



Lokmanya Tilak Jankalyan Shikshan Sanstha's
Lokmanya Tilak College of Engineering
An Autonomous Institute Affiliated to University of Mumbai

(Approved by AICTE, Accredited by NAAC 'A' Grade & four programs by NBA)

Sector-04, Koparkhairane, Navi Mumbai - 400 709



An Autonomous Institute Affiliated to University of Mumbai



Department of Electrical Engineering

Curriculum Structure for Final Year Engineering

(With effect from Academic Year 2024-25)

Approved by Board of Studies on: 15-10-24

Approved by Academic Council on: 18-10-24



Lokmanya Tilak Jankalyan Shikshan Sanstha's
Lokmanya Tilak College of Engineering

An Autonomous Institute Affiliated to University of Mumbai

(Approved by AICTE, Accredited by NAAC 'A' Grade & four programs by NBA)

Sector-04, Koparkhairane, Navi Mumbai - 400 709



DEPARTMENT OF ELECTRICAL ENGINEERING

CURRICULUM STRUCTURE FOR FINAL YEAR ENGINEERING PROGRAM

(w.e.f.A.Y.2024-25)

Preamble

Lokmanya Tilak College of Engineering (LTCE) is founded by a Nagpur-based trust known as Lokmanya Tilak Jankalyan Shikshan Sanstha (LTJSS). The Sanstha was established in 1983, by Honourable Dr. Satish Chaturvedi. At present, there are 28 educational institutes run by the Sanstha in Nagpur. The Sanstha derives its philosophy from the magnanimous mathematician, educationist, social reformer Lokmanya Bal Gangadhar Tilak, who dedicated his life for the cause of Swaraj. Lokmanya Tilak College of Engineering was established in 1994, approved by the All-India Council for Technical Education, New Delhi, recognised by the Govt. of Maharashtra, accredited by NAAC with 'A' grade and is affiliated to the University of Mumbai. Within the span of 30 years of its inception, LTCE has grown leaps and bounds in terms of popular courses being offered at U. G.,

P.G. and Ph.D. level. Four of its branches viz., Electrical, Mechanical, Electrical and Electronics and Telecommunications Engg. have been accredited by NBA. The Institute runs the Undergraduate Programmes in Mechanical Engineering, Electrical Engineering, Electronics & Telecommunication Engineering, Electrical Engineering, Electronics Engineering, Electrical Science & Engineering (Data Science), Electrical Science & Engineering (Artificial Intelligence & Machine Learning) and Electrical Science & Engineering (IoT & Cyber Security Including Blockchain Technology). Institute also offers Doctoral Programmes in Mechanical Engineering and Electrical Engineering. LTCE stands steadfast in its mission of continuing efforts for the betterment of its students and society.

The National Education Policy 2020, recently implemented by the Government of India, envisions providing quality education to all young people, with the primary goal of nurturing well-rounded, thoughtful, and creative individuals. NEP 2020 also emphasizes the importance of developing character, ethical values, constitutional principles, intellectual curiosity, scientific temper, creativity, and other related virtues. The Government of Maharashtra has instructed autonomous colleges to update their curriculum and begin implementing the National Education Policy (NEP) 2020. We are fully committed to ensuring the effective and meaningful adoption of NEP 2020 in its true essence. At "Lokmanya Tilak College of Engineering", the holistic development of learners has always been our top priority and central focus. LTCE embraced the NEP philosophy as early as 2022 wherein we have introduced the concept of Honors and Minors programs on emerging fields including AI & ML, Data Science, Cyber Security, IoT, Blockchain, etc., as per the guidelines of University of Mumbai and in 2024, we proudly graduated our first batch under this holistic curriculum. The curriculum for 2024-28 is structured in line with the recommendations of NEP 2020, AICTE, and UGC. It now includes courses in emerging technologies and multidisciplinary areas to ensure relevance to industry and practical applications. Greater focus has been placed on experiential learning to move away from rote memorization.



Lokmanya Tilak Jankalyan Shikshan Sanstha's
Lokmanya Tilak College of Engineering
 An Autonomous Institute Affiliated to University of Mumbai

(Approved by AICTE, Accredited by NAAC 'A' Grade & four programs by NBA)

Sector-04, Koparkhairane, Navi Mumbai - 400 709



LokmanyaTilakCollegeofEngineering,NaviMumbai(Autonomous Institute Affiliated to University of Mumbai)
 Program Structure for Final Year Electrical Engineering SemesterVII

CourseCode	CourseName	TeachingScheme(Contact Hours)			CreditsAssigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
EEC701	ElectricalDrives&Control	3	--	--	3	--	3	
EEC702	ElectricalPower System III	3	--	--	3		3	
EEDC701 X	DepartmentOptionalCourse – 3	3	--	--	3	--	3	
EEDC702 X	DepartmentOptionalCourse – 4	3	--	--	3	--	3	
ILO701 X	InstituteOptional Course – 1	3	--	--	3	--	3	
EEL701	ElectricalDrives& Control Lab	--	2	--	--	1	1	
EEL702	SimulationLabIII	--	2	--	--	1	1	
EEL703	PowerElectronics Design Lab	--	2	--	--	1	1	
EEP701	MajorProjectI	--	6#	--	--	3	3	
Total		15	12		--	6	21	
ExaminationScheme								
CourseCode	CourseName	Theory						
		InternalAssessment			End Sem. Exam	Exam.Dur at ion(in Hrs)		
		TestI	TestII	Avg.				
EEC701	ElectricalDrives&Control	20	20	20	80	3	--	100



Lokmanya Tilak Jankalyan Shikshan Sanstha's
Lokmanya Tilak College of Engineering
An Autonomous Institute Affiliated to University of Mumbai

(Approved by AICTE, Accredited by NAAC 'A' Grade & four programs by NBA)

Sector-04, Koparkhairane, Navi Mumbai - 400 709



EEC702	ElectricalPower System III	20	20	20	80	3	--	--	100
EEDC701 X	DepartmentOptional Course – 3	20	20	20	80	3	--	--	100
EEDC702 X	DepartmentOptional Course – 4	20	20	20	80	3	--	--	100
ILO701X	InstituteOptional Course - 1	20	20	20	80	3	--	--	100
EEL701	ElectricalDrives& ControlLab	--	--	--	--	--	25	25	50
EEL702	SimulationLabIII	--	--	--	--	--	25	25	50
EEL703	PowerElectronics Design Lab	--	--	--	--	--	25	25	50
EEP701	MajorProjectI	--	--	--	--	--	50	--	50
Total		--	--	100	400		125	75	700

#indicatesworkloadofLearner(NotFaculty),forMajorProject



Lokmanya Tilak Jankalyan Shikshan Sanstha's
Lokmanya Tilak College of Engineering
 An Autonomous Institute Affiliated to University of Mumbai

(Approved by AICTE, Accredited by NAAC 'A' Grade & four programs by NBA)

Sector-04, Koparkhairane, Navi Mumbai - 400 709



(Autonomous Institute Affiliated to University of Mumbai)

