University of Mumbai

No. AAMS(UG)/20 of 2022-23

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/47 of 2021 dated 21st January, 2021 relating to the Scheme (Sem. III to VIII) and revised syllabus (Rev-2019 'C' Scheme) for the B.E. in Electrical Engineering (Sem. III & IV).

They are hereby informed that the recommendations made by the Board of Studies in Electrical Engineering at its meeting held on 13th November, 2021 and subsequently passed by the Board of Deans at its meeting held on 27th December 2021 vide item No. 6.12 have been accepted by the Academic Council at its meeting held on 28th December, 2021 **vide** item No. 6.12 and that in accordance therewith, the reduced syllabus for B.E. (Electrical Engineering) (Rev-2019 'C' Scheme) for Direct Second Year (Sem.III) as Direct Second Year (DSE) students admission is delayed by the six months due to COVID-19 situation, has been brought into force with effect from the academic year 2021-22 only. (The same is available on the University's website www.mu.ac.in).

(Sudhir S. Puranik)
REGISTRAR

MUMBAI – 400 032
4th May, 2022

To

The Principals of the Affiliated Colleges, and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.12/28/12/2021

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No. AAMS(UG)/20 -A of 2022-23 4th May, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies Electrical Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Sudhir S. Puranik)
REGISTRAR

Copy for information and necessary action :-

1. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
2. **College Teachers Approval Unit (CTA),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA)**
5. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
6. **The Deputy Registrar, Executive Authorities Section (EA)**
   He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
7. **The Deputy Registrar, PRO, Fort, (Publication Section),**
8. **The Deputy Registrar, Special Cell,**
9. **The Deputy Registrar, Fort Administration Department (FAD) Record Section,**
10. **The Deputy Registrar, Vidyanagari Administration Department (VAD),**

Copy for information :-

1. **The Director, Dept. of Information and Communication Technology (DICT), Vidyanagari,**
   He is requested to upload the Circular University Website
2. **The Director of Department of Student Development (DSD),**
3. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**
4. **All Deputy Registrar, Examination House,**
5. **The Deputy Registrars, Finance & Accounts Section,**
6. **The Assistant Registrar, Administrative sub-Campus Thane,**
7. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
8. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
9. **P.A to Hon'ble Vice-Chancellor,**
10. **P.A to Pro-Vice-Chancellor,**
11. **P.A to Registrar,**
12. **P.A to All Deans of all Faculties,**
13. **P.A to Finance & Account Officers, (F & A.O),**
14. **P.A to Director, Board of Examinations and Evaluation,**
15. **P.A to Director, Innovation, Incubation and Linkages,**
16. **P.A to Director, Department of Lifelong Learning and Extension (DLLE),**
17. **The Receptionist,**
18. **The Telephone Operator,**

Copy with compliments for information to :-

19. **The Secretary, MUASA**
20. **The Secretary, BUCTU.**

AC – 28/12/2021
Item No. - 6.12

UNIVERSITY OF MUMBAI

Bachelor of Engineering
(Electrical Engineering)

Direct Second Year (Sem. III) Admitted Students for the current Academic Year 2021-22 Only due to Covid Pandemic

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

Under
FACULTY OF SCIENCE & TECHNOLOGY

Program Structure for Second Year Engineering
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
EEC301	Engineering Mathematics-III	3	--	1	3	--	1	4
EEC302	Electrical Circuit Analysis	3		--	3		--	3
EEC303	Fundamentals of Electrical Machines & Measurements	4	--	--	4	--	--	4
EEC304	Electrical Power System I	3	--	--	3	--	--	3
EEC305	Analog Electronics	3	--	--	3	--	--	3
EEL301	Electrical Machines & Measurements Lab	--	2	--	--	1	--	1
EEL302	Electronics Lab-I	--	2	--	--	1	--	1
EEL303	Simulation Lab-I	--	2	--	--	1	--	1
EEL304	SBL-I: Applied Electrical Engineering Lab	--	4	--	--	2	--	2
EEM301	Mini Project – 1A	--	4$	--	--	2	--	2
Total		**16**	**14**	**1**	**16**	**07**	**1**	**24**

Examination Scheme

Course Code	Course Name	Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test I	Test II	Avg					
EEC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
EEC302	Electrical Circuit Analysis	20	20	20	80	3	--	--	100
EEC303	Fundamentals of Electrical Machines & Measurements	20	20	20	80	3	--	--	100
EEC304	Electrical Power System-I	20	20	20	80	3	--	--	100
EEC305	Analog Electronics	20	20	20	80	3	--	--	100
EEL301	Electrical Machines & Measurements Lab	--	--	--	--	--	25	25	50
EEL302	Electronics Lab-I	--	--	--	--	--	25	25	50
EEL303	Simulation Lab-I	--	--	--	--	--	25	25	50
EEL304	SBL-I: Applied Electrical Engineering Lab	--	--	--	--	--	50	--	50
EEM301	Mini Project – 1A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**100**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project

Semester-III								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEC301	**Engineering Mathematics-III**	**03**	**-**	**01**	**03**	**-**	**01**	**04**

Examination Scheme								
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**25**	**-**	**-**	**125**

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Scalar and Vector Product: Scalar and vector product of three and four vectors.

Course Objectives	**The course is aimed:** 1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, and its applications. 2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills 3. To familiarize the concept of complex variables, C-R equations, harmonic functions, its conjugate and mapping in complex plane. 4. To understand the basics of Linear Algebra and its applications 5. To use concepts of vector calculus to analyze and model engineering problems.
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Apply the concept of Laplace transform to solve the real integrals in engineering problems. 2. Apply the concept of inverse Laplace transform of various functions in engineering problems. 3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems. 4. Find orthogonal trajectories and analytic function by using basic concepts of complex variables. 5. Illustrate the use of matrix algebra to solve the engineering problems. 6. Apply the concepts of vector calculus in real life problems.

Module	Detailed Contents	Hours
1.	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform. 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	**07**

2.	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof). **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	**06**
3.	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.	**07**
4.	**Module: Complex Variables:** 4.1 Function $f(z)$ of complex variable, limit, continuity and differentiability of $f(z)$Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof). 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function $f(z)$when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.	**07**
5.	**Module: Linear Algebra: Matrix Theory** 5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors. (Without Proof). 5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley- Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix **Self-learning Topics:** Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices**.**	**06**
6.	**Module: Vector Differentiation and Integra**l 6.1 **Vector differentiation**: Basics of Gradient, Divergence and Curl (Without Proof) 6.2 **Properties of vector field:** Solenoidal and irrotational (conservative) vector fields 6.3 **Vector integral:** Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. **Self-learning Topics:** Gauss' divergence Theorem and applications of Vector calculus.	**06**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in

Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment-I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment-II) when additional 40% (approx.) syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References Books:

1. Advanced engineering mathematics, H.K. Das, S. Chand, Publications
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics, Wylie and Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

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Semester-III								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEC302	**Electrical Circuit Analysis**	**03**			**03**			**03**

Examination Scheme								
Theory					Term Work/Practical/Oral			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**-**	**-**	**-**	**100**

Course Objectives	**The course is aimed:** 1. To impart the knowledge of various fundamental electrical theorems for analysis of electrical circuits from application point of view. 2. To inculcate the problem solving and analysis skills in students.
Course Outcomes	**Upon successful completion of this course, the learner will be able to** 1. Apply network theorems for the analysis of electrical circuits. 2. Obtain the transient and steady-state response of electrical circuits. 3. Develop and analyse transfer function model of system using two port network parameters. 4. Analyse time domain behaviour from pole zero plot. 5. Analyse electrical network using graph theory. 6. Analyse the effect of switching conditions on electrical networks using differential equations and Laplace Theorem.

Module	Detailed Contents	Hours
1.	**First and Second Order Circuits:** Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.	**06**
2.	**Electrical Circuit Analysis Using Laplace Transforms:** The Laplace transform and its application in electrical circuit analysis, transient and steady state response to step, ramp and impulse signals.	**06**
3.	**Two port parameters:** Open circuit, short circuit, transmission and hybrid Parameters, relationships between parameter sets, reciprocity and symmetry conditions; **Self-learning Topics**: Parallel connection of two port networks, cascade connection of two-port networks.	**04**
4.	**Network Functions- Poles and Zeros:** Network functions for one port and two port networks, Driving point and transfer functions, poles and zeros of network functions, restrictions on Pole and zero locations for driving point functions and Transfer functions, time domain behavior from pole - zero plot. **Self-learning Topics**: Ladder network, General network.	**04**

Additional Self- learning Topics: Electrical Circuit Analysis-With DC Dependent Sources: Mesh analysis, Super mesh analysis, Nodal analysis, Super node analysis, Source transformation and Source shifting. Superposition theorem, Thevenin's theorems and Norton's theorem and Maximum power transfer theorem; **Graph Theory and Network Topology:** Introduction, Graph of network, Tree, Co-tree, Loop incidence matrix, Cut set matrix, Tie set matrix and Loop current matrix, Number of possible tree of a graph, Analysis of network equilibrium equation.

