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UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electrical Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

From Co-coordinator's Desk:

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

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's), course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of Studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enable a much-required shift in focus from teacher-centric to learner-centric education. Since the workload estimated is based on the investment of time in learning, not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. **Choice Based Credit and Grading System** were implemented for First Year of Engineering (Undergraduate) from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year of Engineering (Undergraduate) in the academic year 2017-2018 and so on.

Dr. Suresh K. Ukarande
Coordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and to achieve recognition of the institution or program meeting certain specified standards. The main-focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as a Chairman, Board of Studies in Electrical Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for undergraduate program in Electrical Engineering, more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs and POs of undergraduate program in Electrical Engineering are listed below;

Program Educational Objectives (PEOs)

- *Graduates will have successful career in industry or pursue higher studies to meet future challenges of technological development.*
- *Graduates will develop analytical and logical skills that enable them to analyze and design Electrical Systems and their Controls.*
- *Graduates will achieve professional skills to expose themselves by giving an opportunity as an individual as well as team.*
- *Graduates will undertake research activities in emerging multidisciplinary fields.*

Program Outcomes (POs)

- **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

- **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Dr. S. R. Deore,
Chairman,
Board of Studies in Electrical Engineering,
Member - Academic Council
University of Mumbai

Program Structure for
SE Electrical Engineering
University of Mumbai
(With Effect from 2017-18)

Scheme for Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EEC301	Applied Mathematics - III	4	-	1	4	-	1	5
EEC302	Electronic Devices and Circuits	4	-	-	4	-	-	4
EEC303	Conventional and Non-Conventional Power Generation	3	-	1	3	-	1	4
EEC304	Electrical and Electronics Measurement	4	-	-	4	-	-	4
EEC305	Electrical Machine – I	4	-	-	4	-	-	4
EEL301	Electrical and Electronics Measurement Lab	-	2	-	-	1	-	1
EEL302	Object Oriented Programming and Methodology Lab	-	4#	-	-	2	-	2
EEL303	Electronics Lab - I	-	2	-	-	1	-	1
EEL304	Electrical Machine Lab- I	-	2	-	-	1	-	1
Total		**19**	**10**	**2**	**19**	**5**	**2**	**26**

 # Out of four hours, 2 hours theory shall be taught to entire class and 2 hours practical in batches

Examination Scheme for Semester III

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term Work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
EEC301	Applied Mathematics - III	80	32	20	8	25	10	-	-	-	-	-	-	125
EEC302	Electronic Devices and Circuits	80	32	20	8	-	-	-	-	-	-	-	-	100
EEC303	Conventional and Non-Conventional Power Generation	80	32	20	8	25	10	-	-	-	-	-	-	125
EEC304	Electrical and Electronics Measurement	80	32	20	8	-	-	-	-	-	-	-	-	100
EEC305	Electrical Machine –I	80	32	20	8	-	-	-	-	-	-	-	-	100
EEL301	Electrical and Electronics Measurement Lab	-	-	-	-	25	10	-	-	25	10	-	-	50
EEL302	Object Oriented Programming and Methodology Lab	-	-	-	-	25	10	-	-	-	-	50	20	75
EEL303	Electronics Lab - I	-	-	-	-	25	10	-	-	-	-	25	10	50
EEL304	Electrical Machine Lab - I	-	-	-	-	25	10	-	-	-	-	25	10	50
Total		**400**	**-**	**100**	**-**	**150**	**-**	**-**	**-**	**25**	**-**	**100**	**-**	**775**

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
EEC301	**Applied Mathematics-III (abbreviated as AM-III)**	**4**	**1**	**4**	**1**	**5**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
EEC301	Applied Mathematics-III	20	20	20	80	3	25	125

Course Objectives	• To Develop knowledge and skill based foundation in Mathematics amongst students needed for the field of Electrical Engineering • To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems. • To prepare student to apply reasoning informed by the contextual knowledge to Electrical Engineering practice. • To prepare students to work as part of teams on multi-disciplinary projects.
Course Outcomes	Students will be able • To demonstrate basic knowledge of Laplace Transform, Fourier series, Bessel Functions, Vector Algebra and Complex Variable. • To identify and Model the problems of the field of Electrical Engineering and solve it.

