 marks: Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO7012	**Reliability Engineering**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEIO7012	**Reliability Engineering**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	1. To familiarize the students with various aspects of probability theory 2. To acquaint the students with reliability and its concepts 3. To introduce the students to methods of estimating the system reliability of simple and complex systems 4. To understand the various aspects of Maintainability, Availability and FMEA procedure
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. Understand and apply the concept of Probability to engineering problems 2. Apply various reliability concepts to calculate different reliability parameters 3. Estimate the system reliability of simple and complex systems 4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Contents	Hours
1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
3	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
4	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
5	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05

6	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

References:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO7013	**Management Information System**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEIO7013	**Management Information System**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	1. The course is blend of Management and Technical field. 2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built 3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage 4. Identify the basic steps in systems development
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. Explain how information systems Transform Business 2. Identify the impact information systems have on an organization 3. Describe IT infrastructure and its components and its current trends 4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making 5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Contents	Hours
1	**IntroductiontTo Information Systems (IS):** Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	04
2	**Data and Knowledge Management:** Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management **Business intelligence (BI):** Managers and Decision Making, BI for Data analysis and Presenting Results	07
3	**Ethical issues and Privacy:** Information Security. Threat to IS, and Security Controls	07
4	**Social Computing (SC):** Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	07
5	**Computer Networks** Wired and Wireless technology, Pervasive computing, Cloud computing model.	06
6	**Information System within Organization:** Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process.	08

	Acquiring Information Systems and Applications: Various System development life cycle models.	

References:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO7014	**Design of Experiments**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEIO7014	**Design of Experiments**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	1. To understand the issues and principles of Design of Experiments (DOE) 2. To list the guidelines for designing experiments 3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action 2. Apply the methods taught to real life situations 3. Plan, analyze, and interpret the results of experiments

Module	Contents	Hours
1	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
2	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
3	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07

4	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

References:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO7015	**Operations Research**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme								
		Theory						Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg						
EEIO7015	**Operations Research**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**	

Course Objectives	1. Formulate a real-world problem as a mathematical programming model. 2. Understand the mathematical tools that are needed to solve optimization problems. 3. Use mathematical software to solve the proposed models.
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness. 2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change. 3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems. 4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Contents	Hours
1	**Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems,	14

	Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
2	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
3	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
4	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
5	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
6	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO7016	**Cyber Security and Laws**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEIO7016	**Cyber Security and Laws**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	1. To understand and identify different types cybercrime and cyber law 2. To recognized Indian IT Act 2008 and its latest amendments 3. To learn various types of security standards compliances
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. Understand the concept of cybercrime and its effect on outside world 2. Interpret and apply IT law in various legal issues 3. Distinguish different aspects of cyber law 4. Apply Information Security Standards compliance during software design and development

Module	Contents	Hours
1	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	04
2	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	09
3	**Tools and Methods Used in Cyberline:** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	06
4	**The Concept of Cyberspace** : E-Commerce, The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	08
5	**Indian IT Act:** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	06

6	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	06

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information Technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes by Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on: The Information Technology ACT, 2008- TIFR: https://www.tifrh.res.in
9. Website for more information: A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primerprofessionals-33538

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO7017	**Disaster Management and Mitigation Measures**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEIO7017	**Disaster Management and Mitigation Measures**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	1. To understand physics and various types of disaster occurring around the world 2. To identify extent and damaging capacity of a disaster 3. To study and understand the means of losses and methods to overcome /minimize it. 4. To understand role of individual and various organization during and after disaster 5. To understand application of GIS in the field of disaster management 6. To understand the emergency government response structures before, during and after disaster
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1 Get to know natural as well as manmade disaster and their extent and possible effects on the economy. 2 Plan of national importance structures based upon the previous history. 3 Get acquainted with government policies, acts and various organizational structure associated with an emergency. 4 Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Contents	Hours
1	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
2	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
3	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and coordination of in disaster management, rescue operations-how to start with and	06

	how to proceed in due course of time, study of flowchart showing the entire process.	
4	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
5	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
6	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

References:

1. 'Disaster Management' by Harsh K. Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Assessment:

Internal Assessment for 20 marks: Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)