Program Structure for Final Year Electrical Engineering Departmental & Institutional Optional Courses

Semester VII

Semester	Departmental & Institutional Level Optional Courses	Code & Course
VII	Department Optional Course-3	EEDC7011: Digital Control System
		EEDC7012: HVDC Transmission Systems
		EEDC7013: Internet of Things
		EEDC7014: Digital Signal Processors and Applications
VII	Department Optional Course	EEDC7021: Microgrid and Smart-grid
		EEDC7022: Power System Dynamics and Control
		EEDC7023: Artificial Intelligence and Machine Learning
		EEDC7024: Electrical Machine Design
VII	Institute Optional Course-1	ILO7011: Product Lifecycle Management
		ILO7012: Reliability Engineering
		ILO7013: Management Information System
		ILO7014: Design of Experiments
		ILO7015: Operation Research
		ILO7016: Cyber Security and Laws
		ILO7017: Disaster Management and Mitigation Measures
		ILO7018: Energy Audit and Management
		ILO7019: Development Engineering



Lokmanya Tilak Jankalyan Shikshan Sanstha's
Lokmanya Tilak College of Engineering
 An Autonomous Institute Affiliated to University of Mumbai

(Approved by AICTE, Accredited by NAAC 'A' Grade & four programs by NBA)

Sector-04, Koparkhairane, Navi Mumbai - 400 709



(Autonomous Institute Affiliated to University of Mumbai)

Program Structure for Final Year Electrical Engineering Semester VIII

CourseCode	CourseName	TeachingScheme(Contact Hours)			CreditsAssigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
EEC801	ElectricalSystemDesign, ManagementandAuditing	4	--	--	4	--	--	4	
EEDC801X	DepartmentOptional Course – 5	3	--	--	3	--	--	3	
EEDC802X	DepartmentOptional Course – 6	3	--	--	3	--	--	3	
ILO801X	InstituteOptional Course - 2	3	--	--	3	--	--	3	
EEL801	Electrical System DesignandAuditLab	--	2	--	--	1	--	1	
EEL802	Measurement and InstrumentationLab	--	2	--	--	1	--	1	
EEP801	MajorProjectII	--	12#	--	--	6	--	6	
Total		13	16	--	13	8	--	21	
ExaminationScheme									
CourseCode	CourseName	Theory					TermW ork	Pract/ Oral	Total
		InternalAssessment			End Sem. Exam	Exam.Du rat ion(in Hrs)			
		TestI	TestII	Avg.					
EEC801	Electrical System Design,Managem ent and Auditing	20	20	20	80	3	--	--	100
EEDC801X	DepartmentOptional Course – 5	20	20	20	80	3	--	--	100
EEDC802X	DepartmentOptional Course – 6	20	20	20	80	3	--	--	100



Lokmanya Tilak Jankalyan Shikshan Sanstha's
Lokmanya Tilak College of Engineering
An Autonomous Institute Affiliated to University of Mumbai

(Approved by AICTE, Accredited by NAAC 'A' Grade & four programs by NBA)

Sector-04, Koparkhairane, Navi Mumbai - 400 709



ILO801X	InstituteOptional Course - 2	20	20	20	80	3	--	--	100
EEL801	Electrical System DesignandAuditLab	--	--	--	--	--	25	25	50
EEL802	Measurement and InstrumentationLab	--	--	--	--	--	25	25	50
EEP801	MajorProjectII	--	--	--	--	--	100	50	150
		--	--	80	320	--	150	100	650

Students group and load of faculty per week. Major Project I and II:
Students can form groups with minimum 3 (Three) and not more than 4 (Four)
Faculty Load: In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

LokmanyaTilakCollegeofEngineering,NaviMumbai(Autonomous Institute Affiliated to University of Mumbai)Program Structure for Final Year Electrical Engineering Departmental & Institutional Optional Courses

SemesterVIII

Semester	Departmental & Institutional Level Optional Courses	Code&Course
VIII	DepartmentOptionalCourse–5	EEDC8011:PowerQualityandFACTs
		EEDC8012:AutomationandControl
		EEDC8013:AdvancedElectricDrives
		EEDC8014:HighPowerSwitchingConverters
VIII	DepartmentOptionalCourse–6	EEDC8021:PowerSystemPlanningandReliability
		EEDC8022:LightingSystemDesign
		EEDC8023:CyberPhysicalSystems
		EEDC8024:ElectricVehicleSystemDesign
VIII	InstituteOptionalCourse–2	ILO8021:ProjectManagement
		ILO8022:FinanceManagement
		ILO8023:EntrepreneurshipDevelopment andM a n a g e m e n t
		ILO8024:HumanResourceManagement
		ILO8025:ProfessionalEthicsandCSR
		ILO8026:ResearchMethodology
		ILO8027:IPRandPatenting
		ILO8028:DigitalBusinessManagement
		ILO8029:EnvironmentalManagement

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

	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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

	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	10

	zero cancellation on the controllability & observability.	
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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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 Duration			

		Test 1	Test 2	Avg	Exam	(in Hrs)			
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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

Text /Reference Books:-

1. Vijay Madiseti 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", O'Reilly 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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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,	05

	Trapezoidal Method. Implementation of digital filters and transformations	
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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

	<i>Review of Smart Grid Technologies:</i> Introduction to Smart Meters, Real Time Pricing, 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) <i>Communication Network for Microgrids & Smart Grid:</i> 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 Hatziaargyriou, 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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course Code	Course Name	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:	04

	Basic concepts, Voltage collapse, Voltage stability analysis, Prevention of voltage collapse.	
6	Method of Improving Stability: Transient system enhancement methods, Small signal stability enhancement method	04

Text Books/ Reference Books:-

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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 electric machines and transformers 2. To introduce software tools used in design of electric 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,	07

	methods for cooling of transformers	
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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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, Fault tree analysis and Event tree Analysis	05
---	--	----

References:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Connor, "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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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	IntroductionTo 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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

	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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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 General 2^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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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. Myers, 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.**

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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
---	---	----

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

	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 Lieberman, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut

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.**

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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. Kenneth 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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

	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**

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)

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

4	Post 73rd Amendment Scenario: 73 rd 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. Gol, Constitution (73rd Gol, New Delhi Amendment) Act, Gol, 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**

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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	Pract	Total

		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)	Work	& Oral	
		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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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-engineering> or 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 (X_d) and quadrature axis reactance (X_q) 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 (x_d''), transient (x_d') and steady state reactance (x_d) 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-engineering> or 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:

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEC801	Electrical System Design, Management and Auditing	Theory	Pract./Tut.	Theory	Pract /Tut.	Total
		4	--	4	--	4

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					
EEC801	Electrical System Design, Management and Auditing	20	20	20	80	03	-	-	100

Course Objectives	To impart knowledge of 1. Designing electrical distribution network 2. Electrical energy audit in the distribution system
Course Outcomes	Upon successful completion of this course, the learner will be able: 1. To do sizing, selecting transformer, switchgear and cable as required for distribution system 2. To illustrate Engineering knowledge in energy audit and energy efficient technologies to improve energy efficiency 3. Describe the energy conservation through energy monitoring and targeting 4. Analyse and Evaluate the energy audit data for targeting possible opportunities of energy saving