Module	Contents	Hours
1	**Laplace Transform** **Laplace Transform (LT) of Standard Functions:** Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of $e^{at}, Sin(at), \cos(at), \sinh(at), \cosh(at), t^n$ Heaviside unit step function, Dirac-delta function, Laplace transform of Periodic function **Properties of Laplace Transform:** Linearity, first shifting theorem, second shifting theorem, multiplication by t^n ,Division by *t*, Laplace Transform of derivatives and integrals, change of scale, convolution theorem, Evaluation of integrals using Laplace transform.	07
2	**Inverse Laplace Transform & its Applications:** Partial fraction method, Method of convolution, Laplace inverse by derivative. **Applications of Laplace Transform:** Solution of ordinary differential equations, Solving RLC circuit differential equation of	06

	first order and second order with boundary condition using Laplace transform (framing of differential equation is not included).	
3	**Fourier Series:** **Introduction:** Orthogonal and orthonormal set of functions, Introduction of Dirichlet's conditions, Euler's formulae. **Fourier Series of Functions:** Exponential, trigonometric functions of any period =2L, even and odd functions, half range sine and cosine series Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	11
4	**Vector Algebra & Vector Differentiation:** **Review of Scalar and Vector Product**: Scalar and vector product of three and four vectors, Vector differentiation, Gradient of scalar point function, Divergence and Curl of vector point function. **Properties:** Solenoidal and irrotational vector fields, conservative vector field.	07
5	**Vector Integral** Line integral, Green's theorem in a plane, Gauss' divergence theorem and Stokes' theorem	06
6	**Complex Variable & Bessel Functions:** **Analytic Function:** Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and it application, Harmonic function, orthogonal trajectories. **Mapping:** Conformal mapping, Bilinear transformations, cross ratio, fixed points **Bessel Functions:** Bessel's differential equation, Properties of Bessel function of order +1/2 and -1/2, Generating function, expression of $\cos(x\sin\theta)$, $\sin(x\sin\theta)$ in term of Bessel functions	11

Books Recommended:

Text books:

1. H.K. Das, "Advanced engineering mathematics",S . chand , 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Murry R. Spieget, *"Vector Analysis",* Schaum's outline series, Mc-Graw Hill

Publication

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

Term work:
Term work shall consist of minimum eight tutorials and assignments (minimum 2).
The distribution of marks for term work shall be as follows:

Tutorials	:15 marks
Assignments	:05 marks
Attendance (Theory and Tutorial)	:05 marks

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

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 question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
EEC302	**Electronic Devices and Circuits (abbreviated as EDC)**	**4**	**-**	**4**	**-**	**4**

Course Code	Course Name	Examination Scheme						
EEC302	Electronic Devices and Circuits	Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (Hrs.)		
		Test 1	Test 2	Avg.				
		20	20	20	80	3	-	100

Course Objectives	• To teach the basic concept of various electronic devices, circuits and their application • To develop ability among students for problem formulation, system design and solving skills
Course Outcomes	Students will be able • To Identify the different types of diodes and their applications in electronic circuits • To analyze the dc and ac parameters of BJT JFET, and differential amplifiers • To demonstrate and analyze the effects of various parameters on performance of BJT and JFET amplifier. • To analyze the effects of negative feedback in BJT and JFET amplifiers. • To identify the effects of cascading in BJT and JFET amplifiers. • To analyze the different types of oscillators.

Module	Contents	Hours
1	**Diode:** Basic construction, Operation and characteristics of diode, Application of diode as clipper and clampers, Construction, Principle of operation and application of special diode – 1) Zener, 2) LED, 3) Schottky, 4) Photodoide. Full Wave Bridge Rectifier with and without Filter, Analysis: specification of the devices and components required for C, LC, CLC filter.	08
2	**Bipolar Junction Transistor:** Construction and Characteristics of various configurations of	14