4. Only **Four questions need to be solved**.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO7018	**Energy Audit and Management**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEIO7018	**Energy Audit and Management**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation. 2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management 3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. To identify and describe present state of energy security and its importance. 2. To identify and describe the basic principles and methodologies adopted in energy audit of a utility. 3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. 4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities 5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Contents	Hours
1	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
2	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
3	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10

4	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
6	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

References:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO7019	**Development Engineering**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		3	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)	Term Work	Oral	Total
		Test 1	Test 2	Avg					
EEIO7019	**Development Engineering**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development 2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas 3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals 4. To understand the Nature and Type of Human Values relevant to Planning Institutions
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. Apply knowledge for Rural Development. 2. Apply knowledge for Management Issues. 3. Apply knowledge for Initiatives and Strategies 4. Develop acumen for higher education and research. 5. Master the art of working in group of different nature. 6. Develop confidence to take up rural project activities independently

Module	Contents	Hours
1	**Introduction to Rural Development:** Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development, Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	**Post-Independence Rural Development:** Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04
3	**Rural Development Initiatives in Five Year Plans:** Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06

4	**Post 73rd Amendment Scenario:** 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
5	**Values and Science and Technology:** Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10
6	**Ethics:** Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

References:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V., Conflicting Rationalities: -Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Assessment:

Internal Assessment for 20 marks: Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEL701	**Electrical Drives and Control Lab**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		--	**2**		**1**	**1**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEL701	**Electrical Drives and Control Lab**	---	---	---	---	--	**25**	**25**	**50**

Course Objectives	1. To impart practical knowledge on electrical drives and its control
Course outcomes	Upon successful completion of this course, the learner will be able : 2. To analyze the dynamic performance of ac and dc drives. 3. To analyze the dynamics of electrical braking in ac and dc drives 4. To analyze the control aspects and the performance of power electronic drives. 5. To use simulation tools to evaluate the performance of ac and dc drive

Syllabus:

Same as that of Course Drives and Control (EEC701) with the following additions: - Starting of DC/AC motors, Speed Control of DC Motor with Half Controlled Converter, Dual Converter, Speed Control of Wound Rotor Induction Motor, Control of Special Machines like Brushless DC (BLDC) Motor, Permanent Magnet Synchronous Motor (PMSM), Stepper Motor, Switched Reluctance Motor (SRM), Synchronous Reluctance Motor (SyRM).

Suggested List of Laboratory Experiments:

1. Measurement of Moment of Inertia by Retardation Test
2. Study of Different Speed Sensing, Current Sensing and Voltage Sensing devices used for closed loop controlled drive.
3. Developing Sensor/interfacing Circuits required for the drive.
4. Single phase fully-controlled rectifier fed DC drive/Single phase half controlled rectifier fed DC drive / Three phase fully controlled rectifier fed DC drive/ Three phase half controlled rectifier fed DC drive/Dual Converter controlled fed DC drive. (Simulation/ Hardware)
5. Chopper Controlled DC drive. (Simulation/ Hardware)
6. Closed loop Control of DC drive (Simulation/ Hardware).
7. Simulation of Starting of DC motor (Conventional resistance start and any one Soft-start scheme)
8. Dynamic braking, Plugging of DC motor.
9. Plugging of three phase Induction Motor.
10. V control and V/f control of Induction Motor using PWM Inverter.
11. Rotor resistance control of IM
12. Slip Power Recovery Scheme (Static Scherbius Drive).
13. Hands on Experience in Programming a general purpose three phase Induction Motor Industrial Drive.
14. Vector Control of three phase Induction Motor (Simulation/Hardware).
15. DTC of three phase Induction Motor (Simulation/Hardware).
16. Control of Special Machines like Brushless DC (BLDC) Motor, Permanent Magnet Synchronous Motor (PMSM), Stepper Motor, Switched Reluctance Motor (SRM), Synchronous Reluctance Motor (SyRM)

Any other experiment based on the syllabus which will help students to understand the topic/concept.

Term work:

Term work shall consist of minimum eight experiments with minimum six hardware experiments.