Module	Contents	Hours
--------	----------	-------

1	Introduction: Types of electrical Projects, Types of electrical system, review of components of electrical system, different plans/ drawings in electrical system design, single line diagram in detail, Tendering, Estimation	05
2	Design of Power Distribution System: Different types of distribution systems and selection criteria, Electrical Earthing, Electrical load size, L.F, D.F, future estimates, substation equipment options, design considerations in transformer selection, sizing and specifications; Selection of HT/LT switchgears, metering, switchboards and MCC, protection systems, coordination and discrimination. IS standards applicable in above design	10
3	Selection / Sizing of Cable and Auxiliary system: Cables selection and sizing, cable installation and management systems, bus bars design; Basics of selection of emergency/backup supplies, UPS, DG Set, Batteries; Preliminary design of interior lighting system. IS standards applicable in above designs	07
4	Energy Monitoring and Targeting: Defining monitoring and targeting. Elements of monitoring and Targeting. Analysis techniques for energy optimization, Cumulative Sum of Differences (CUSUM), Electricity billing. Energy Management of Electrical Systems: Electrical load management and maximum demand control, Power factor improvement and its benefit, selection and location of capacitors, distribution and transformer losses.	10
5	Energy Audit: Introduction to Energy Conservation Act 2001, Energy Audit: Definition-need, Types of energy audit, Energy Management (audit) approach understanding energy costs, Bench marking, Maximizing system efficiencies, optimizing input energy requirement, fuel and energy substitution. Energy Audit instruments. Electrical Energy Performance Assessment: Motors and	10

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

	Variable Speed Drives, Lighting Systems. Basics of HVAC system assessment for electrical energy usage.	
6	Energy Efficient Technologies: Energy efficient BLDC Fans, Smart lighting system for indoor and outdoor applications, Maximum Demand controllers, Automatic Power Factor Controllers, Energy Efficient Motors, Soft starters, Variable Frequency Drives, Energy Efficient Transformer. Energy saving potential of each technology. Use of Energy Management system (EMS) and Building Management System (BMS).	10

Text Books:

1. Handbook of Electrical Installation Practice, Fourth Edition, by Geofry Stokes, Blackwell Science 2.
2. Energy-Efficient Electric Motor, Third Edition, By Ali Emadi, New Marcel Dekker, Inc., 2005.
3. Electrical Energy Efficiency: Technologies and Applications by Andreas Sumper and Angelo Baghini, John Wiley & Sons, Ltd., 2012
4. Electrical Calculations and Guidelines for Generating Stations and Industrial Plants by Thomas E. Baker, CRC Publications, 2012
5. Electrical Installations Handbook, Third Edition, by Gunter Seip, MCD Verilag, 2000

6. Electrical Installation Designs, Fourth Edition by Bill Atkinson, Roger Lovegrove and Gary Gundry, John Wiley & Sons, Ltd, 2013.
7. Handbook of International Electrical Safety Practices, by Princeton Energy Resources International, Scrivener Publishing, 2010.
8. Designing with Light: Lighting Handbook, by Anil Valia, Lighting System
9. Energy Management Handbookll, by W.C. Turner, John Wiley and sons
10. Handbook on Energy Audits and Managementll, by Amit Kumar Tyagi, TERI
11. Introduction to Efficient Electrical System Design, by Stephen Ayraud and Albert Thumann, The Fairmount Press

Reference Books:

1. Energy Auditing Made Simplell, by P. Balasubramanian, Seperation Engineers (P) Ltd
2. University of Mumbai, Electrical Engineering, Rev. 2016-17 Page 51
3. Electrical Installation Calculations: for Compliance with BS 7671:200, Fourth Edition, by Mark Coates, Brian Jenkins, John Wiley & Sons, Ltd, 2010
4. Energy Management Principles, by C.B. Smith, Peragamon Press
5. Energy Conservation Guidebook, by Dale R. Patrick, Stephon Fadro, E. Richardson, Fairmont Press
6. Handbook of Energy Auditsll, by Albert Thumann, William J. Younger, Terry Niehus, CRC Press

Web Reference /Video Courses

1. <http://www.energymanagertraining.com/>
2. <http://www.bee-india.nic.in/>

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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEDO8011	Power Quality and FACTs	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					

EEDO8011	Power Quality and FACTs	20	20	20	80	03	--	-	100
----------	-------------------------	----	----	----	----	----	----	---	-----

Course Objectives	1. To get awareness about non-linear loads in power system. 2. To understand the concept of Flexible AC Transmission System 3. To introduce the operation of various FACTS controllers.
Course outcomes	Upon successful completion of this course, the learner will be able to: 1. Analyze the problems due to non-linear loads 2. Suggest the solution to improve power quality. 3. Illustrate the aspects of flexible ac transmission system over conventional ac transmission system and analyze the concept of load compensation. 4. Categorize the static shunt and series compensation for transmission line. 5. Outline the concept of voltage and phase angle regulators

Module	Contents	Hours
1.	Power Quality Introduction: Disturbances, Unbalance, Distortion, Voltage Fluctuations, Flicker, Quality Assessment	03
2.	Harmonics and its effects : Definition of harmonics, odd and even harmonics, Harmonic phase rotation and phase angle relationship, Causes of voltage and current harmonics, individual and total harmonic distortion with problems, Power assessment under waveform distortion with numerical. Effects of harmonics on rotating Machines, Transformers and Cables, Overloading of Neutral conductor	07
3.	Power quality improvement: Power factor when both voltage and current are sinusoidal, Power factor compensation using capacitor (vector diagram and numerical included), power factor when voltage is sinusoidal and current is non-sinusoidal (numerical included), Effect of capacitor compensation in power factor improvement under non-sinusoidal condition. Mitigation of harmonics- Passive filters- Advantages and disadvantages of passive filters- Active filters shunt connection, series connection and hybrid connection, Instantaneous PQ theory.	10
4.	General concept of FACTS and Load Compensation: Transmission Interconnections, Flow of Power in AC system, What Limits the Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of controllable Parameters, Basic Types of FACTS Controllers, Benefits from FACTS Technology, Objectives in load compensation, ideal compensator, Practical considerations, Power factor correction and Voltage Regulation in single phase systems	08
5.	Static shunt and series compensators: Objectives of shunt compensation, Methods of controllable VAR generation, Variable impedance type static Var generator (TCR, TSR, TSC, FC-TCR), Switching converter type Var	08

	generators, basic operating principle. Objectives of series compensation, Variable impedance type series compensation (only GCSC, TSSC and TCSC), Switching converter type series compensation (only SSSC)	
6.	Static voltage and phase angle regulators- Objectives of voltage and phase angle regulators- TCVR and TCPAR	03

Text Books:-

1. "Power System Harmonics" Jos Arrillaga, Neville R Watson
2. "Electric Power Quality" , G.T.Heydt
3. "Electric Power Systems and Quality" , Roger C. Dugan, Mark F. McGranaghan, H.Wayne Beatyd
4. "IEEE-519 Standard
5. 'Hingorani N.G.. & Gyugi L., —Understanding FACTS : Concepts and Technology of Flexible AC Transmission Systems,|| Wiley-IEEE Press.
6. Timothy J. E. Miller —Reactive power control in Electric Systems,|| Wiley India Edition.

Reference Books:-

1. "Power System Quality Assessment", J. Arrillaga, N.R.Watson, S.Chen
2. "Power Quality" , C. Shankaran, CRC press
3. "Reactive power control in electric systems" by Timothy J. E. Miller
4. "Power Quality Enhancement Using Custom Devices" Arindam Ghosh, Gerard Ledwich
5. "Power Electronics" Ned Mohan, Undeland, Robbins, John Wiley Publication
6. "Power System Analysis- Short Circuit Load Flow and Harmonics" J.C.Das.
7. "Flexible AC transmission system" by Yong Hua Song Institution of Electrical Engineers, London

Website Reference/ Video Courses:

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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEDO8012	Automation 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					
EEDO8012	Automation and Control	20	20	20	80	03	--	-	100

Course Objectives	To impart the fundamentals knowledge in the field of Automation and Control
Course outcomes	Upon successful completion of this course, the learner will be able to 1. Understand basic terminologies and concepts associated with Automation and Control 2. Demonstrate comprehension of various Robotic sub-systems 3. Understand kinematics and dynamics to explain exact working pattern of robots

Module	Contents	Hours
--------	----------	-------

1.	Introduction: Basic concepts of Automation: Definition, three laws, DOF; Elements of Robotic Systems: Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance. Automation: Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Levels of Automations	06
2.	Robot Grippers and Sensors: Types of Grippers, Design aspects for gripper, Force analysis for various basic gripper system. Sensors for Robots: Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.	08
3.	Drives and Control Systems: Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers. Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Control System Components such as Sensors, Actuators and others.	06
4.	Kinematics: Transformation matrices and their arithmetic, link and joint description, Denavit - Hartenberg parameters, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators:-Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics, Trajectory generations	08
5.	Machine Vision System: Vision System Devices, Image acquisition, Masking, Sampling and quantization, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. Robot Programming :- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands,	06

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

	subroutines.	
6.	Modeling and Simulation for manufacturing Plant Automation: Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation.	05

Text Books:-

1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 04
2. Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986.
3. Shimon Y. Nof, Handbook of Industrial Robotics, John Wiley Co, 01.
4. Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education.
5. Industrial Automation: W.P. David, John Wiley and Sons

Reference Books:-

1. Richard D. Klafter , Thomas A. Chmielewski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 02.
2. Handbook of design, manufacturing & Automation: R.C. Dorf, John Wiley and Sons.

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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEDO8013	Advanced Electric Drives	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	Exam.			

		Test 1	Test 2	Avg	Sem. Exam	Duration (in Hrs)			
EEDO8013	Advanced Electric Drives	20	20	20	80	03	--	-	100

Course Objectives	To impart the knowledge of 1. The advanced control techniques used in induction motor (IM) drives 2. The control of Sinusoidal Surface Permanent Magnet (SPM) synchronous machine (PMSM) drives
Course outcomes	Upon successful completion of this course, the learner will be able to: 1. To select suitable V/f control scheme of IM based on the application. 2. To illustrate vector control and indirect vector control of IM. 3. To explain how to achieve sensorless vector control of IM. 4. To discuss various adaptive control schemes used in IM drives 5. To analyze direct torque control (DTC) used in induction motor drives. 6. To describe the speed control schemes used in PMSM drives

Module	Contents	Hours
1.	Introduction: Variable frequency operation of three phase symmetrical induction machine, Scalar control methods – Voltage fed inverter control: Open loop V/f control; Closed loop V/f control with slip regulation; Closed loop V/f control with torque and flux control, Current controlled voltage fed inverter drive, Current fed inverter drive with speed and flux control, Efficiency optimization control by flux program.	08
2.	Vector control of Induction Motor (IM): Introduction, Direct or feedback vector control, Flux vector estimation – Voltage model and current model, Indirect or feed forward vector control, Slip gain tuning, Stator flux oriented vector control.	10
3.	Sensorless vector control of IM: Slip calculation, Direct synthesis from state equations, Model Referencing Adaptive System (MRAS), Speed adaptive flux observer, Extended Kalman filter.	05
4.	Adaptive control of IM: Self tuning control, MRAC, Sliding mode control, Fuzzy control, Neural control.	05
5.	Direct Torque and Flux Control of IM: Conventional Direct torque and flux control (direct torque control (DTC)) of IM using switching table of inverter voltage vectors.	05
6.	Synchronous Motor Drives: Sinusoidal SPM Machine Drives: V/Hz control, self-control, Vector control.	06

Text Books:-

1. Modern Power Electronics and A.C. Drivell, B. K. Bose, PHI.
2. Electric Motor Drives: Modeling, Analysis and Controlll, R.Krishnan,.PHI
3. Control of Electrical drivesll, W. Leonhard, Springer-Verlag,

Reference Books:-

1. Power Semiconductor Controlled Drives, G. K. Dubey, Prentice-Hall International.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

2. Fundamentals of Electrical Drives, G. K. Dubey, Narosa Publishing House.
3. Analysis of Electric Machinery, P.C. Krause, McGraw Hill, New York

Website Reference/ Video Courses:

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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEDO8014	High Power Switching Converters	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					
EEDO8014	High Power Switching Converters	20	20	20	80	03	--	-	100

Course Objectives	1. To understand and select high power devices, gain knowledge about power modules, suitable packaging and latest market trends. 2. To understand and analyse high power converters and the protection needed for the converters. 3. To keep abreast with the latest technologies and research going on in different areas related to high power converters. 4. To enhance the knowledge of practical aspects in the design of Power Converters. 5. To deliver technological solution in the field of power electronics.
Course outcomes	Upon successful completion of this course, the learner will be able to 1. Analyze and understand high power devices and practical issues in implementing high power converters. 2. Understand protection aspects and design considerations to build proper power electronics systems. 3. Design closed loop control and discretize controllers for using digital control methods. 4. Analyze and design converters in the fields of drives, power generation and energy conversion, industrial applications, extraction of energy from renewable sources

Module	Contents	Hours
1.	High power switching devices: Review of high power devices - diodes, SCRs, GTOs and IGBTs-ratings and switching characteristics, view of power device market trend, series connected devices, voltage equalization techniques-static and dynamic, constraints in paralleling IGBTs, intelligent power modules, packages for high power devices, wide band gap devices.	04
2.	High power converters and Protection: Multi pulse controlled rectifiers-12 pulse, introduction to higher pulse controlled rectifiers, Cascaded H bridge multilevel inverters, Modular Multi level converters, Practical Aspects in Building Three-Phase Power Converters- Motor drives, Grid applications, Protection aspects-Over current, Over voltage, temperature, snubber design-component selection, basics of resonant snubber and regenerative snubber, numerical.	10
3.	Design considerations: Electrical specifications, Mechanical specifications, Environmental specifications, EMI/EMC specifications, Hardware specifications, Thermal Management, Selection of switching frequency, Selection of switching device and topology, control and isolation, cost.	06