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment-TEST-I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment Test-II) when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Books Recommended:

Text Books:

1. W H Hayt, S M Durbin, J E Kemmerly, *Engineering Circuit Analysis,* Tata McGraw-Hill Education, 2013.
2. M. E. Van Valkenburg, *Network Analysis,* 3rd Edition, PHI Learning.
3. D. Roy Choudhury, *Networks and System,* 2nd Edition, New Age International.
4. M. E. Van Valkenburg, *Linear Circuits,* Prentice Hall.
5. C. K. Alexander and M. N. O. Sadiku, *Electric Circuits*, McGraw Hill Education, 2004.
6. K. V. V. Murthy and M. S. Kamath, *Basic Circuit Analysis*, Jaico Publishers, 1999

Reference Books:

1. F. F. Kuo, *Network Analysis and Synthesis*, John Wiley and sons.
2. N Balabanian and T.A. Bickart, *Linear Network Theory: Analysis, Properties, Design and Synthesis*, Matrix Publishers.
3. C. L.Wadhwa, *Network Analysis and Synthesis*, New Age International.
4. B. Somanathan Nair, *Network Analysis and Synthesis*, Elsevier Publications.

NPTEL/ Swayam Course:

1. **Course: Basic Electric Circuits By Prof. Ankush Sharma (IIT Kanpur); https://swayam.gov.in/nd1_noc19_ee36/preview**
2. **Course: Basic Electrical Circuits by Prof. Nagendra Krishnapura (IIT Madras) https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee64/**

Semester-III								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEC303	**Fundamentals of Electrical Machines & Measurements**	**04**	**-**	**-**	**04**	**-**	**-**	**04**

Examination Scheme								
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**-**	**-**	**-**	**100**

Course Objectives	**The course is aimed:** 1. To study the concepts of magnetism and energy conversion. 2. To familiarize with the operational characteristics of DC machines and their applications. 3. To learn the working principles of various analog and digital instruments & devices used for measurement of the various electrical and electronic parameters.
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Illustrate the principle of energy conversion in single and double excited machines. 2. Understand and analyze the significance of the DC machines performance parameters. 3. Implement various starting methods and speed control methods for DC machines applications 4. Evaluate the working of various sensors, transducers and analog / digital instruments used in electrical and electronic measurements. 5. Analyze the use and performance of bridges used in electrical and electronic measurements. 6. Illustrate the need for extension of range of meters and calibration in instruments.

Module	Detailed Contents	Hours
1	**Electromechanical Energy Conversion:** Principle, Energy stored in magnetic field, Field and co energy, Force and torque equations, Torque in singly and doubly excited systems, Magnetic field in rotating machines, Rotating MMF wave Leakage flux and magnetic saturation. **Self-learning Topics:** MMF in distributed windings Winding inductance	**06**
2	**DC Machines:** Review of construction and components of DC machine; Characteristics of DC generators and motors (speed – torque and performance); Braking methods, Losses and efficiency, Swinburne's, Hopkinson's and Retardation tests;	**05**
3	**Potentiometers, Bridges and Transducers:** **Potentiometers:** Basic potentiometer circuit; **Bridges:** Wheatstone, Kelvin's double bridge, Maxwell's bridge, Schering Bridge, Q meter. **Transducers:** Classification of transducers, Hall effect, Optical and digital transducers.	**05**

	Basic requirements of signal conditioning circuits. Amplifier, Filter, and linearization circuit. **Self-learning Topics:** Hay's bridge, Anderson's bridge, velocity, force and torque measurement.	
4	**Digital Measurements:** Advantages of digital meters over analog meters, Resolution & sensitivity of digital meters, Working principles of digital Voltmeter and Ammeter, Working principles and features of Digital Tachometer and Digital Megger **Self-learning Topics:** Multi-meter; Digital Storage Oscilloscope; Introduction to MEMS (micro-electromechanical systems) technology and their applications in electrical and automotive domain.	**06**

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment-I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment-II) when additional 40% (approx.) syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Books Recommended:

Text Books:

1. Bimbhra P. S., *Electric Machinery*, Khanna Publisher,
2. Bimbhra P. S., *Generalized Machine Theory*, Khanna Publisher,
3. S. K. Pillai, *A first course on Electrical Drives*, New Age Publication
4. V. K. Mehta, *Principles of Electrical Machines*, S Chand Publications
5. AK Sawhney, *Electrical & Electronic Measurements and Instrumentation*, Dhanpat Rai & Sons
6. Helfric and Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, PHI
7. H.S.Kalsi, *Electronic Instrumentation*, Third Edition, Tata McGraw Hill
8. Ramon Pallaá S-Areny and J. G. Webster, *Sensors And Signal Conditioning*, Second Edition, John Wiley & Sons, Inc.

Reference Books:

1. M. G. Say and E. O. Taylor, *Direct current machines*, Pitman publication
2. Ashfaq Husain, *Electric Machines*, Dhanpat Rai and Co. Publications
3. Alan.S.Moris, *Principle of Measurement & Instrumentation*, Prentice Hall of India
4. RS Sirohi & Radhakrisnan, *Electrical Measurement & Instrumentation*, New Age International
5. M. V. Deshpande, *Electric Machines*, PHI
6. Vedam Subramanyam, *Electrical Drive-concept and applications*, TMH Publication
7. Sabrie Soloman, *Sensors Handbook*, Second Edition, McGraw Hill

NPTEL/ Swayam Course:

Course: Electrical Machines – I By Prof. Tapas Kumar Bhattacharya (IIT Kharagpur)
https://swayam.gov.in/nd1_noc20_ee60/preview

Semester-III								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEC304	**Electrical Power System-I**	**03**	**-**	**-**	**03**	**-**	**-**	**03**

Examination Scheme								
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**-**	**-**	**-**	**100**

Course Objectives	**The course is aimed:** 1. To learn basics of electrical power systems and its different components. 2. To acquaint knowledge of transmission / distribution line and its parameters. 3. To learn representation and performance evaluation of power systems. 4. To understand electric cable and earthing
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Understand the power system and its components. 2. Categorize the ac transmission / distribution lines and understand the insulators. 3. Evaluate the parameters of different types of ac transmission / distribution lines. 4. Draw the PU reactance diagram of a power system for analysis. 5. Analyse the performance of transmission lines. 6. Study the performance parameters of electric cable and earthing.

Module	Detailed Contents	Hours
1	**Transmission / Distribution Systems and Line Parameters:** Definition of inductance, internal and external flux linkage of single conductor, inductance of single phase two wire line, inductance of three phase three wire line with symmetrical and unsymmetrical spacing, concept of GMR and GMD, inductance of three phase double circuit line, inductance of bundled conductor lines, Capacitance of transmission line, capacitance of single phase line, capacitance of three phase line with symmetrical and unsymmetrical spacing, effect of earth on transmission line capacitance (single phase only) **Self-learning Topics:** Basic structure of power system: generation, transmission and distribution; Types of AC Transmission / Distribution Lines**:** single phase two wire, three phase three wire (symmetrical and unsymmetrical spacing), three phase double circuit, three phase four wire, concept of composite and bundle conductor.	**10**
2	**Representation of Power System Components:** Per Unit (PU) system, advantage of PU system, PU impedance diagram, representation of load (Numerical).	**02**
3	**Performance of Transmission Line:** Ferranti effect, evaluation and estimation of generalized circuit constant (ABCD) for short and medium lines. **Self-learning Topics:** surge impedance loading, tuned power line.	**03**

4	**Electric Cable and Earthing:** **Electric Cable:** Classification and construction of cable, insulation resistance of cable, capacitance of single core and three core cable, grading of cable, inter-sheath grading, capacitance grading **Earthing:** Earthing definition, step and touch potentials; neutral grounding and its methods.	**05**

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment-I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment-II) when additional 40% (approx.) syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Books Recommended:

Text Books:

1. Fredrick T Morse, *Power Plant Engineering*, East-West Press Pvt Ltd
2. Mahesh Verma, *Power Plant Engineering*, Metrolitan Book Co Pvt Ltd
3. RK Rajput, *A Text Book of Power System engineering*, Laxmi Publication
4. George W Sutton-(Editor), *Direct Energy Conversion*, Lathur University, Electronic Series Vol-3 McGraw Hill
5. D. P. Kothari, I. J. Nagrath, *Power System Engineering*, 3 Edition, Mc Graw Hill
6. B.R. Gupta, *Power System Analysis And Design*, S.Chand
7. J B. Gupta, *A Course in Power System*, S. K. Kataria & Sons
8. Mehta V.K., *Principles of Power System*, S Chand

Reference Books:-

1. Stevenson and Grainger, *Modern Power System Analysis*, 1 Edition, TMH publication
2. W. D. Stevenson, *Elements of Power System*, 4 Edition TMH

NPTEL/ Swayam Course:

Course: **Power System Analysis, By Prof. Debapriya Das (IIT Kharagpur)**
https://swayam.gov.in/nd1_noc19_ee62/preview

Semester-III								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEC305	**Analog Electronics**	**03**	**-**	**-**	**03**			**03**

Examination Scheme								
Theory					Term Work/Practical/Oral			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	**20**	**20**	**80**	**03 Hrs**	**-**	**-**	**-**	**100**

Course Objectives	**The course is aimed:** 1. To understand the characteristics of diode, transistors and FETs. 2. To understand design of different biasing circuits of BJT and MOSFET. 3. To understand the functioning of Op-Amplifier and design of Op- amp based circuits. 4. To understand the functioning of linear voltage regulators and IC 555.
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Analyze the performance of various rectifiers and filter circuits. 2. Illustrate the use DC and AC parameters of BJT in analysis of amplifier circuits. 3. Apply the knowledge of MOSFET's DC/ AC parameters in analysis of amplifier and switching applications of MOSFET. 4. Understand the functioning of OP-AMP and design OP-AMP based circuits. 5. Illustrate the practical design aspect of regulated power supply circuits using linear regulators. 6. Understand applications of commonly used special semiconductor devices.