The distribution of marks shall be as follows:

Experiments Performance	: 10 marks
Journal	: 10 marks
Attendance	: 05 marks

The final certification and acceptance of term work ensures the minimum passing in the term work.

Practical and Oral Examination:

Practical and Oral examination shall be based on entire syllabus of experiments conducted in **'EEL701: Electrical Drives and Control Lab'** and '**EEC701: Electrical Drives & Control**' syllabus

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEL702	**Simulation Lab-III**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		--	**2**		**1**	**1**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEL702	**Simulation Lab-III**	---	---	---	---	--	**25**	**25**	**50**

Course Objectives	The course is aimed: 1. To understand basic block sets of different simulation platform used in electrical /electronic circuit design. 2. To understand use and coding in different software tools used in electrical/ electronic circuit design
Course outcomes	Upon successful completion of this course, the learner will be able to 1. Develop the skill to use the software packages to model and program electrical and electronics systems 2. Model different electrical and electronic systems and analyze the results 3. Articulate importance of software packages used for simulation in laboratory experimentation /research/industry by analyzing the simulation results. 4. Simulate circuits for performance analysis.

Suggested Software Tools to be Used for Simulation Lab-II:

1. Students should be encouraged to use open source softwares such as SCILAB, LTSPICE, Texas Instrument's 'Webbench', Ngspice, Solve Elec etc. for carrying out the lab simulation listed below.
2. Use of Professional Licensed versions of softwares like MATLAB, Proteus, LabVIEW, NI Multisim, PSpice, PSim, PSCAD, TINA etc. is also allowed.
3. Use of 'Python' platform for simulating components/ circuit behaviour should also be emphasized
4. Many of the following suggested experimentation can be carried out on Virtual lab platform

Suggested List of Laboratory Experiment: Minimum eight experiments need to be performed from various subjects domain. Some of the simulation experiments can also be selected based on the department elective offered

Power Electronics Design and Control

1. Simulation of a Buck or Boost or Buck-Boost DC-DC converter for switched mode power supplies (any one converter)
2. Simulation of feed-back compensator for closed- loop control of Buck or Boost or Buck-Boost DC-DC converter for extraction of energy from renewable energy sources (any one converter)
3. Simulation single phase or three phase SPWM technique for control of bridge inverter for an AC load
4. Simulation of a single-phase bridge inverter for an AC load
5. Simulation a feed-back compensator for a single-phase bridge inverter
6. Simulation of a feedback compensator for a flyback converter for Laptop charger /for LED lighting system /mobile phone charger or any other application.
7. Simulation of digital control of a DC-DC converter

EPS-III: (Virtual Power Lab experiments @https://www.vlab.co.in/broad-area-electrical-engineeringor any other simulation tools to be used)

1. To study the Synchronization of alternator with infinite bus bar.

2. To determine the direct axis reactance (Xd) and quadrature axis reactance (Xq) of synchronous machine.
3. To determine positive sequence, negative sequence and zero sequence reactances of an alternator.
4. To Study the over-current relay and the effect of PSM and TSM.
5. To determine the sub-transient (xd"), transient (xd') and steady state reactance (xd) of a synchronous machine.
6. To Study the Ferranti Effect of a transmission line/cable.
7. To study the differential Protection of a three phase delta-delta connected transformer.
8. To study the Protection of a three phase Induction Motor using Numerical Relay.

Microgrid/ Smart-grid:

1. Simulation of DC-DC Converters (unidirectional /Bidirectional) with Voltage mode control / current mode control for DC Microgrid application.
2. Simulation of DC-AC Converter (Inverter) with Voltage mode control / current mode control for AC Microgrid application.
3. Simulation of DC-AC Converter (Inverter) with grid connected mode operation for AC Microgrid application.
4. Simulation of power sharing between two (or more) DC-DC Converters in DC Microgrid scenario
5. Simulation of power sharing between two Inverters in AC Microgrid scenario
6. Simulation/Emulation of smart grid technologies

High voltage Engineering: (Virtual Power Lab experiments @https://www.vlab.co.in/broad-area-electrical-engineeringor any other simulation tools to be used)

1. Study of Impulse Voltage Generator
2. Parametric Analysis of Impulse Voltage Waveform
3. Study of Impulse Current Generator
4. Parametric Analysis of Impulse Current Waveform
5. Critical Flashover of a Sphere Gap using IVG
6. Study of Rectangular Pulse Current Generator
7. Functioning of Voltage Doubler
8. 3-Stage Cockroft Walton Voltage Multiplier
9. Application of High Voltage D.C. Test Source

Any other simulations / algorithms based on semester VII syllabus, which will help students to understand topic / concept.