4.	Closed-Loop control: Analog PWM controllers, Digital control-advantages, Signal conditioning and sampling, digital implementation of PWM modulator-single update and double update mode, PI & PR controller discretization, effect of computational delay, Processors in converter control, Grid synchronization techniques, introduction to non-linear control methods.	08
5.	High power AC drives: Line side requirements, motor side challenges, switching device constraints, converter configurations, control aspects, case studies of drive application.	05
6.	Grid interfaced converters: Requirements and challenges, high power grid interfaced converters, current control, voltage control, grid synchronization, filter design, dc link voltage control, case studies on grid interfacing of renewable energy sources.	06

Text Books:-

1. Dorin O. Neacsu, "Switching Power Converters, Medium and High Power", CRC press, Taylor & Francis group, second edition, 2017.
2. Bin Wu, "High Power Converters and AC drives", IEEE press, John Wiley & Sons.
3. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
4. Simon Ang, Alejandro Oliva, "Power-Switching Converters", Taylor and Francis group.
5. A Yazdani, R. Iravani, "Voltage- Sourced Converters in Power Systems", Wiley, IEEE press.
6. B. Jayant Baliga, "Silicon Carbide Power Devices", World Scientific, 2005.

Reference Books:-

1. R. Teodoresco, M. Liserrie, P. Rodríguez "Grid Converters for Photovoltaic and Wind Power Systems", John Wiley and Sons.
2. L. Umanad, "Power Electronics: Essentials & Applications", Wiley.
3. V. Ramanarayanan, "Course Material on Switched Mode Power Conversion", 2007.
4. M. Jamil, M. Rizwan, D.P Kothari, "Grid Integration of Solar Photovoltaic Systems", CRC press, Taylor & Francis.
5. Peter Friedrichs, T. Kimoto, L. Ley and G. Pensl, "Silicon Carbide, Volume 2: Power Devices and Sensors", Wiley Publications, 2011.

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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEDO8021	Power System Planning and Reliability	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					
EEDO8021	Power System Planning and Reliability	20	20	20	80	03	--	-	100

Course Objectives	Student shall be able 1. To use reliability theory as a tool for decision support for design, operation and planning of electric power system. 2. To familiarize the students with various aspects of probability theory. 3. To acquaint the students with reliability and its concepts. 4. To introduce the students to methods of estimating the system reliability of simple and complex systems.
Course outcomes	Upon successful completion of this course, the learner will be able to 1. To explain the basic modelling of power system components for reliability evaluation and planning. 2. To describe load forecasting models for short-term and long-term power system planning. 3. To describe the methodologies to solve generation system reliability calculation and generation planning. 4. To describe how to calculate reliability indices for combined generation and transmission systems. 5. To carry out planning and reliability for distribution system.

Module	Contents	Hours
1.	Power System Planning and Load Forecasting: Objectives of power system planning, Short term, medium term and long term planning; Classification and characteristics of loads, Load forecasting methods: Extrapolation, Co Relation Techniques; Energy forecasting, Weather load model, Peak load forecasting	08
2.	Basic Concepts of Reliability: Failure analysis and Reliability parameters, Hazard models and Bath-tub curve, Series and Parallel Systems, Continuous Markov process, Frequency and Duration approach	08
3.	Generation Planning and Reliability: Generation system model, Capacity Outage Probability Table, Recursive algorithm for systems including derated states, Evaluation of Loss of Load Expectation, Evaluation of Loss of Energy Expectation	08
4.	Composite Generation and Transmission Systems: Radial configurations, Conditional probability approach, Network configurations System and load point indices, Application to practical systems	06
5.	Distribution Planning and Reliability: Evaluation techniques, Additional interruption indices, Application to radial systems	06
6.	Impact of Renewable Energy penetration: Impact analysis of high renewable energy penetration on stability and reliability of power system. Case studies based on Solar PV and Wind generation loss.	05

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

Text / Reference Books:-

1. Power System Planning - R.N. Sullivan, Tata McGraw Hill Publishing Company Ltd. 2. Modern Power System Planning - X. Wang & J.R. McDonald, McGraw Hill Book Company. 3. Electrical Power Distribution A.S. Pabla Tata McGraw Hill Publishing Company Ltd. 4. Reliability Evaluation of Engineering System - Roy Billinton & Ronald N. Allan, Springer Publication. 5. Reliability Evaluation of Power System - Roy Billinton & Ronald N. Allan, Springer Publication. 6. Electrical Power Distribution Engineering - T. Gonen, McGraw Hill Book Company.

Website Reference/ Video Courses:

1. **NPTEL Course:** Operation and Planning of Power Distribution Systems By Prof. Sanjib Ganguly, IIT Guwahati

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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEDO8022	Lighting System 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					
EEDO8022	Lighting System Design	20	20	20	80	03	--	-	100

Course Objectives	1. To introduce various laws of illumination, lighting parameters, light sources, luminaries and their characteristics to be used for lighting design. 2. To introduce lighting design considerations for interior and exterior applications. 3. To adapt to the LED based solid state lighting with different lighting control technologies and standards.
Course outcomes	Upon successful completion of this course, the learner will be able to: 1. Identify and describe the various laws of illumination, lighting parameters, light sources, luminaries and their Photometric characteristics. 2. Identify and describe various LED lighting components / subsystems, thermal management and lifetime studies. 3. Formulate and design an Interior Lighting system through standards, design considerations and calculation for different application areas. 4. Formulate and design an Exterior Lighting system through standards, design considerations and calculation for different application areas. 5. Identify and describe different Lighting Control schemes. 6. Identify and describe Solid-State Lighting technology, it's applications in Lighting for health and safety and solar powered schemes.

Module	Contents	Hours
1.	Introduction: Review of Light, Color and Photometry: Laws of illumination, illumination entities. Radiometric and photometric standards, Photometric measurement procedure assessment of lamp efficacy, Color temperature, Colorimetry- Measurement of CRI, Glare, Solid-State Lighting: Drivers for LED lamps, standards and regulations, LED luminaries, LED Light Distributions,	04
2.	Lamps and Luminaries: Lamp: Review of development, construction and characteristics: Incandescent lamp, Discharge lamps, induction lamp, and LED lamp; LED Lighting Components and Subsystems, OLEDs, light-emitting polymers (LEPs) Thermal Management and Lifetime Studies; Luminaire: optical control, Control gear: ballast, standard and electronic, Luminaries photometry, Luminaire testing procedures	08
3.	Interior Lighting Design & Calculation: Objectives, quality and quantity of lighting. Lamp /Luminaire selection and placement, design considerations and calculation. Glare Consideration and control. Indoor lighting design by lumen method, by point by point method. Applications: residential, educational institute, industries, sports centers, commercial premises: retail stores, offices etc. Applicable standards.	12
4.	Exterior Lighting Design & Calculation: Exterior lighting system- Road lighting system, Utility area lighting, Sports lighting, Decorative flood lighting. Applicable standards	06

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

5.	Lighting Control: Introduction to Lighting Control, Controls, Selection of Lighting Controls, Design of Lighting Control Scheme, Lighting and LEED, Daylighting control, Controlling LED Lighting Systems, Smart Lighting Fixtures, Digital Lighting Networks, DMX control.	04
----	---	----

6.	Recent trends in Lighting: Smart Street Lighting with Remote Monitoring and Control System, Solar Powered LED Lighting, Tunable White Lighting and RGB LED based Colored Lighting. Lighting for health and safety, Circadian Rhythm and Human Centric Lighting. DC Microgrid based Lighting System	05
----	---	----

Text Books:-

1. Anil Valia, Designing with Light – A Lighting Handbook, International Lighting Academy
2. M. Nisa Khan, Understanding LED Illumination, CRC Press 2013
3. Anil Valia, LED LIGHTING SYSTEMS All you need to know, International Lighting Academy
4. National Lighting Code- 2011
5. Kao Chen, Energy Management in Illumination Systems, CRC Press.
6. John L. Fettes, The Hand Book of Lighting Surveys and Audits, CRC Press.

Reference Books:-

1. Illuminating Engineering Society, —The IES Lighting Handbook, 10th Edition
2. J. L. Lindsey and S. C. Dunning, —Applied Illumination Engineering, Third Edition, Fairmont Press, 2016
3. Lamps and Lighting – Edited by J.R. Coaton and A.M. Marsden, 4th Edition
4. Lighting for health and safety – N.A. Smith, Butterworth-Heimann.
5. Human Factors in Lighting – Peter R. Boyce, Taylor & Francis.

Website Reference/ Video Courses:

1. **NPTEL Course:** Illumination Engineering, Prof. N.K. Kishore, 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEDO8023	Cyber Physical 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					
EEDO8023	Cyber Physical Systems	20	20	20	80	03	--	-	100

Course Objectives	1. To understand design, and analysis of cyber-physical systems - the tight integration of computing, control, and communication. 2. To explore various applications for CPS like in smart-grids, smart buildings, electric vehicle systems etc.
Course outcomes	Upon successful completion of this course, the learner will be able to: 1. Understand the Cyber-Physical Systems in the real world with hardware and software platforms. 2. Illustrate various automated control design aspects 3. Describe various methods of safety assurance in CPS 4. Correlate the safety aspects and attack related issues in CPS 5. Illustrate the impact of attack and defense against on CPS deployment in the fields like smartgrid, vehicular systems etc.

Module	Contents	Hours
1.	Introduction: Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS; CPS HW platforms: Processors, Sensors, Actuators, CPS Network, CPS SW stack RTOS, Scheduling Real Time control tasks.	06
2.	CPS Hardware platforms: Embedded systems, Hybrid systems, Control theory and systems, Computer-aided verification and synthesis, Complex networks, Programming models, Application areas: Transportation, medical devices, aerospace	08
3.	CPS software components: Mapping software components to ECUs, CPS Performance Analysis: effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion	06
4.	Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques. Stability Analysis: CLFs, MLFs, stability under slow switching, Performance under Packet drop and	06

	Noise.	
5.	Methods for Safety Assurance of Cyber-Physical Systems: Advanced Automata based modelling and analysis: Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, zenoness, Formal Analysis: Flow pipe construction, reachability analysis, Analysis of CPS Software, Weakest Pre-conditions, Bounded Model checking	08
6.	Secure Deployment of CPS: Attack models, Secure Task mapping and Partitioning, State estimation for attack detection; Case study: Vehicle ABS hacking, Power Distribution; Case study: Attacks on Smart grid.	05

Text Books:-

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

1. Lee, Edward Ashford, and Sanjit Arunkumar Seshia, Introduction to embedded systems: A Cyber-physical systems Approach, Lee & Seshia, 2011.
2. Alur, Rajeev, Principles of Cyber-Physical Systems, MIT Press, 2015.\
3. Raj Rajkumar, Dionisio de Niz and Mark Klein, Cyber-Physical Systems, Addison Wisley, 2017
4. Wolf, Marilyn. High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing. Elsevier, 2014.
5. T. D. Lewis "Network Science: Theory and Applications", Wiley, 2009.
6. P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer-Verlag 2009.
7. C. Cassandras, S. Lafortune, "Introduction to Discrete Event Systems", Springer 2007.
8. Constance Heitmeyer and Dino Mandrioli, "Formal methods for real-time computing", Wiley publisher, 1996

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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits assigned		
EEDO8024	Electric Vehicle System 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					
EEDO8024	Electric Vehicle System Design	20	20	20	80	03	--	-	100

Course Objectives	1. To illustrate the design philosophies used in the EV domain. 2. To explore the selection of power and control architecture of EV drives 3. To study the design aspects of EV battery packs and other auxiliary systems
Course outcomes	Upon successful completion of this course, the learner will be able to 1. To select and size the electric motor for a particular EV application and performance criteria 2. To select and size the battery pack to meet desired EV performance and 3. To design the EV drive system with functional safety considerations. 4. To illustrate the use of hybrid energy source for EV performance improvement 5. To illustrate the design aspects of Automotive Subsystem 6. To design the EV chargers and charging infrastructure

Module	Contents	Hours
1.	Selection and Sizing of EV Electric Motors: Electric Vehicle modelling, Tractive force calculations, Design considerations for 2W and 4W EVs; Torque, power and Speed requirement, Traction Limit, Maximum Acceleration Limit, Maximum Grade Limit. Vehicle Power Demand during Driving Cycles. Application Examples of EV /HEV motors with vehicles and motor specifications.	07
2.	Selection and Sizing of Energy Storage for EV: Selection of type of Battery pack for 2W and 4W EVs; Battery pack sizing: Design considerations: Range per charge, range anxiety, EV motor power requirement; Impact of road conditions, environmental conditions and traffic conditions. Selection and sizing of Fuel cell for FCEV, design considerations; Battery-ultra-capacitor hybrid combination sizing, performance analysis.	08
3.	Automotive Subsystem Design: Electronic Control Unit (ECU) and its Control Features, Communications between ECUs. Acceleration and braking control, regenerative braking; Automotive Steering Systems. Design considerations of HVAC controller	06
4.	EV System integration: EMC design on ECU level, EMC design on system level and in special subsystems, Radiated emissions and Conducted emissions, EMI EMC measurements.	04
5.	Design of EV Chargers: Design considerations for AC charger: vehicle interface and charging protocol design. applicable charging standards Design of On-Board Charger (OBC)-Schematic, power topology and control, Power capacities. Design considerations of DC fast charger: vehicle interface and charging protocol design. Connectivity and applicable charging standards	08
6.	Functional Safety of Automotive Electronics:	06

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

	Functional Safety requirements of Automotive Electronics; ASIL identification and safety goal finalization, ISO 26262. Energy Storage integrity / protection: rupture and toxic gas management; low energy stranding, Unintended vehicle movement, shock protection, and Elimination of potential thermal/ explosive event.	
--	--	--

Text / Reference Books:-

1. Design and Control of Automotive Propulsion Systems by Zongxuan Sun and Guoming Zhu, CRC Press, 2015
2. Electric Vehicle Machines and Drives Design, Analysis and Application by K. T. Chau, IEEE Press and Wiley, 2015
3. I. Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4. M. Ehsani, Y. Gao, S.E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press. 2005
5. Sheldon Williamsom, Energy Management Strategies for Electric and Plug-in Hybrid Vehicles, Springer 2013
6. J. Larminie and J. Lowry, Electric Vehicle Technology Explained, Wiley, 2003
7. EMC and Functional Safety of Automotive Electronics by Kai Borgeest, IET, 2018

Website Reference/ Video Courses:

1. NPTEL Web Course: Electric Vehicles - Part 1 by Prof. Amit Kumar Jain D IIT Delhi
2. NPTEL Web Course: Fundamentals of Electric vehicles: Technology & Economics, by Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha and Prof. L Kannan, IIT Madras,
3. NPTEL Web Course: Introduction to Hybrid and Electric Vehicles by Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati
4. Infineon's IGBT Simulation Tools:
<https://www.infineon.com/cms/en/tools/landing/igbt.html>
5. Semikron Semisel:
<https://www.semikron.com/service-support/semisel-simulation.html>

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.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII			
Course Code	Course Name	Teaching scheme (Contact Hours)	Credits Assigned

EEIO8021	Project 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					
EEIO8021	Project Management	20	20	20	80	3	--	--	100

Course Objectives	1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques. 2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1. Apply selection criteria and select an appropriate project from different options. 2. Write work break down structure for a project and develop a schedule based on it. 3. Identify opportunities and threats to the project and decide an approach to deal with them strategically. 4. Use Earned value technique and determine & predict status of the project. 5. Capture lessons learned during project phases and document them for future reference

Module	Contents	Hours
1	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	05
2	Initiating Projects: How to get a project started, selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	06
3	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface; Coordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM,	08

	GANTT chart, Introduction to Project Management Information System (PMIS).	
4	Planning Projects: Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	06

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

5	5.1 Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings 5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit 5.3 Project Contracting Project procurement management, contracting and outsourcing,	08
6	6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects 6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	06

References:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

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**

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO8022	Finance 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					
EEIO8022	Finance Management	20	20	20	80	3	--	--	100

Course Objectives	1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques. 2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1 Understand Indian finance system and corporate finance 2 Take investment, finance as well as dividend decisions

Module	Contents	Hours
--------	----------	-------

1	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System. Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
2	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
3	Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

4	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
5	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
6	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.

2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO8023	Entrepreneurship Development 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					
EEIO8023	Entrepreneurship	20	20	20	80	3	--	--	100

	Development and Management								
--	-----------------------------------	--	--	--	--	--	--	--	--

Course Objectives	1 To acquaint with entrepreneurship and management of business 2 Understand Indian environment for entrepreneurship 3 Idea of EDP, MSME
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1 Understand the concept of business plan and ownerships 2 Interpret key regulations and legal aspects of entrepreneurship in India 3 Understand government policies for entrepreneurs

Module	Contents	Hours
1	Overview of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
2	Business Plans and Importance of Capital to Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship and Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
3	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
4	Indian Environment for Entrepreneurship: key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc.	08
5	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08

6	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05
---	--	----

References:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.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.**

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO8024	Human Resource 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					
EEIO8024	Human Resource Management	20	20	20	80	3	--	--	100

Course Objectives	1 To introduce the students with basic concepts, techniques and practices of the human resource management 2 To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations 3 To familiarize the students about the latest developments, trends & different aspects of HRM 4 To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers
-------------------	--

Course Outcomes	Upon successful completion of this course, the learner will be able to: 1 Understand the concepts, aspects, techniques and practices of the human resource management. 2 Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective. 3 Gain knowledge about the latest developments and trends in HRM. 4 Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.
-----------------	--

Module	Contents	Hours
1	Introduction to HR • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	05
2	Organizational Behaviour (OB) • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	07

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

3	Organizational Structure & Design • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	06
4	Human resource Planning • Recruitment and Selection process, Job-enrichment, Empowerment – Job Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning Training & Development: Identification of Training Needs, Training Methods	05

5	Emerging Trends in HR - Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment - Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	06
6	HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries) Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, 2016, Pearson Publications

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)

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

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

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO8025	Professional Ethics and Corporate Social	Theor y	Pract./Tut.	Theory	Pract./Tut.	Total

	Responsibility (CSR)	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					
EEIO8025	Professional Ethics and Corporate Social Responsibility (CSR)	20	20	20	80	3	--	--	100

Course Objectives	1 To understand professional ethics in business 2 To recognized corporate social responsibility
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1 Understand rights and duties of business 2 Distinguish different aspects of corporate social responsibility 3 Demonstrate professional ethics 4 Understand legal aspects of corporate social responsibility

Module	Contents	Hours
1	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
2	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
3	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
4	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05

5	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
6	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO8026	Research Methodology	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					
EEIO8026	Research Methodology	20	20	20	80	3	--	--	100

Course Objectives	1 To understand Research and Research Process 2 To acquaint students with identifying problems for research and develop research strategies 3 To familiarize students with the techniques of data collection, analysis of data and interpretation
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1 Prepare a preliminary research design for projects in their subject matter areas 2 Accurately collect, analyze and report data 3 Present complex data or situations clearly 4 Review and analyze research findings

Module	Contents	Hours
1	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
2	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
3	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

4	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	08
---	---	----

5	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
6	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	04

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO8027	IPR and Patenting	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					
EEIO8027	IPR and Patenting	20	20	20	80	3	--	--	100

Course Objectives	1 To understand intellectual property rights protection system 2 To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures 3 To get acquaintance with Patent search and patent filing procedure and applications
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1 understand Intellectual Property assets 2 assist individuals and organizations in capacity building 3 work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Contents	Hours
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non patentable inventions, Types of patent applications (e.g. Patent of addition etc.), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08

06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07
----	---	----

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO8028	Digital Business 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					
EEIO8028	Digital Business Management	20	20	20	80	3	--	--	100

Course Objectives	1 To familiarize with digital business concept 2 To acquaint with E-commerce 3 To give insights into E-business and its strategies
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1 Identify drivers of digital business 2 Illustrate various approaches and techniques for E-business and management 3 Prepare E-business plan

Module	Content	Hours
1	Introduction to Digital Business Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts, Difference between physical economy and digital economy. Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services), Opportunities and Challenges in Digital Business	09

2	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and infrastructure	06
4	Managing E-Business- Managing Knowledge, Management skills for e-business, managing Risks in e –business, Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

5	E-Business Strategy- E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization-Business plan preparation Case Studies and presentations	08

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

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**.