	BJT. Biasing Circuits: Types, dc circuit analysis, load line, thermal runaway, stability factor analysis, thermal stabilization and Compensation. Modeling: Small signal analysis of CE configurations with different biasing network using h-parameter model. Introduction to re-model and hybrid-pi model. Amplification derivation of expression for voltage gain, current gain, input impedance and output impedance of CC, CE amplifiers, Study of frequency response of BJT amplifier.	
3	**Field Effect Transistor:** Types, construction and their characteristics, Biasing circuits for FET amplifiers, FET small signal analysis, derivation of expressions for voltage gain and output impedance of CS amplifiers. MOSFET- Types, construction and their characteristics	08
4	**Feedback Amplifier:** Introduction to positive and negative feedback, negative feedback -current, voltage, Series and Shunt type. It's effect on input impedance, output impedance, voltage gain, current gain and bandwidth	07
5	**Cascade amplifiers:** Types of coupling, effect of coupling on performance of BJT and JFET amplifiers, Darlington-pair	03
6	**Oscillators:** Positive feedback oscillators, frequency of oscillation and condition for sustained oscillations of a) RC phase shift, b)Wien bridge, c)Hartley/ Colpitts with derivations, crystal Oscillator, UJT relaxation oscillator	08

Books Recommended:

Text Books:

1. Robert Boylestad and Louis Nashelsky, *Electronic Devices and Circuits*, Prentice-Hall of India.
2. Millman and Halkias, '*Electronic Devices and Circuits*', Tata McGraw-Hill.
3. David Bell, *Electronic Devices and Circuits*, Oxford University Press

Reference Books:

1. Thomas Floyd, '*Electronic Devices'*, Prentice-Hall of India
2. Ramakant A. Gayakwad, *Op-Amps and Linear Integrated Circuits*
3. Neamen D.A., *Electronic Circuit Analysis and Design*, McGraw Hill International.
4. S. Salivahanan, N. Suresh Kumar, "*Electronic Devices and Circuits" TMH*

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 question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
EEC303	**Conventional and Non-Conventional Power Generation (abbreviated as CNCPG)**	**3**	**1**	**3**	**1**	**4**

Course Code	Course Name	Examination Scheme						
		Theory					Term work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
EEC303	Conventional and Non-conventional Power Generation	20	20	20	80	03	25	125

Course Objectives	• To impart the knowledge of basics of different types of power generation & power plants in detail so that it helps them in industry oriented learning
Course outcomes	Students will be able • To analyse the economics of power generation • To illustrate, the operation of thermal power plant • To describe, the classification of hydro power plant and significance of hydrograph • To illustrate, the operation of nuclear power plant • To compare the operation of Diesel and Gas Turbine power plant. • To illustrate operation of various Non-Conventional Energy sources

Module	Contents	Hours
1	**Conventional and Non- Conventional sources of energy** Present energy scenario worldwide and Indian perspective. **Economics of the power plant** Load curve, load duration curve, various factors and effects of fluctuating load on operation and methods of meeting fluctuating load. Selection of generating equipment, depreciation of plant, cost of electrical energy-Fixed and operating cost of different plants, effect of load factor on unit cost. Role of load diversity in power system economy and basic tariff methods **(*Numerical).**	05

2	**Thermal power plant** Law of Thermodynamics. Analysis of steam cycle-Carnot, Rankine. PV and TS diagram, Reheat cycle and Regenerative cycle. Layout of power plant. Selection of site, Lay out of Coal handling Plant, pulverized coal handling, Fluidized bed combustion, Ash handling, Dust collection, Forced draught and induced draught fans, Water tube Boiler and Fire tube boiler. Impulse turbine and reaction turbine. Accessories: Feed pump, injector, economizer, air preheater, super heater, steam separator, Direct contact condensers and Surface condenser, and cooling towers.	09
3	**Hydro power plant** Rainfall, run off and its measurement hydrograph, flow duration curve, mass curve, reservoir storage capacity, layout of hydroelectric power plant, Selection of site, classification of hydro power plant, construction and working of turbine-Pelton, Kaplan, Francis. **(*Numerical)**	05
4	**Nuclear power plant** Introduction of nuclear engineering, fission, fusion, nuclear materials, thermal fission reactor, layout of nuclear power plant, Selection of site, PWR, BWR, reactor control, introduction to liquid metal, fast breeder reactors and plasma technology.	06
5	**Gas turbine and Diesel power plant** Brayton cycle operation, Layout of gas turbine power plant, types of gas turbine power plant. Diesel cycle, Principle of Diesel power plant, layout, significance of components of diesel power plant. Comparison with gas turbine power plants in terms of advantages and disadvantages	04
6	**Power Generation using non-conventional energy sources** **Solar Energy** Solar Flat plate collectors, Solar concentrators, Dish and Parabolic trough concentrating generating systems, Central tower solar thermal power plants. Basic principle of power generation in a PV cell, Band gap and efficiency of PV cells solar cell characteristics. **Wind Energy** Basic component of WEC, Types of wind turbine-HAWT, VAWT, Performance parameters of wind turbine, Power in wind, Wind electric generators and site selection. **Fuel Cell** Introduction to fuel cell, principle of operation of fuel cell, Types of fuel cell **Other sources** Basics of power generation: Biomass, geothermal and tidal energy sources and OTEC.	07

Note: *Numerical should be covered in tutorials.

Books Recommended:

Text Books:

1. MV Deshpande, *Elements of Power station design,* Tata McGraw Hill

2. DH Bacon, *Engineering Thermodynamics,* London Butterworth

3. PK Nag, *Power Plant Engineering-Steam & Nuclear,* Tata McGraw Hill

Reference 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

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.

Term work:

Term work shall consist of minimum two group assignments followed by seminar, report on power plant visit and four tutorials based on the syllabus. The distribution of marks for term work shall be as follows:

Tutorial and Visit	:10 marks
Assignments and Seminar	:10 marks
Attendance (Theory and Tutorial)	:05 marks

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

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 question will be randomly selected from all the modules.

University of Mumbai						
Course code	**Course Name**	**Teaching scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
EEC304	**Electrical and Electronics Measurement (abbreviated as EEM)**	**4**	**-**	**4**	**-**	**4**

Course Code	Course Name	Examination Scheme						
		Theory					Term work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
EEC304	Electrical and Electronics Measurement	20	20	20	80	03	-	100

Course Objectives	• Students should be able to understand working principles of various analog and digital instruments & devices used for measurement of the various electrical parameters. • To understand the measurement of physical parameters using sensors.
Course Outcomes	Students will be able • To illustrate the working principle of measurement instruments. • To analyse the working of various analog and digital instruments in electrical measurements. • To analyse the concept of extension of range of meters used in electrical measurements. • To analyse the performance of bridges used in electrical measurement process. • To illustrate the need for calibration process in instruments. • To analyse the performance of transducers involved in electrical measurement.

Module	Content	Hours
1	**Principles of Analog Instruments:** Errors in Measurement, Difference between Indicating and Integrating Instruments. Moving coil and Moving iron Instruments, Ammeters Shunts & Voltmeter Multiplier. Extension of ranges by using shunt, Multipliers, Dynamometer type Wattmeter & Power Factor meters. Reed Moving Coil type Frequency Meters. Weston type Synchroscope. DC Permanent magnet moving coil type Galvanometers. Ballistic	16

	Galvanometer and AC Vibration Galvanometer **(only the basic working Principle and Applications)**.	
2	**Principles of Digital Instruments:** Advantages of digital meters over analogue meters. Resolution & sensitivity of digital meters. Working principles of digital Voltmeter, Ammeter, Frequency meter, Phase Meter, Energy meter, Tachometer and Multi-meter.	10
3	**Measurement of Resistance:** Wheatstone's Bridge, Kelvin's Double Bridge and Megger.	05
4	**Measurement of Inductance & Capacitance:** Maxwell's Inductance bridge, Maxwell's Inductance & Capacitance Bridge, Hay's bridge, Anderson's Bridge, Desaugthy's Bridge, Schering Bridge and Q meter	05
5	**Potentiometer:** Basic potentiometer circuit, standardization, Crompton's Type Potentiometer and its applications for calibration of Ammeter, Voltmeter and Wattmeter and measurement of resistance and power.	04
6	**Transducers:** Electrical Transducers, Active & Passive Transducers, Resistive Transducer-Potentiometer, Resistance Pressure Transducer, Resistive Position Transducer, Temperature Transducer- Resistance Thermometer, Thermistor, Thermo couple, RTD, Inductive Transducer-Using Self Inductance, Variable Reluctance type, Differential Output Transducers, LVDT, RVDT, Capacitive Transducer-Capacitive Pressure Transducer Piezo Electric Transducer, Photo Electric Transducer (Photo emissive, Photo Conductive, Photo Voltaic)	08

Books Recommended:

Text Books:

1. Electrical & Electronic Measurements and Instrumentation by AK Sawhney, Dhanpat Rai & Sons
2. Modern Electronic Instrumentation and Measurement Techniques by Helfric and Cooper, Prentice Hall of India
3. Electronic Instrumentation By H.S.Kalsi, Third Edition, Tata McGraw Hill

Reference Books:

1. Principle of Measurement & Instrumentation by Alan.S.Moris, Prentice Hall of India
2. Electrical Measurement & Instrumentation by RS Sirohi & Radhakrisnan, New Age International

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 question will be randomly selected from all the modules.

University of Mumbai						
Course code	**Course Name**	**Teaching scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Tutorial**	**Theory**	**Tutorial**	**Total**
EEC305	**Electrical Machine-I (abbreviated as EMC-I)**	**4**	**-**	**4**	**-**	**4**

Course code	Course Name	Examination Scheme						
		Theory					Term Work	Total
		Internal Assessment			End Sem. Exam	Exam Duration (Hrs.)		
		Test 1	Test 2	Avg.				
EEC305	Electrical Machines-I	20	20	20	80	3	-	100

Course Objectives	• Students should understand the concepts of DC machines, Reluctance motor, Stepper motors and their applications. • To impart industry oriented learning.
Course Outcomes	Students will be able • To analyze series parallel magnetic circuits to determine circuit parameters and losses. • To illustrate principle of energy conversion in single and double excited machines. • To understand the performance parameters of dc machines. • To analyze the effect of performance parameters and application of dc motors. • To analyze the performance of dc machines by conducting various test. • To illustrate the principle of operation and applications of stepper motors.

Module	Contents	Hours
1	**Basics of Magnetism** Magnetic field, Magnetic circuit, Numerical from series parallel magnetic circuit, Flux linkage, Inductance and energy, Faraday's laws, Hysteresis and eddy current losses.	04
2	**Electromechanical Energy Conversion** Principle, Energy stored in magnetic field, Torque in singly excited magnetic field, Reluctance motor, Doubly excited magnetic field, Torque from energy and Co- energy. Dynamic equations	08
3	**DC Machines** Construction of machine, Basic design concept of lap and wave winding, Principle of operation, Significance of commutator and	10

	brushes, EMF and torque equation, concept of back EMF, Armature reaction, Methods to minimize the effect of Armature reaction, Process of commutation, Methods to improve commutation.	
4	**DC Motor** Characteristics of DC Motors, speed-torque characteristic equations (Drives approach), Electrical braking (Rheostatic, regenerative and plugging with numerical and speed-torque characteristic equation), Necessity of starter, concept of soft starting, Block diagram of soft starter, Speed control of DC shunt and series motor, losses and efficiency, Applications of DC motor.	14
5	**Testing of DC Motor** Retardation, Brake load, Swinburne, Hopkinson's and field test.	06
6	**Stepper Motor** Working principle, construction of stepper motor, Classification, Variable reluctance stepper motor (VRSM), Permanent magnet stepper motor, Characteristics of stepper motor (Static and dynamic characteristic) Applications of stepper motor. **(No Numerical)**	06

Books Recommended:

Text Books:

1. Bimbhra P. S., *Electric Machinery* , Khanna Publisher,
2. Bimbhra P. S., *Generalized Machine Theory*, Khanna Publisher,
3. E. G. Janardanan, *Special Electrical Machines,* PHI
4. S. K. Pillai, *A first course on Electrical Drives,* New age publication
5. V. K. Mehta, *Principles of Electrical Machines,* S Chand Publication
6. G. K. Dubey, *Fundamentals of Electrical Drives*, Narosa Publication

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. M. V. Deshpande, *Electric Machines*, PHI
4. Vedam Subramanyam, *Electrical Drive-concept and applications*, TMH Publication
5. A. E. Fitzgerald, Kingsly, Stephen., *Electric Machinery*, Tata McGraw Hill
6. K. Venkatratnam, *Special Electrical Machines,*

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 question will be randomly selected from all the modules.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
EEL301	**Electrical and Electronics Measurement Lab (abbreviated EEM Lab)**	**-**	**2**	**-**	**1**	**1**

Course Code	Course Name	Examination Scheme							Total
		Theory				Practical			
		Internal Assessment			End Sem. Exam	Term Work	Pract. and Oral	Oral	
		Test 1	Test 2	Avg					
EEL301	Electrical Network and Measurement Lab	-	-	-	-	25	-	25	50