Note: Students and teachers are encouraged to use the virtual labs whose links are as given below The remote-access to Labs in various disciplines of Science and Engineering is available. Students can conduct online experiments which would help them in learning basic and advanced concepts through remote experimentation.

Virtual Lab Website Reference

1. http://vlab.co.in/broad-area-electrical-engineering
2. http://vlab.co.in/broad-area-electronics-and-communications

Term work:

Term work shall consist of minimum eight experiments. The distribution of marks shall be as follows:

Experiments Performance	: 10 marks
Journal	: 10 marks
Attendance	: 05 marks

The final certification and acceptance of term work ensures the minimum passing in the term work.

Oral Examination:

Oral examination will be based on all the laboratory experiments carried out in **EEL702- Simulation Lab-III**

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEL703	**Power Electronics Design Lab**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		--	**2**		**1**	**1**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEL703	**Power Electronics Design Lab**	---	---	---	---	--	**25**	**25**	**50**

Course Objectives	1. To provide hands on / skill-sets to model / design and implement the power electronics systems/ subsystems 2. To impart knowledge on practical aspects of power electronics converters design
Course outcomes	Upon successful completion of this course, the learner will be able to 1. Illustrate design of auxiliary circuits for Power Electronic systems. 2. Analyse the requirements, model and design a compensator for a power electronic converter. 3. Create a power electronic converter for a particular application. 4. Implement control algorithm for a power electronic converter in hardware / simulation platform

Suggested Power Electronics (PE) Design Lab exercises:

Group 1: PE Converter Hardware

1. Implementation of a Buck or Boost or Buck-Boost DC-DC converter for switched mode power supplies (any one converter)
2. Model and design of feed-back compensator for closed- loop control of Buck or Boost or Buck-Boost DC-DC converter for extraction of energy from renewable energy sources (any one converter)
3. Implement a single-phase bridge inverter for an AC load
4. Model and design a feed-back compensator for a single-phase bridge inverter
5. Model and design a feedback compensator for a flyback converter for Laptop charger /for LED lighting system /mobile phone charger or any other application.
6. Implement any power electronic converter for a specific application.

Group 2: PE Converter Control – Coding (programming)

1. Implement single phase or three phase SPWM technique for control of bridge inverter for an AC load
2. Implementation of microcontroller / DSP code for voltage mode control (VMC) of DC-DC converter
3. Implementation of microcontroller / DSP code for current mode control (CMC) of DC-DC converter
4. Implementation of microcontroller / DSP code for VMC/ CMC of an inverter
5. Implementation of microcontroller / DSP code for v/f control of induction motor / any other drive application
6. Implementation of any control coding for any PE Converter.

Group 3: Aux System / Protection / Heatsink

1. Design of Gate driver circuits for different power semi-conductor switches (Si devices or Wide band gap devices like SiC or GaN etc.)
2. Design of Snubber circuit and analysing its impact on the operation of switch used in PE converter or inverter
3. Design of heat sink for a PE converter and verify its thermal performance

4. Design AC/DC voltage and Current Sensing (isolated/ or non-isolated) circuit for feedback control of a PE converter
5. Design of over current / short circuit protection system for any PE converter
6. Design of any specific auxiliary systems commonly used in Power Electronic systems.

Term work Requirements:

a. Design / Modelling and Implementation of **minimum one exercise** from each group mentioned above (total three at least).
b. Detailed report including all the details of design / modelling and implementation (with photographs) shall be submitted as a part of term-work.
c. Institute shall arrange a visit to a Power Electronic industry or seminar (by students) based on survey of power electronic converters or power electronic systems for specific applications. Report for the same shall be submitted as a part of the term-work.