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEIO8029	Environmental 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					
EEIO8029	Environmental Management	20	20	20	80	3	--	--	100

Course Objectives	1 Understand and identify environmental issues relevant to India and global concerns 2 Learn concepts of ecology 3 Familiarise environment related legislations
Course Outcomes	Upon successful completion of this course, the learner will be able to: 1 Understand the concept of environmental management 2 Understand ecosystem and interdependence, food chain etc. 3 Understand and interpret environment related legislations

Module	Contents	Hours
1	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
2	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
3	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
4	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
5	Total Quality Environmental Management, ISO-14000, EMS certification.	05
6	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, **T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

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.**

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEL801	Electrical System Design	Theory	Pract./Tut.	Theory	Pract./Tut.	Total

	and Audit Lab	--	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					
EEL801	Electrical System Design and Audit Lab	---	---	---	---	--	25	25	50

Course Objectives	To explore the effectiveness of various energy efficient technologies from design and utilization perspective.
Course outcomes	Upon successful completion of this course, the learner will be able: 1. Prepare the SLD for electrical system 2. Evaluate the energy efficiency of the electrical systems 3. Size and select the cable for electrical distribution network 4. Analyse the impact of various energy efficient technologies 5. Illustrate the impact of fuel substitution on energy consumption 6. Design energy efficient electrical system

Syllabus: Same as that of Courses of Sem-VIII EEC801: Electrical System Design, Management and Auditing

Suggested List of Tutorials/Case Studies/ Experiments

- 1) Tutorial on developing of Single line diagram of your own house
- 2) Tutorial on illumination system for the given installation
- 3) Tutorial on EELD (Energy Efficient Lighting Design) in comparison to Standard lighting design in terms of LPD
- 4) Tutorial on designing of power distribution network for a given installation
- 5) Tutorial on sizing and selection of Cables for electrical distribution network
- 6) Tutorial Motor retrofitting by Energy Efficient Motor
- 7) Tutorial on CUSUM analysis of a given installation
- 8) Case Study on analysing the effectiveness of power factor improvement towards improving energy efficiency
- 9) Case Study on analysing effectiveness of VFD in comparison to Damper control
- 10) Case study on fuel substitution
- 11) Experimentation to analyse energy efficiency of VFD based Pumping System
- 12) Experimentation to analyse energy efficiency of different lamps (T5, T8, CFL, and LED lamp)
- 13) Experimentation to analyse the effectiveness of power factor improvement based installation
- 14) Conduction of preliminary audit of any section / facility/ department of engineering institute or nearby industry
- 15) Conduction of detailed audit of any section / facility/ department of engineering institute or nearby industry

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

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

Term work:

Term work shall consist of minimum eight tutorials /case studies/ 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 entire syllabus of 'EEC801: Electrical System Design, Management and Auditing' and EEL801

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VII						
Course code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEL802	Measurement and Instrumentation Lab	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		--	2		1	1

Course code	Course Name	Examination Scheme			
		Theory	Term	Oral	Total

		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)	Work		
		Test 1	Test 2	Avg					
EEL802	Measurement and Instrumentation Lab	---	---	---	---	--	25	25	50

Course Objectives	1. To get acquainted with analog and digital measurement and instrumentation 2. To illustrate the challenges in real time measurements
Course outcomes	Upon successful completion of this course, the learner will be able to 5. Understand the construction, principle and characteristics of different types of digital measuring instruments 6. Apply the knowledge about different instruments and can identify the best suitable instrument for a required typical measurement. 7. Learn about the digital programming of different types of circuits. 8. Understand the conversion of digital to analog signal and vice versa.

Suggested list of experiments:

1. Experiment demonstrating concepts relating to Measurements: True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity.
2. Experiment demonstrating errors in measurements.
3. Measurements of R, L and C using bridge or LCR meter
4. Measurement of very low and high resistance
5. Experiment with Sensors and Transducers for physical parameters: temperature, pressure, torque, flow. Speed and Position Sensors.
6. Measurement of Current and Voltage Measurements. Shunts, Potential Dividers. Instrument Transformers, Hall Sensors.
7. Measurement of high voltage /current
8. Isolated and un-isolated measurement
9. Use of Digital Multi-meter, True RMS meters, Clamp-on meters, Meggers.
10. Use of DSO to capture transients like a step change in R-L-C circuit.
11. Usage of DSO for steady state periodic waveforms produced by a function generator. Selection of trigger source and trigger level, selection of time-scale and voltage scale. Bandwidth of measurement and sampling rate.
12. Download of one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
13. Analog Signal processing and Digital Signal Processing
14. Measurement and instrumentation using microcontroller boards like Arduino/pic18F/ MSP430

Any other experiment related to measurement and instrumentation can be conducted.

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>

Reference books:

1. Alan S Morris (2001), Measurement and Instrumentation Principles, 3rd/e, Butterworth Hienemann
2. David A. Bell (2007), Electronic Instrumentation and Measurements 2nd/e, Oxford Press
3. S. Tumanski (2006), Principle of Electrical Measurement, Taylor & Francis
4. Ilya Gertsbakh (2010), Measurement Theory for Engineers, Springer

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 **EEL802- Measurement and Instrumentation Lab**

University of Mumbai, Electrical Engineering, Rev. 2019 'C' Scheme

ELECTRICAL ENGINEERING - SEMESTER-VIII						
Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
EEP801	Major Project - II	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		--	12 ^{\$}	--	6	6

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					
EEP801	Major Project - II	--	--	--	--	--	100	50	150

\$ indicates work load of Learner (Not Faculty)

Course Objectives	5. To design and develop a moderately complex electrical/electronic/digital circuit with practical applications. 6. To understand basic concepts of circuit design while developing the project. 7. 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.
Course Outcomes	Upon successful completion of this course, the learner will be able to: 10. Identify problems based on societal /research needs. 11. Apply Knowledge and skill to solve societal problems in a group. 12. Develop interpersonal skills to work as member of a group or leader. 13. Draw the proper inferences from available results through theoretical/ experimental/ simulations. 14. Analyse the impact of solutions in societal and environmental context for sustainable development. 15. Use standard norms of engineering practices 16. Excel in written and oral communication. 17. Demonstrate capabilities of self-learning in a group, which leads to life-long learning. 18. Demonstrate project management principles during project work
<u>Guidelines for Assessment of Major Project- II:</u> 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 : 40 ○ Marks awarded by review committee : 40 ○ Quality of Project report : 20 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: <u>Assessment criteria of Major Project-II.</u> Major Project shall be assessed based on following criteria;	

13. Quality of literature survey/ need identification
14. Clarity of Problem definition based on need.
15. Innovativeness in solutions
16. Feasibility of proposed problem solutions and selection of best solution
17. Cost effectiveness
18. Societal impact
19. Innovativeness
20. Cost effectiveness
21. Effective use of skill sets
22. Effective use of standard engineering norms
23. Contribution of an individual's as member or leader
24. Clarity in written communication

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

Oral Examination:

Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai. Students should be motivated to publish a paper in Conferences/students competitions based on the work.

Major Project II shall be assessed based on following points:

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