Module	Detailed Contents	Hours
1	**Bipolar Junction Transistor:** BJT as an amplifier *DC Circuit Analysis:* Types of biasing circuits, load line, thermal runaway. *AC Circuit Analysis:* Small signal analysis of CE configurations with different biasing network using H-parameter model; Amplification derivation of expression for voltage gain, current gain, input impedance and output impedance of CE amplifiers. **Self-learning Topics:** BJT's hybrid-pi model and r_e Model; Study of frequency response of BJT amplifier.	**05**
2	**Field Effect Transistor:** Types of FETs, basics of construction and working principle; MOSFET structure and I-V characteristics. MOSFET as an amplifier *DC Circuit Analysis*: Types of biasing circuits of MOSFET and region of operation. **Self-learning Topics:** Small signal model of MOSFET CS amplifier, derivation of expressions for voltage gain and output impedance of MOSFET CS amplifier.	**04**

3	**Operational Amplifiers:** Differential amplifier, direct coupled multi-stage amplifier, Block diagram of Op-amp, ideal op-amp, non-idealities in an op-amp, Frequency response; Idealized analysis and design of Inverting and Non-inverting amplifier. Design of different Op-amp circuits- adder, integrator and differentiator. **Self-learning Topics:** Comparator (ZCD, window comparator); Instrumentation amplifier (using 3 Op-amp); First order Low Pass Filter using op-amp; Oscillator (Wein bridge), Square-wave generator;	**05**
4	**Linear Voltage Regulators and Timer:** Design of voltage supply using IC-7805 and LM317 (Numerical). IC-555- Functional block diagram, study of Mono-stable and Astable Multivibrator using IC555.	**03**
5	**Special Purpose Semiconductor Devices:** Applications of rectifier diode and zener diode as clippers; Principle of operation and applications of Schottky diode; Basics of Opto-isolator.	**03**

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment-I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment-II) when additional 40% (approx.) syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Books Recommended:

Text Books:-

1. Neamen D.A., *Electronic Circuit Analysis and Design*, McGraw Hill International.
2. Robert Boylestad and Louis Nashelsky, *Electronic Devices and Circuits*, PHI
3. Ramakant A. Gayakwad, *Op-Amps and Linear Integrated Circuits*, PHI, 2000
4. Millman and Halkias, *Electronic Devices and Circuits*, Tata McGraw-Hill.
5. A. S. Sedra and K. C. Smith, *Micro-electronic Circuits*, Oxford University Press, 1998.

Reference Books:-

1. David Bell, *Electronic Devices and Circuits*, Oxford University Press
2. Thomas Floyd, *Electronic Devices*, PHI
3. S. Salivahanan and N. Suresh Kumar, "*Electronic Devices and Circuits, TMH*
4. P. Horowitz and W. Hill, *The Art of Electronics*, Cambridge University Press, 3rd Edition

NPTEL/ Swayam Course:

1. **Course**: **Analog Electronic Circuits By Prof. Pradip Mandal (IIT Kharagpur)**
   https://swayam.gov.in/nd1_noc20_ee45/preview
2. **Course: Analog Electronic Circuit By Prof. Shouribrata Chatterjee (IIT Madras)**
   https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee89/

Semester-III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEL301	**Electrical Machines and Measurements Lab**	-	**02**	-	-	**01**	-	**01**

Examination Scheme								
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract./ Oral	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	**25**	-	**25**	**50**

Course Objectives	**To impart the knowledge on the following :** 1. Practical understanding of DC machines and their applications. 2. Working principles of various sensors, transducers and instruments used for measurement of the various physical parameters.
Course Outcomes	**Upon successful completion of this course, the learner will be able to** 1. Illustrate and analyze the performance of DC machines. 2. Demonstrate different speed control methods of DC motors. 3. Illustrate and analyze the working of various sensors, transducers and instruments used for measurement of the various physical parameters. 4. Demonstrate the use of bridges for measurements of passive electrical components. 5. Understand and analyse the working signal processing circuits used in measurements and instruments

Syllabus: Same as **EEC303: Fundamentals of Electrical Machines and Measurements**

Suggested List of Laboratory Experiments: Minimum Two from 1 – 9 and Two from 10 – 16, in all minimum Four experiments need to be performed.

1. Open circuit and load characteristics of DC shunt generator.
2. Load characteristics of DC compound generator with differential and cumulative connections.
3. Load test on DC shunt motor.
4. Load test on DC compound motor.
5. Load test on DC series motor.
6. Speed control of DC shunt motor.
7. Retardation test of DC motor.
8. Swinburne's test on DC motor.
9. Hopkinson's test on DC motor.
10. Measurement of the medium resistance using Wheatstone bridge.
11. Measurement of the low resistance using Kelvin’s double bridge.
12. Measurement of inductance using Maxwell’s bridge.
13. Measurement of capacitance using Schering’s bridge.
14. Measurement of R/L/C using a bridge technique as well as LCR meter.
15. Current Measurement using Shunt, CT, and Hall Sensor.
16. Measurement of temperature using RTD/ Thermistor
17. Measurement of Pressure using Pressure transducer.
18. Study of Signal Processing circuits used for sensors/ transducers.
19. Range Extension of meters used in electrical and electronic measurements.