References Books:

1. Mohan, Ned. et.al, "Power Electronics Converters, Applications and Design", Wiley India Pvt. Ltd., New Delhi.
2. L. Umanand, Bhatt, "Design of Magnetic Components for Switched Mode Power Converters", John Wiley & Sons

Web Courses:

1. **NPTEL course:** Design of Power Electronic Converters, Prof. Shabari Nath, IIT Guwahati.
2. **NPTEL course:** Advanced Power Electronics and Control, Prof. Avik Bhattacharya, IIT Roorkee

Term work:

Term work shall consist of **minimum three exercises with detailed reports as mention in requirements**. The distribution of marks shall be as follows:

Lab Performance (design/ modelling/ implementation)	:15 marks
Industry Visit / Seminar Report	:05 marks
Attendance	:05 marks

The final certification and acceptance of term work ensures the minimum passing in the term work.

Oral Examination:

Oral examination will be based on experiments carried out in **EEL703**

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEP701	**Major Project - I**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		--	**6$**	**--**	**3**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
EEP701	**Major Project - I**	--	--	--	--	--	50	-	50

$ indicates work load of Learner (Not Faculty)

Course Objectives	1. To design and develop a complex electrical/electronic/digital circuit/ interdisciplinary problem with practical relevance 2. To understand basic concepts of circuit/ system design while developing the project. 3. To enable the students to gain hands-on experience independently proposing and implementing the project and thus acquire the necessary confidence to deal with complex electrical/electronic/digital systems. 4. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. Identify problems based on societal /research needs. 2. Apply Knowledge and skill to solve societal problems in a group. 3. Develop interpersonal skills to work as member of a group or leader. 4. Draw the proper inferences from available results through theoretical/ experimental/ simulations. 5. Analyse the impact of solutions in societal and environmental context for sustainable development. 6. Use standard norms of engineering practices 7. Excel in written and oral communication. 8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning. 9. Demonstrate project management principles during project work

Major Project -Topic Selection and Approval Guidelines

1. The group may be of maximum FOUR (04) students.
2. Students should propose project ideas & finalize the project idea in consultation with guide/ HOD. Students should select a problem which addresses some real life applications.
3. Students should identify different components/ devices, instruments, simulation/emulations software tools required for the project.
4. Students should submit implementation plan in the form of Gantt/ PERT/ CPM chart, which will cover weekly activity of project.
5. A log-book to be prepared by each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty.

Application Domains:

List of key application domains from where students are encouraged to derive Major Projects topics (but not limited to):

1) Smart Agriculture solutions

2) Power converter applications in various Applications
3) IoT based applications in power systems
4) AI/ML applications in disaster management
5) Renewable Energy
6) Energy Conservation
7) Energy Storage
8) Battery Charging and Protection
9) Fire Safety
10) Electrical System Protection
11) Lighting Control
12) Wireless Power Transfer
13) Electrical Components Testing
14) Electrical Parameters Measurement
15) Non-conventional Electricity Generation
16) Laboratory Equipment
17) E-Mobility / Electric Vehicles
18) Video Surveillance Systems
19) Robotics for Hazardous applications
20) Waste Management System
21) Smart City Solutions
22) Smart Classrooms and learning Solutions
23) Design of Electrical Equipment
24) PLC based automation system
25) Power system Monitoring System

Students can identify the Major project topic either from above suggested domains or any other relevant electrical engineering domains. The inter-disciplinary nature of the project is also desirable.

Guidelines for Assessment of Major Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for Major Project- I shall be as below;
  - Marks awarded by guide/supervisor based on log book : 20
  - Marks awarded by review committee : 20
  - Quality of Project report : 10

Review/progress monitoring committee may consider following points for assessment as mentioned in general guidelines. Two reviews shall be conducted based on presentation given by students group based on the following criteria:

Assessment criteria of Major Project-I.

Major Project shall be assessed based on following criteria;

1. Quality of literature survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness

6. Societal impact
7. Innovativeness
8. Cost effectiveness
9. Effective use of skill sets
10. Effective use of standard engineering norms
11. Contribution of an individual's as member or leader
12. Clarity in written and oral communication

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines.