SCHEME OF INSTRUCTION AND SYLLABI

B.TECH DEGREE IN

Electrical Engineering

(Department of Electrical Engineering)

AS Per NEP2020

EFFECTIVE FROM 2022-2023

National Institute of Technology Delhi

(NIT DELHI)

Department of Electrical Engineering
National Institute of Technology Delhi

1.1 About the Department

Department of Electrical Engineering (EE), National Institute of Technology Delhi was established in 2010 under the ages of Ministry of Human Resource and Development (MHRD), Govt. of India. Currently it is offering one Undergraduate (B. Tech) course and one Postgraduate (M. Tech) courses in Power Electronics & Drives. The Department also offers PhD programme in relevant areas. The department is equipped with state-of-the-art facilities to carry out research work at all levels. The research focus of the department is in the area of power system reliability, power electronics, renewable energy systems, power systems, control/time delay systems, pattern recognition, image processing etc. The department also actively involved in multi-disciplinary research activities. The UG program is embraced by rigor and span to prepare a practicing engineer for a lifetime of creative work and ongoing technical learning. The department provides healthy & competitive environment for all round development of students leading to several remarkable achievements in GATE, CAT, GRE, TOEFEL, PSUs etc. The department has laboratories, equipped with latest equipment and software platforms, to impart state-of-the art technical knowledge. The department aims to setup new laboratories such as Green Energy Technologies, Digital Control & FPGA Design, Biometric etc. The Department has active collaborations with Institutes & research institutes in India and abroad.
The Department of EE has a blend of young as well as experienced dynamic faculty membersand is committed to provide quality education and research in the field. Faculty members of the department have excellent academic & research credentials and published numerous peer reviewed journal articles/ papers, Books, Book Chapters etc. in diversified field and having adequate experience in advanced research. The department hopes to achieve the national goals and objectives of industrialization and self-reliance. As a result, it hopes to produce graduates with strong academic and practical background so that they can fit into the industry immediatelyupon graduation.

1.2 Vision

- To prepare the global technocrats trained to meet the changing industrial technologies and to mould them into successful and ethical professionals, globally competent in Electrical Engineering and allied fields contributing to nation building.

1.3 Mission

- Offering state-of-art curriculum with advanced laboratory facility and innovative practices in teaching-learning to pursue a career in Electrical Engineering and allied fields.
- To provide a conducive environment for applied interdisciplinary research leading to successful entrepreneurs/professionals.

B. Tech. (Electrical Engineering)

2.1 Preamble

B. Tech. (Electrical Engineering) program offered at NIT Delhi is designed to equip students witha unique blend of skill sets that include:

- Strong theoretical foundation
- Predominantly practice-oriented approach with access to well-equipped and specialized laboratories, and supervised internship via the Practice School
- Hands-on technical training
- Life skills orientation
- Hard and soft skills
- Business perspective, along with emphasis on innovation and entrepreneurship

2.2 Salient Features

- Minimum Credits requirements for completion of B. Tech program is 160.
- The Curriculum is based on the guidelines of National Education Policy (NEP) – 2020.
- The curriculum has embedded the Multi Exit/ Multi Entry in the B. Tech program.
- There is provision of Major degree and Minor Degree for students.
- The curriculum is designed to meet the prevailing and ongoing industrial requirements.
- The curriculum includes Project based Education with Projects every year.
- The curriculum is flexible and offers Choice Based Credit System (CBCS).
- The curriculum inherits the Value based Education and offers Interdisciplinary/ Multidisciplinary Courses.
- The Curriculum offers Digital Pedagogy & Flipped Learning with adequate motivation for Entrepreneurship/ Startups.
- The curriculum aims the Holistic Development of the students.

2.3 Cardinal Mentions

- Students exiting after completing 1st Year, 2nd Year and 3rd Year will be awarded Certificate, Diploma and Advanced Diploma in Electrical Engineering respectively. A minimum Credit requirement for Certificate is 40 Credits, Diploma is 80 Credits and Advanced Diploma is 120 Credits respectively.

- The students can opt for Minor Degree across any specialization offered in the Institute from 5th Semester e.g. a student pursuing B. Tech. (Electrical Engineering) may opt for Minor Degrees offered by the different Departments in the Institute depending upon his/her interest.

- The students opting for Minor Degree will have to earn additional credits for the Minor Degree as per Institute norms which may vary from time to time.