Course Objectives	• Students should be able to understand working principles of various analog and digital instruments & devices used for measurement of the various electrical parameters. • To understand the measurement of physical parameters using sensors.
Course Outcomes	Students will be able • To illustrate the working principle of bridges • To do measurement of various electrical circuit parameters. • To calibrate various electrical measuring instruments. • To illustrate the concept of extension of range of meters used in electrical measurements. • To do the measurement of various process parameters. • To illustrate the working principle of sensors

Syllabus: Same as that of Course EEC304 Electrical and Electronics Measurement

Suggested List of Laboratory Experiments:

1. Measurement of the medium resistance using Wheatstone Bridge.
2. Measurement of the low resistance using Kelvin's Double Bridge.
3. Measurement of inductance using Maxwell's Bridge.
4. Measurement of inductance using Hay's Bridge.
5. Measurement of inductance using Anderson's Bridge.
6. Measurement of capacitance using Desauty's bridge.

7. Measurement of capacitance using Schering's bridge.
8. Calibration of Crompton DC Potentiometer.
9. Calibration of Ammeter/Voltmeter/Wattmeter using Potentiometer.
10. To measure output voltage and displacement using LVDT and draw graph to verify the characteristics of output voltage Vs Displacement.
11. Measurement of temperature using RTD.
12. To Study various Thermocouples and Estimate their Response times.
13. Calibration of single phase energy meter by direct loading.
14. To measure output voltage and force using strain gauge and draw graph to verify the characteristics of force Vs Output voltage.

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

Term Work:

Term work shall consist of minimum 8 experiments. The distribution of marks for term work shall be as follows:

Experiments Performance	:10 Marks
Journal	:10 Marks
Attendance (Theory and Practical)	: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.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
EEL302	**Object Oriented Programming and Methodology Lab (abbreviated OOPM Lab)**	**-**	**4#**	**-**	**2**	**2**

Course Code	Course Name	Examination Scheme							Total
		Theory				Practical			
		Internal Assessment			End Sem. Exam	Term Work	Pract. and Oral	Oral	
		Test 1	Test 2	Avg					
EEL302	Object Oriented Programming and Methodology Lab	-	-	-	-	25	50	-	75

Course Objectives	• To learn the object oriented programming concepts • To study various java programming constructs like multithreading, exception handling, packages etc. • To explain components of GUI based programming.
Course Outcomes	Students will be able • To apply fundamental programming constructs. • To illustrate the concept of packages, classes and objects. • To elaborate the concept of strings, arrays and vectors. • To implement the concept of inheritance and interfaces. • To implement the notion of exception handling and multithreading. • To develop GUI based application.

- **Prerequisite:** Structured Programming Approach

Module	Content	Hours
1	**OO Concepts:** Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism. **Features of Java, JVM** **Basic Constructs/Notions:** Constants, variables and data types, Operators and Expressions, Revision of Branching looping	02
2	**Classes, Object and Packages** Class, Object, Method.	05

	Constructor, Static members and methods Passing and returning Objects Method Overloading Packages in java, creating user defined packages, access specifiers.	
3	**Array, String and Vector** Arrays, Strings, String Buffer Wrapper classes, Vector	04
4	**Inheritance and Interface** Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword, Implementing interfaces, extending interfaces	03
5	**Exception Handling and Multithreading** Error vs Exception, try, catch, finally, throw, throws, creating own exception Thread lifecycle, Thread class methods, creating threads, Synchronization	04
6	**GUI programming in JAVA** **Applet:** Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing. **Event Handling:** Event classes and event listener **Introduction to AWT:** Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box, and Radio Buttons.	06

Suggested List of Programming Assignments / Laboratory Work:

1. Program on various ways to accept data through keyboard and unsigned right shift operator.
2. Program on branching, looping, labelled break and labelled continue.
3. Program to create class with members and methods, accept and display details for single object.
4. Program on constructor and constructor overloading
5. Program on method overloading
6. Program on passing object as argument and returning object
7. Program on creating user defined package
8. Program on 1D array
9. Program on 2D array
10. Program on String
11. Program on StringBuffer
12. Program on Vector
13. Program on single and multilevel inheritance (Use super keyword)
14. Program on abstract class
15. Program on interface demonstrating concept of multiple inheritance
16. Program on dynamic method dispatch using base class and interface reference.
17. Program to demonstrate try, catch, throw, throws and finally.
18. Program to demonstrate user defined exception