Any other experiments based on 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 08 experiments. The distribution of marks for term work shall be as follows:

Laboratory 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 **EEC303: Fundamentals of Electrical Machines & Measurements**

Semester-III								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEL302	**Electronics Lab-I**	-	**02**	-	-	**01**	-	**01**

Examination Scheme								
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract./ Oral	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	**25**	**25**	-	**50**

Course Objectives	**The course is aimed:** 1. To understand the basic concept of various electronic devices, circuits and their application. 2. To develop ability among students to design and implement electronic circuits.
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Identify the different types of semiconductor devices and demonstrate their applications in electronic circuits. 2. Analyse the performance of different types of rectifier with and without filter. 3. Determine the dc and ac parameters of various semiconductor devices. 4. Illustrate the frequency response of BJT/ MOSFET amplifier. 5. Understand the practical use of Op-amps in signal processing and waveform generators.

Syllabus: Same as that of Course **EEC305 Analog Electronics**

Suggested List of Laboratory Experiments: Minimum Four experiments need to be performed.

1. Use of diode as clipper.
2. BJT biasing network and stability analysis
3. BJT Input and Output Characteristics for CE configuration
4. Frequency response of BJT CE amplifier
5. Study of MOSFET characteristics and calculation of parameters
6. Frequency response of MOSFET CS amplifier
7. Study of differential BJT amplifier
8. Design of OP-AMP based Inverting amplifier and Non-inverting Amplifier
9. Study of OP-AMP as Adder and Subtractor
10. Design of adjustable Voltage regulator based on IC 78XX
11. Design of adjustable Voltage regulator based on LM317
12. Study of V-I characteristics of Schottky diode.
13. Study of opto-isolators

Any other experiment based on 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 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 08 experiments. The distribution of marks for term work shall be as follows:

Laboratory 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 & Oral Examination:

Practical exam will be based on all the experiments carried out & Oral examination will be based on entire syllabus of **EEC305 Analog Electronics.**
The distribution of marks for practical/ oral examination shall be as follows:

- Practical Exam : 15 marks
- Oral Exam : 10 marks

Semester-III								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEL303	**Simulation Lab-I**	**-**	**02**	**-**	**-**	**01**	**-**	**01**

Examination Scheme								
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract./ Oral	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	**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 electric machines/circuits for performance analysis.

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

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, PowerSim, TINA** etc. is also allowed**.**
3. Use of 'Python' platform for simulating components/ circuit behaviour.

Suggested List of Laboratory Experiment: Minimum Four experiments need to be performed from various subjects domain

1. Introduction to basic block sets of simulation platform.
2. Algorithm on matrix operations
3. Simulation of transmission line model
4. Algorithms to determine transmission line performance and parameters
5. Simulation of differential equations
6. Simulation to verify different network theorems with dependent and independent sources
7. Algorithm for generation of standard test signals
8. Simulation / Algorithms to draw the response of electrical network for standard test signals.
9. Simulation / Algorithms to draw the pole zero plot of electrical networks
10. Simulation of DC motor performance characteristics
11. Simulation of various measurement bridges l Maxwell's bridge, Hay's bridge etc.
12. Design of OP-AMP based Inverting amplifier and Non-inverting Amplifier
13. Study of OP-AMP as Adder and Subtractor

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

Note:

Students and teachers are also 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 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 consists of minimum 08 simulation / algorithms from various subject domains. The distribution of the term work shall be as follows:

Simulation / Algorithm	: 20 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 **Simulation Lab-I**

Semester-III								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEL304	**Skill Based Lab (SBL-I) Applied Electrical Engineering Lab**	**-**	**04**	**-**	**-**	**02**	**-**	**02**

Examination Scheme								
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract./ Oral	Oral	
Test-I	Test-II	Average						
-	**-**	**-**	**-**	**-**	**50**	**-**	**-**	**50**

Course Objectives	**The course is aimed:** 1. To provide hands on experience to use laboratory instruments for testing and measurement. 2. To develop the ability to repair and maintain electrical equipment/ appliances 3. To impart the knowledge of electrical installation on institute campus. 4. To impart the knowledge of Electrical fire and shock hazards safety.
Course Outcomes	**Upon successful completion of this course, the learner will be able to** 1. Demonstrate the effective use of various electrical and electronic measuring lab equipments. 2. Identify various electrical LV/HV substation, supply equipments and their network connection 3. Identify and use different low voltage protective switchgears along with residential / industrial wiring practices. 4. Illustrate the understanding of Repair and maintenance of common electrical appliances. 5. Handle Electrical fire and shock hazards safety challenges in real practice.