2.4 Program Educational Objectives (PEOs)

PEO-1	Engineering Graduates will excel in Electrical fields both in the industry and academics by analyzing the requirement technically and applying their knowledge in a professional manner.
PEO-2	Demonstrate multi-disciplinary knowledge and skills to analyze, interpret and create solutions to the real-life electrical engineering problems.
PEO-3	Apply the knowledge of electrical engineering to solve problems of social relevancepursue higher education and research.
PEO-4	Engage in lifelong learning, career enhancement and adopt to changing professionaland societal needs.

2.5 Program Outcomes (POs)

PO-1	**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO-2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using firstprinciples of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needswith appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO-4	**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.
PO-5	**Modern Tool usage:** Create, select, and apply appropriate techniques, resources, andmodern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO-6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledgeto assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO-7	**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.
PO-8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilitiesand norms of the engineering practice.
PO-9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**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.
PO-11	**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.
PO-12	**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.

2.6 Program Specific Objectives (PSOs)

PSO -1	Analysis, synthesis and design of electrical equipment and systems to enhance the quality of human life.
PSO -2	Development of innovative and environment – conscious technologies to sustainhuman life.

B. Tech. (Electrical Engineering) Semester wise Credit Structure

Sl. No.	**Courses**	**Credits**								**Total**
		1st Year		**2nd Year**		**3rd Year**		**4th Year**		
		1st Sem	**2nd Sem**	**3rd Sem**	**4th Sem**	**5th Sem**	**6th Sem**	**7th Sem**	**8th Sem**	
1	Program Core	4	7	8	15	16	9	7	4	62
2	Program Electives					3	3	6		15
3	Open Electives						3	3		9
4	Applied Sciences	7	5	4						18
5	Humanities	2					3			5
6	Summer Training & Project		1	0	1	1	2	4	16	23
7	Allied Engineering	7	7	8	4		0			28
Total		**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**160**

Teaching Scheme

Semester I

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	PHLB 102	Electrical Engineering Materials	3	0	0	3
2.	EEBB 102	Basic Electrical Engineering	3	0	2	4
3.	MEBB 162	Engineering Visualization	3	0	2	4
4.	MALB 101	Advanced Calculus	3	1	0	4
5.	MEPB 121	Product Design and Realization Laboratory	0	0	2	1
6.	HMLB 101	Communication Skills	2	0	0	2
7.	CELB 101	Environmental Sciences	2	0	0	2
	Total Credits		16	1	6	20

Semester II

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	MALB 153	Ordinary Differential Equation and Transforms	3	1	0	4
2.	EELB 151	Network Analysis	3	0	0	3
3.	CSBB 181	Problem Solving and Computer Programming	3	0	2	4
4.	MELB 151	Engineering Mechanics	3	0	0	3
5.	EEBB 152	Electrical Workshop	3	0	2	4
6.	HSPB 150	Holistic Health & Sport	0	0	2	1
7.	EEPB 153	Project	0	0	2	1
	Total Credits		15	1	8	20

Semester III

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	MABB 203	Numerical & Engineering Optimization Methods	3	0	2	4
2.	EELB 201	Electro Magnetic Field Theory	3	1	0	4
3.	EEBB 202	Electronic Devices and Circuits	3	0	2	4
4.	EELB 203	Signal & Systems	3	0	0	3
5.	EEBB 204	Electrical Measurements	3	0	2	4
6	EEPB 205	Technical Report Writing	0	0	2	1
	Total Credits		15	1	8	20

Semester IV

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	EEBB 251	Electrical Machines-I	3	0	2	4
2.	EEBB 252	Control Systems	3	0	2	4
3.	EELB 253	Power Transmission and Distribution	3	0	0	3
4.	EEBB 254	Digital Electronics and Logic Design	3	0	2	4
5.	EEBB 255	Internet of Things	2	0	2	3
6.	HMPB 256	Professional Ethics	0	0	2	1
7.	EEPB 257	Project	0	0	2	1
	Total Credits		14	0	12	20

NOTE: Summer Training (6-8 Weeks) is mandatory for each student to continue the program and the evaluation will take place in the Semester-V.