19. Program on multithreading
20. Program on concept of synchronization
21. Program on Applet to demonstrate Graphics, Font and Color class.
22. Program on passing parameters to applets
23. Program to create GUI application without event handling using AWT controls
24. Program to create GUI application with event handling using AWT controls
25. Mini Project based on content of the syllabus. (Group of 2-3 students)

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

Term Work:
Term work shall consist of minimum 16 experiments, assignments (min 2) and class test. The distribution of marks for term work shall be as follows:

Experiments Performance	:10 marks
Assignments	:05 marks
Class Test	:05 marks
Attendance	:05 marks

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

Practical/Oral Examination:
Practical/Oral examination will be based on entire syllabus.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
EEL303	**Electronics Lab-I (abbreviated EL Lab-I)**	**-**	**2**	**-**	**1**	**1**

Course Code	Course Name	Examination Scheme							Total
		Theory				Practical			
		Internal Assessment			End Sem. Exam	Term Work	Pract. and Oral	Oral	
		Test 1	Test 2	Avg					
EEL303	Electronics Lab-I	-	-	-	-	25	25	-	50

Course Objectives	• To understand the basic concept of various electronic devices, circuits and their application. • To develop ability among students to design and implement electronic circuits.
Course Outcomes	Student will be able • To identify the different types of semiconductor devices and demonstrate their applications in electronic circuits. • To determine the dc and ac parameters of semiconductor devices and differential amplifiers. • To analyze the performance of different types of rectifier with and without filter. • To plot frequency response of BJT and JFET amplifier. • To analyze effect of feedback on the performance of amplifier. • To analyze the performance of different type of oscillators

Syllabus: Same as that of Course EEC302 Electronic Devices and Circuits

Suggested List of Laboratory Experiments:

1. Study of V-I characteristics of standard PN junction diode, zener diode, schottkey diode.
2. Use of diode as clipper and clamper
3. Rectifier- Filter performance analysis
4. BJT biasing network stability analysis
5. BJT Input and Output Characteristics for CE/CB/CC configuration
6. Frequency response of BJT CE amplifier
7. Study of JFET characteristics and calculation of parameters
8. Study of MOSFET characteristics and calculation of parameters

9. Frequency response of JFET CS amplifier
10. Study of negative feedback on amplifier performance
11. Study of photo devices applications
12. Study of differential BJT amplifier
13. Study of Darlington pair amplifier
14. Study of a RC phase shift oscillator
15. Study of a Wien Bridge oscillator
16. Study of a Hartley/Colpitts oscillator

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

Term work:

Term work shall consist of minimum 10 experiments. The distribution of marks for term work 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/Oral Examination:

Practical/Oral examination will be based on entire syllabus.

University of Mumbai						
Course Code	**Course Name**	**Teaching Scheme (Contact Hours)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
EEL304	**Electrical Machine Lab-I (abbreviated EMC Lab-I)**	**-**	**2**	**-**	**1**	**1**

Course Code	Course Name	Examination Scheme							Total
		Theory				Practical			
		Internal Assessment			End Sem. Exam	Term Work	Pract. and Oral	Oral	
		Test 1	Test 2	Avg					
EEL304	Electrical Machine Lab-I	-	-	-	-	25	25	-	50

Course Objectives	• Students should understand the concepts of DC machines, Reluctance motor, Stepper motors and their applications. • To impart industry oriented learning.
Course Outcomes	Students will be able • To demonstrate different speed control methods of dc motors. • To illustrate and analyze the performance of dc motors.

Syllabus: Same as EEC-305 (Electrical Machines-I)

Suggested List of Laboratory Experiment:

1. Speed control of DC shunt motor.
2. Load test on DC shunt motor.
3. Load test on DC series motor.
4. Load test on DC compound motor.
5. Brake test on DC motor.
6. Open circuit and load characteristic of DC shunt generator.
7. Rheostatic braking of DC motor.
8. Plugging of DC motor.
9. Retardation test of DC motor.
10. Swinburne's test on DC motor.
11. Hopkinson's test on DC motor.
12. Study of Stepper motor drive.
13. Field test

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

Term work:

Term work shall consist of minimum 8 experiments. The distribution of marks for term work 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/Oral Examination:

Practical/Oral examination will be based on entire syllabus.