Module	Detailed Contents	Hours
1	**Use of Lab Equipments:** *Standard Lab Equipments*: Multi-meter, Power Supply, Function Generator, Tachometer, thermometer, clamp-on meter, DSO etc. (**Study two the equipments**) *Special Measuring Equipments*: True RMS multi-meter, Lux meter, Megger, LCRQ meter, Power Meter, Thermal Analyser, Anemometer, Humidity Meter, Earthing Resistance meter, Insulation Resistance meter etc. (**Study at least one such equipments**) **Lab Activities**: Students should be trained to use these classes of lab equipments with good expertise achieved. Students should clearly understand and differentiate the situations in which use of each of these equipments is best suitable.	**04**
2	**Electrical LV/HV Substation and Supply Equipments:** Electrical LV/HV Substation: RMU, Transformer, HV switchgear and panels, LV switchgears and panels, HT metering, LT metering APFC panel, Backup DG sets, UPS, Changeover switchgears, Feeder Pillar, Solar PV Installation. Single line diagram (SLD), Supply Utility service: Electricity bills and details. **Students should study the actual electrical supply system on institute campus, prepare SLD for the network and detailed report on actual ratings of the complete system.**	**06**

3	**Residential/ Industrial Wiring and switch-gears** Wiring materials, selection of wire, conductor sizing, Cables and cable management Estimation and costing of residential wiring (**Simple numerical on wiring of single room**); Fire retardant wires. Different switching and protection devices (MCBs/ Fuses/Relays), selection and sizing connection of energy meter and distribution board, wiring standards (IS-732, section 4). (**Students should be given demonstration of real life devices and DBs in use**). **Students should perform following experiments (Any Two)** 1. Identify different types of cables/wires, switches and their uses. 2. Identify different types of fuses & fuse carriers, MCB and ELCB, MCCB with ratings and usage. 5. Wiring of simple light circuit for controlling light/fan point (PVC conduit wiring and wiring accessories) 6. Wiring of fluorescent lamps and light sockets (6 A). 7. Wiring of Power circuit for controlling power device (16A socket) 8. Design of Staircase wiring / Go-down wiring / Tunnel wiring 9. Demonstration and measurement of power/energy consumption and repair maintenance of electric iron/mixer grinder/ washing machine/refrigerator/ air conditioner/water heater/geyser/single phase pump/exhaust fan.	**06**
4	**Repair and Maintenance of House-hold Appliances and Machines:** Testing, fault finding, Dismantling, assembling and testing after repairs of house hold appliances like standard fan and regulator, BLDC fan, heater, geyser, mixer, washing machine, microwave oven, LED lamps/tubes, Induction Cooker, Air cooler etc. (**Minimum one such appliances must be studied**) Troubleshooting of 1 ph and 3ph transformers and motors (**Any one**)	**04**
5	**Electrical Fire Prevention and Safety in Buildings:** Guidelines and charts for electrical fire prevention, role of electrical switchgear and protection devices, Earth leakage and Earth Resistance measurements, Preventive maintenance, Thermal analysis of electrical installations, Electrical Fire mitigation ; Electrical Shock safety, symptoms and emergency first aid; **Self Study:** Indian Electricity Act and National Electrical Code (**Training of Electrical Fire Prevention and Safety must be provided to all the students)**	**04**

Term Work:

Term work shall consist of minimum requirement as given in the syllabus. The distribution of marks for term work shall be as follows:

Laboratory Performance : 30 marks
Journal : 10 marks
Attendance : 10 marks

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

Books Recommended:

1. J. B. Gupta, *Electrical Installation Estimating & Costing,* S. K. Kataria & Sons, 2009
2. Raina Bhattachraya, *Electrical Design Estimating And Costing,* New Age International,
3. K B. Bhatia, *Electrical Appliances and Devices,* Khanna Publications
4. K B. Bhatia, *Fundamentals of Maintenance of Electrical Equipments,* Khanna Publications
5. BIS SP 30:National Electrical Code
6. Electricity Act 2003

Semester-III								
Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
EEM301	**Mini Project – 1A**	-	**04$**	-	-	**02**	-	**02**

$ indicates work load of Learner (Not Faculty)

Examination Scheme								
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	Term Work	Pract./ Oral	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	**25**	-	**25**	**50**

Course Objectives	**The course is aimed:** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** 1. Identify problems based on societal /research needs. 2. Apply Knowledge and skill to solve societal problems in a group. 3. Develop interpersonal skills to work as member of a group or leader. 4. Draw the proper inferences from available results through theoretical/ experimental/simulations. 5. Analyse the impact of solutions in societal and environmental context for sustainable development. 6. Use standard norms of engineering practices 7. Excel in written and oral communication. 8. Demonstrate capabilities of self-learning in a group, which leads to life long learning. 9. Demonstrate project management principles during project work.