Semester V

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	EEBB 301	Electrical Machines-II	3	0	2	4
2.	EELB 302	Power System Analysis	3	1	0	4
3.	EELB XXX	Elective-I	3	0	0	3
4.	EEBB 303	Microprocessors and Microcontrollers	3	0	2	4
5.	EEBB 304	Power Electronics	3	0	2	4
6.	EEPB 305	Summer Training -I	-	-	-	1
	Total Credits		15	1	6	20

Semester VI

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	EEBB 351	Electric Drives	3	0	2	4
2.	EEPB 352	Electrical Simulation Lab	0	0	2	1
3.	EELB 353	Switchgear & Protection	3	1	0	4
4.	HMLB 352	Engineering Economics and Accountancy	3	0	0	3
5.	EELB 3XX	Elective-II	3	0	0	3
6.		Open Elective-I	3	0	0	3
7.	EEPB 354	Project	0	0	4	2
	Total Credits		15	1	8	20

Open Elective:

Course Code	Course Title	L	T	P	Credits
EELB 391	Fundamentals of Renewable Energy Systems	3	0	0	3

NOTE: Summer Training (6-8 Weeks) is mandatory for each student to continue the program and the evaluation will take place in the Semester-VII.

Semester VII

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	EELB 401	Smart Grid	3	0	0	3
2.	EELB 402	Fundamentals of Machine Learning	3	0	0	3
3	EELB 4XX	Elective-III	3	0	0	3
4	EELB 4XX	Elective-IV	3	0	0	3
5.		Open Elective-II	3	0	0	3
6.	EEPB 403	Power System Lab	0	0	2	1
7.	EEPB 404	Summer Training -II	0	0	4	2
8.	EEPB 405	Project Work	0	0	4	2
	Total Credits		15	0	10	20

Semester VIII

Sl.No.	Course Code	Course Title	L	T	P	Credits
1	EEPB 451	Project Report	-	-	-	16
2	EEPB452	Independent Study and Seminar	0	0	8	04
	Total Credits					20

Department Elective Courses of Specialization in Major Degree of ElectricalEngineering

Bouquet 1 of Department Elective Courses
[Specialization in **Power Electronics** with B. Tech. (EE)]

Course Structure:

S. No.	Elective No.	Course Code	CourseName	L	T	P	Credits
1.	Elective 1	EELB 312	Distributed Power Generation	3	0	0	3
2.	Elective 2	EELB 361	Switched Mode DC-DC Converters	3	0	0	3
3.		EELB362	Special Electrical Machines	3	0	0	3
4.		EELB373	Utilization of Electrical Energy	3	0	0	3
5.	Elective 3 & Elective 4	EELB 411	Power Converters for Renewable Energy Sources	3	0	0	3
6.		EELB 414	Fundamental of Electric Vehicles	3	0	0	3
7.		EELB 415	Power Quality	3	0	0	3

Bouquet 2 of Department Elective Courses
[Specialization in **Power Systems** with B. Tech. (EE)]

Course Structure:

S. No.	Elective No.	Course Code	CourseName	L	T	P	Credits
1.	Elective 1	EELB 312	Distributed Power Generation	3	0	0	3
2.		EELB322	Power System Deregulation	3	0	0	3
3.		EELB 323	Renewable Energy Systems	3	0	0	3
4.	Elective 2	EELB 371	Power System Operation and control	3	0	0	3
5.		EELB372	Energy Auditing and Management	3	0	0	3
6.		EELB373	Utilization of Electrical Energy	3	0	0	3
7.	Elective 3 & Elective 4	EELB 414	Fundamental of Electric Vehicles	3	0	0	3
8.		EELB 415	Power Quality	3	0	0	3
9.		EELB 425	Power System Stability	3	0	0	3

Bouquet 3 of Department Elective Courses
[Specialization in **Signal Processing and Control** with B. Tech. (EE)]

Course Structure:

S. No.	Elective No.	Course Code	CourseName	L	T	P	Credits
1.	Elective 1	EELB 331	Advanced Applications of IOT	3	0	0	3
2.		EELB332	Industrial Automation and Control	3	0	0	3
3.	Elective 2	EELB 381	Image Processing	3	0	0	3
4.		EELB382	Intelligent Control Systems	3	0	0	3
5.	Elective 3 & Elective 4	EELB 431	Biomedical Instruments and Data Interpretation	3	0	0	3
6.		EELB 432	Sensor Design and System Development	3	0	0	3
7.		EELB 433	Embedded Control Systems Modeling and Simulation	3	0	0	3

Course no: PHLB 102	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course				YES
Course Title	**Electrical Engineering Materials**			
Course Coordinator				
Course objectives:	To familiarize students with the properties of various types of electrical engineering materials			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Materials for Electrical Engineering
	Author	B.M.Tareev
	Publisher	Higher School Pubishing House
	Edition	1st
2.	Title	Electronic Properties
	Author	R. Rose, L.A. Shepard and J. Wulff
	Publisher	Wiley Eastern Pvt. Ltd
	Edition	1st

Content

Magnetic Materials

Dia, Para, Ferro, anti-ferro and Ferri magnetic materials, soft and hard magnetic materials, tapes and films, magnetic anisotropy magnetostriction,effect of impurities, losses in magnetic materials.

Semiconductors

Silicon wafer preparation, different fabrication techniques involved in electronic chip in VLSI technology, conductivity of materials electrical and thermal conductivity of materials, bimetals high temperature materials, thermocouples, free electron theory of metals, factors affecting electric conductivity of metals, thermal conductivity of metals, heat developed in current carrying conductors, thermoelectric effect, super conductivity.

Dielectric Materials

Field vectors, polarization, Ferro electricity and Piezo electrics, behavior of polarization under impulse and frequency switching, dielectric loss, spontaneous polarization.

	Insulating Materials Electrical, mechanical and thermal properties of liquid, solid, fibrous insulating materials, glass, ceramic, mineral and plastic materials, relationships between structure and electrical, mechanical, thermal, chemical properties.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEBB 102	Open Course (Y/N)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
Type of course	N0	N0	Yes	No
Course Title	**Basic Electrical Engineering**			
Course Coordinator				
Course objectives:	• To introduce the fundamental concepts relevant to DC and AC circuits • Highlight the importance of electromagnetism and transformers in transmission and distribution of electric power. • To explain the working principle, construction, applications of DC machines, AC machines			
POs				
Semester	Autumn: **I Semester**		Spring: NA	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	2	4
Prerequisite course code as per proposed course numbers	Nil			
Prerequisite credits	Nil			
Equivalent course codes as per proposed course and old course	Nil			
Overlap course codes as per proposed course numbers	Nil			

Text Books:		
1.	Title	Introduction to Electrical Engineering
	Author	Mulukutla S. Sarma
	Publisher	Oxford Press
	Edition	
2.	Title	Electrical Engineering Fundamentals
	Author	V. D. Toro
	Publisher	PHI
	Edition	2015
Reference Book:		
1.	Title	Basic Electrical Engineering
	Author	V.N. Mittle
	Publisher	McGraw Hill Education
	Edition	2017
2.	Title	Basic Electrical and Electronics Engineering

	Author	S.K. Bhattacharya
	Publisher	pearson
	Edition	2nd
Content	**Unit I: Fundamentals Of DC Circuits** Introduction to DC and AC circuits, Active and passive two terminal elements, Ohms law, Voltage-Current relations for resistor, inductor, capacitor, Kirchhoff's laws, Mesh analysis, Nodal analysis, Ideal sources –equivalent resistor, current division, voltage division, Star-Delta Transformation **Unit II: Magnetic Circuits** Introduction to magnetic circuits, analogy between electrical and magnetic circuit, Simple magnetic circuit with DC and AC excitations-Faraday's laws, induced emfs and inductances, magnetic leakages, B-H curve, hysteresis and eddy current loss, magnetic circuit calculations, mutual coupling **Unit III: AC Circuits** Sinusoids, Generation of AC, Average and RMS values, Form and peak factors, concept of phasor representation, J operator Analysis of R-L, R-C, R-L-C circuits Introduction to three phase systems - types of connections, relationship between line and phase values. **Unit IV: Single- Phase Transformer** Principle of operation, construction, emf equation, equivalent circuit, power losses, efficiency, introduction to auto transformer **Unit V: Electrical Machines** Working principle, construction and applications of DC machines and AC machines. **Basic Electrical Engineering Laboratory:** (i) Verification of KVL & KCL, (ii) Mesh analysis & Nodal Analysis, (iii) Star Delta Transformation, (iv) Analysis of AC circuit:- RL, RC & RLC, (v) Series resonance analysis, (vi) study of machines:- DC & AC machines, (vii) Transformer Analysis.	
Course Assessment	Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%. Lab: Continuous Evaluation 50%, End Semester 50%. 60% weightage to theory and 40 % weightage to laboratory for overall grading. Continuous evaluation shall depend on course coordinator.	

Course no: MEBB 162	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**No**
Type of Course	**THOERY**			
Course Title	**ENGINEERING VISUALIZATION**			
Course Coordinator				
Course objectives:	1. To impart and inculcate proper understanding of the theory of projection. 2. To improve the visualization skills. 3. To enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient. 4. To impart the knowledge on understanding and drawing of simple residential/office buildings.			
Course Outcomes (Cos)	CO-1	Recall the use of different instruments used in Engineering Drawing and Importance of BIS and ISO codes.		
	CO-2	Illustrate various types of mathematical curves and scale.		
	CO-3	Classify different types of projection and Construct Orthographic projection of Point, Line, Plane and Solid.		
	CO-4	Construct Isometric Projection and Conversion of Orthographic view to Isometric view and vice-versa.		

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	**48**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Engineering Drawing
	Author	N. D. Bhatt
	Publisher	CharotarPublishing House Pvt. Ltd.
	Edition	Fifty Third 2014
Reference Books:		
1.	Title	AutoCAD 2007 Bible
	Author	E. Finkelstein
	Publisher	Wiley Publishing Inc.
	Edition	2007

Content	**UNIT I**: Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons. Scales: Plain scales, Diagonal scales, Scale of chords. **UNIT II**: Curves used in Engineering Practice: Ellipse, Parabola, Hyperbola, normal and tangents to these curves, Involute, Cycloid, Epi-cycloid, Hypo-cycloid, Spiral, Helix on cone and cylinder. **UNIT III**: Orthographic projection of points: Principles of Orthographic projection, Projections of points. Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces, Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes. **UNIT IV**: Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section. **UNIT V:** Isometric views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects. Assembly drawings of the machine parts. **NOTE:** Interpretation of drawings: Introduction of CAD package to construct a simple solid model, using a CAD package to construct solid models and generating orthographic, isometric, sectional views with dimensioning, Assembly of components and generation of corresponding drawings. Animation of single of machines in CAD.
Course Assessment	Theory (60%): Continuous Evaluation 25%, Mid Semester 25% End Semester 50% Laboratory (40%): Continuous Evaluation 50%

Course no: MALB 101	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course				YES
Course Title	**Advanced calculus**			
Course Coordinator				
Course objectives:	To acquaint the students with the knowledge of series & sequence, single & multiple variable calculus, knowledge of vector calculus and their applications.			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	3	1	0	4	36+12
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Advanced engineering mathematics
	Author	Kreyszig
	Publisher	Wiley-India
	Edition	9th
2.	Title	Advanced engineering mathematics
	Author	Jain/Iyenger
	Publisher	Narosa
	Edition	2nd
3	Title	Advanced engineering mathematics
	Author	Taneja
	Publisher	I K international
	Edition	
4	Title	Advanced engineering mathematics
	Author	Alan Jeffery
	Publisher	Academic Press
	Edition	

Content	**Infinite series:** Tests for convergence of series (Comparison, Ratio, Root, Integral, Raabe's, logarithmic), Alternating series, Absolute convergence, Conditional convergence. **Differential & Integral Calculus of single variable:** Taylor's & MaClaurin's expansion, Radius of curvature, Tracing of some standard curves, Applications of definite integral to Area, Arc length, Surface area and volume (in cartesian, parametric and polar co-ordinates). **Calculus of several variables:** Partial differentiation, Euler's theorem, Total differential, Taylor's theorem, Maxima-Minima, Lagrange's method of multipliers, Application in estimation of error and approximation. **Multiple Integrals:** Double integral (Cartesian and polar co-ordinates), Change of order of integration,Triple integrals (Cartesian, cylindrical and spherical co-ordinates), Beta and Gamma functions, Applications of multiple integration in area and volume. **Vector Differential Calculus:** Continuity and differentiability of vector functions, Scalar and Vector point function, Gradient, Directional Derivative, Divergence, Curl and their applications. **Vector Integral Calculus:** Line integral, Surface integral and Volume integral, Applications to work done by the force, Applications of Green's, Stoke's and Gauss divergence theorems.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MEP 121	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of Course	Laboratory			
Course Title	**PRODUCT DESIGN & REALIZATION LABORATORY**			
Course Coordinator				
Course objectives:	The student will be able to identify the manufacturing processes required to manufacture an engineering product. The student will have a brief exposure of basic manufacturing machineries and processes, which are widely utilized in industries to manufacture products and also introduce the basic principle of 3D modelling of products and develop 3D model using software such as SolidWorks etc.			
COS	1. Define the basic of design (2D and 3D models) and associated tools. 2. Demonstrate the knowledge and necessary skills to create various prototypes in the Sheet metal operation, Fitting Work and Welding operations and to perform sand testing, preparation of moulds. 3. Demonstrate the working principle of lathe machine and able to fabricate the prototypes of desired shape and accuracies.			
POs				
Semester	**Autumn: NO**		**Spring: YES**	
	Lecture	**Tutorial**	**Credits**	**Total teaching hours**
Contact Hours	0	0	1	**12**
Prerequisite course code as per proposed course numbers				
Prerequisite Credits				
Equivalent course codes as per proposed course and old course	MEP 121			
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Introduction to Basic Manufacturing Processes and Workshop Technology
	Author	Rajendra Singh

	Publisher	New Age International Publishers, India
	Edition	2006
Reference Books:		
1.	Title	A Textbook of Workshop Technology: Manufacturing Processes
	Author	R. S. Khurmi& J K Gupta
	Publisher	S. Chand Publications
	Edition	16/e
Content	**UNIT I:** **02** Introduction to Product Design: Basics of Product design, Design process. SolidWorks : Basics and the User Interface, Design Intent, File References, Opening Files, Solid Works User Interface. 2D Sketching, Stages in the Process, Saving Files, what are We Going to Sketch, Sketching, Sketch Entities, Basic Sketching, Rules That Govern Sketches, Design Intent, Sketch Relations, Dimensions, Extrude, Sketching Guidelines. **UNIT II** **04** Fitting Shop: Preparation of Square Fit Work piece, Preparation of T-shape, Preparation of U-shape, Preparation of V-Fit Work piece that contains: Filing, Sawing, Measuring, Punching and Finishing, Practice marking operations. **UNIT III:** **04** Machine Shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools). Demonstration of different operations on Lathe machine. Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting. Study of Quick return mechanism of Shaper. **UNIT IV:** **04** Foundry Shop: Introduction to foundry, Patterns, pattern allowances, ingredients of moulding sand and melting furnaces. Foundry tools and their purposes. Demo of mould preparation. Preparation of mould by using split pattern. **UNIT V:** **04** Welding Shop: Introduction to welding, Study of Welding tools and equipment, Selection of welding electrode and current, Bead practice, Practice of Butt Joint, Lap Joint, T joint. **UNIT VI:** **04** Sheet Metal Shop: Introduction to sheet metal operation, Tools, Metals used in Sheet Metal. Preparation of square tray, preparation of Funnel, Cylinder using a G.I. Sheet.	
Course Assessment	Continuous Evaluation 50% End Semester 50%	

Course no: CELB 101	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	No
Type of course				
Course Title	**Environmental Studies**			
Course Coordinator				
Course objectives:	Gain a comprehensive understanding of the Environmental Science aspects. Develop awareness of environment related issues. Learn about the ethical and moral responsibilities of the engineers towards Environment Learn remedial measures to solve environmental issues.			
POs				

Semester	**Autumn: Yes**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	2	0	0	2	24
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Introduction to Environmental Engineering
	Author	Davis M. L. and Cornwell D. A
	Publisher	McGraw Hill, New York 4/e
	Edition	4
2.	Title	Introduction to Environmental Engineering and Science
	Author	Masters G. M., Joseph K. and Nagendran R
	Publisher	Pearson Education, New Delhi. 2/e
	Edition	2nd
3	Title	Environmental Engineering
	Author	Peavy H. S., Rowe D.R. and Tchobanoglous G
	Publisher	McGraw Hill, New York
	Edition	
4	Title	Introduction to Environmental Engineering
	Author	Mines R. O. and Lackey L. W.
	Publisher	Prentice Hall, New Yark
	Edition	