General Guidelines for Mini Project 1A/ 1B

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project-1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Mini Project 1A/1B–General Guidelines for Execution

Design and Fabrication

a. Initial fabrication of the project by students can be done using standard devices/material/software tools to verify the circuit functionalities Initial project fabrication and testing is expected to be done by soldering/assembling on general purpose PCB/ Bakelite boards or suitable platforms required for the electrical/electronic/digital components. Avoid the use of breadboards.
b. If essential, use of a simulation/ emulation software tools to test and verify the performance of the circuit should be encouraged.
c. Students should prepare the proper drawings (electrical/ mechanical), schematics/ layouts of the project.
d. For final implementation of the circuit, preparation of PCB (if any required) using suitable CAD tools and fabricating the same in the lab is expected.

Devices/ Components/ Systems to be Used:

Students are encouraged to use passive components like resistors, capacitors, inductors etc. If any specialize inductor is not readily available, the fabrication of the same in the lab should be encouraged. Other components like: Transistors, diodes, voltage regulators, logic gates, Op-amps, general purpose microcontroller, DC motors/ AC motors, sensors, actuators, relays etc. (Students may add more components as per the requirement of project).

Testing and analysis of the Project

Students should test the circuit using suitable laboratory equipments like power supply, multi-meter, CRO, DSO etc. In case of any debugging requirement, students should record the problems faced during the testing and solutions sought after for the fault in the circuit.

All the testing results must be well documented in the final project report verifying the functionalities of the propose project.

Use of Reference Material/Literature :

Students are advised to refer Application Notes, research publications & data sheets of various electrical/electronic/digital devices from Texas Instruments, Microchips, International Rectifiers, ST Microelectronics, Philips, NXP and many other manufacturers.

Self-learning and Skill Set Development

Students should be encouraged to develop/ improve their understanding and skill sets by attending various online/offline expert lectures / video lectures/ courses/ webinars/ workshops etc. to facilitate the smooth execution of mini project

1. Understanding passive components viz. resistors, capacitors and inductors from practical point of view: types/ varieties, device packages, applications and cost.
2. Understanding semiconductor components viz. diodes, BJT and JFET/MOSFETs from practical point of view: types/ varieties, device packages, applications and cost.
3. Design principles of simple electrical / electronic circuits with some examples.
4. Selection of switches and circuit protection components.
5. Selection and sizing of wires and conductors.
6. Soldering Practice.

7. Heat-sinking and Enclosure design concepts
8. Overall workmanship while working on the project fabrication.
9. Use of different software tools for design and development of circuits
10. Use of standard as well as advanced laboratory equipments needed for testing of such projects

Suggested Application Domains for Mini Projects:

List of key application domains from where students are encouraged to derive Mini Projects topics:

1. Home/Office automation
2. Renewable Energy
3. Energy Conservation
4. Energy Storage
5. Battery Charging and Protection
6. Fire Safety
7. Electrical System Protection
8. Lighting Control
9. Wireless Power Transfer
10. Electrical Components Testing
11. Electrical Parameters Measurement
12. Non-conventional Electricity Generation
13. Laboratory Equipments
14. E-Mobility
15. Video Surveillance Systems
16. Robotics for Hazardous applications
17. Waste Management System 2.
18. Smart City Solutions
19. Smart Classrooms and learning Solutions
20. Smart Agriculture solutions etc.
21. Health/ Biomedical

Students can identify the mini project topics either from above suggested domains or **any other relevant engineering domains**.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini 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 both semesters shall be as below;
  - Marks awarded by guide/supervisor based on log book : 10
  - Marks awarded by review committee : 10
  - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year Mini Project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
  - First shall be for finalization of problem

- Second shall be on finalization of proposed solution of problem.

- In second semester expected work shall be procurement of components /systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
  - First review is based on readiness of building working prototype to be conducted.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year Mini Project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalization of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Oral Examination:

Mini Project 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

Reference Books:

1. P. Horowitz and W. Hill, "The Art of Electronics", 3rd Edition, Cambridge University Press, 2015
2. R. S. Khandpur, "Printed Circuit Board", McGraw-Hill Education; 1st edition, 2005.
3. Simon Monk, "Hacking Electronic: Learning Arduino and Raspberry Pi", McGraw-Hill Education TAB; 2 edition (September 28, 2017).

Suggested Software Tools:

1. LTspice:https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html#
2. Eagle : https://www.autodesk.in/products/eagle/overview
3. OrCAD: https://www.orcad.com/
4. Multisim : https://www.multisim.com/
5. Webbench:http://www.ti.com/design-resources/design-tools-simulation/webench-power-designer.html
6. Tinkercad : https://www.tinkercad.com/
7. Raspbian OS: https://www.raspberrypi.org/downloads
8. Arduino IDE: https://www.arduino.cc/en/main/software

Online Repository:

1. https://www.electronicsforu.com
2. https://circuitdigest.com
3. https://www.electronicshub.org
4. Github

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