Content	**Unit 1: Multidisciplinary nature of environmental studies** Definition, scope and importance, need for public awareness. **Unit 2: Ecosystem** Ecosystems - Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems: - a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems, Biogeochemical cycles. **Unit 3: Biodiversity and its conservation** Introduction – Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. Inida as a megadiversity nation, Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. **Unit 4: Environmental Pollution** Definition, Cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. nuclear hazards, Causes, effects and control measures of urban and industrial wastes. Pollution case studies. Solid waste Management. **Unit 5: Social Issues and the Environment** From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Climate change, global warming, acid rain, ozone layer depletion and Eutrophication.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MALB 153	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course				YES
Course Title	**Ordinary Differential Equation and Transforms**			
Course Coordinator				
Course objectives:	To impart knowledge of matrices and applications closed form and series solutions of Differential equations, Laplace Transform, Fourier series, Fourier Transform & their applications.			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	3	1	0	4	36+12
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Advanced engineering mathematics
	Author	Kreyszig
	Publisher	Wiley-India
	Edition	9th
2.	Title	Advanced engineering mathematics
	Author	Jain/Iyenger
	Publisher	Narosa
	Edition	2nd
3	Title	Advanced engineering mathematics
	Author	Taneja
	Publisher	I K international
	Edition	
4	Title	Advanced engineering mathematics
	Author	Alan Jeffery
	Publisher	Academic Press
	Edition	

Content	**Matrices:** Rank of a matrix, Inverse of a matrix using elementary transformations, Consistency of linear system of equations, Eigen- values and Eigenvectors of a matrix, Cayley Hamilton theorem, Diagonalization of matrix.

	Ordinary differential equations: Second & higher order linear differential equations with constant coefficients, General solution of homogenous and non - homogenous equations, Method of variation of parameters, Euler-Cauchy equation, Simultaneous linear equations, Applications to simple harmonic motion. **Special Functions:** Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel functions of first kind, Orthogonal property. **Laplace Transforms:** Basic properties, Laplace transform of derivatives and integrals, Inverse Laplace transform, Differentiation and Integration of Laplace transform, Convolution theorem, Unit step function, Periodic function, Applications of Laplace transform to initial and boundary value problems. **Fourier series:** Fourier series, Fourier Series of functions of arbitrary period, Even and odd functions, half range series, Complex form of Fourier Series, Numerical Harmonic analysis. Fourier Transforms: Fourier Transforms, Transforms of derivatives and integrals, Applications to boundary value problem in ordinary differential equations (simple cases only).
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EELB 151	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course				YES
Course Title	**Network Analysis**			
Course Coordinator				
Course objectives:	To familiarize the students with the concepts of network analysis			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Network Analysis
	Author	M.E. Van Valkenburg
	Publisher	PHI
	Edition	
2.	Title	Linear circuit Analysis: Time Domain, Phasor, andLaplace Transform Approaches
	Author	Decarlo & Lin
	Publisher	Oxford
	Edition	
3	Title	Network Analysis and Synthesis
	Author	F.F. Kuo
	Publisher	John Wiley and Sons
	Edition	
4	Title	Engineering Circuit Analysis
	Author	Hayt, Kemmerly & Durbin
	Publisher	Tata McGraw Hill Publishing Company Ltd
	Edition	

Content	**Network Theorems:** Superposition, Thevenin's theorem, Norton's theorem, maximum powertransfer theorem, reciprocity theorem, Miller's theorem **Network Topology and Graph Theory:** Introductory concepts of network graphs, cut sets, loops, cut set and loopanalysis **Network Analysis in time Domain:** Analysis of First and Second order circuits using differential equations **Transient response of networks using Laplace Transform:** Review of properties and applications of Laplace transform of complexwaveform and transient response of R- L- C series, parallel, series-parallel circuits for all kinds of excitations **Two Port Networks:** z, y, h, g, ABCD, inverse ABCD parameters, their inter conversion, interconnection of two 2-port networks **Elements of Realizability:** Positive real functions; definition & properties, Foster's I and II, Cauer's I and II forms, Synthesis of LC, RC, RL Networks, image parameters andbasics of two-port synthesis
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: CSBB 181	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	NO	NO	NO
Type of course	**Core**			
Course Title	**PROBLEM SOLVING AND COMPUTER PROGRAMMING**			
Course Coordinator				
Course objectives:	This course aims to provide the students with a foundation in computer programming. The goals of the course are to develop the basic programming skills in students, and to improve their proficiency in applying the basic knowledge of programming to solve problems related to their field of engineering.			
POs				

Semester	**Autumn: Yes**		**Spring:**		
I	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total teaching hours**
Contact Hours	3	0	2	4	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1	Title	Programming in ANSI C
	Author	E. Balagurusamy
	Publisher	TATA McGraw Hill
	Edition	6th edition, 2012
Reference Book:		
1	Title	Let Us C
	Author	Yashavant Kanetkar
	Publisher	Infinity Science Press
	Edition	13th edition, 2012
2	Title	The C Programming Language
	Author	Brian Kernighan & Dennis Ritchie
	Publisher	Prentice Hall
	Edition	2nd Edition, 1988
3	Title	Schaum's Outline of Programming with C

	Author	Byron S Gottfried
	Publisher	TATA Mc Graw Hill
	Edition	2nd edition, 1996
Content	**Unit – 1** (5 Hours) Introduction to Computers: Hardware and Software. Basic Model of Computation, Notion of Algorithms, Flowcharts, Top down design, Bottom up approaches of problem solving, Number system. **Unit – 2** (9 Hours) Introduction to programming language, Basics of C, Basic Data types – int, float, double, char, Bool, Void. Arithmetic and logical operators: precedence and associativity. Flow of Control- Conditional statements- If-else, Switch-case constructs, Loops- While, do-while, for. **Unit – 3** (7 Hours) Function – User defined functions, library functions, Parameter passing – call by value, call by reference, recursion. **Unit – 4** (7 Hours) Arrays- Advantages and drawbacks, One dimensional, Multi-Dimensional Arrays and strings: Declaration, Initialization, Accessing, Passing arrays and strings as parameters to functions. Pointers, Dynamic memory allocation, Dynamic arrays – One dimensional, Multidimensional dynamic arrays. **Unit – 5** (8 Hours) Structure: Declaration, Initialisation, passing structure to function, Use of pointers in structure. Preprocessors, Macros, File management in C I/O – Opening, closing and editing files. Correctness & Efficiency Issues in Programming, Time & Space measures.	
Course Assessment	Continuous Evaluation 25%	
	Mid Semester 25%	
	End Semester 50%	

Course no: MELB 151	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	No
Type of Course	Theory			
Course Title	**Engineering Mechanics**			
Course Coordinator				
Course objectives:	1.To apply the knowledge of mathematics, Science and Engineering and to expand this into the vast area of 'rigid body mechanics'. 2.To impart knowledge about the basic laws of statics and their applications in problem solving. 3.To enhance the ability to design and solve open ended problems. 4.To prepare the students for higher level of courses in the demine of mechanical engineering.			
POs				

Semester	**Autumn: Yes**		**Spring:**		
I	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total teaching hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:

1. Engineering Mechanics by Shames & Rao – Pearson Education, 2005.
2. Engineering Mechanics by Dr. R.K. Bansal, Lakshmi Publications, 2009.
3. Engineering Mechanics – B. Bhattacharyya, Oxford University Publications, 2008.
4. Engineering mechanics by S S Bhavikatti, New age International Publications, 2017.

Reference Books:

1. Engineering Mechanics by Fedrinand L.Singer – Harper Collings Publishers, 1994.
2. Engineering Mechanics by Seshigiri Rao, Universities Press, Hyderabad, 2005.
3. Engineering Mechanics by Rajsekharan, Vikas Publications, 2005.
4. Engineering Mechanics (Statics and Dynamics) by Hibller and Gupta; Pearson Education, 2016.
5. Engineering Mechanics by S.Timoshenko, D.H.Young and J.V.Rao, Tata McGraw-Hill Company, 2013.
6. Engineering Mechanics by Chandramouli, PHI publications, 2011.
7. Engineering Mechanics –Arthur P. Boresi and Richard J. Schmidt. – Brooks/Cole – Cengage, 2002.

Content	**UNIT - I**

	Introduction to Engineering Mechanics- classification of engineering mechanics – basic terminologies in mechanics - units and dimensions – laws of mechanics – parallelogram and triangular law of forces – Lame‟s theorem- principle of transmissibility – single equivalent force – simple problems. **UNIT - II** **Equilibrium of rigid body**- composition system of forces – resolution of forces – general method of composition of forces – equilibrium of bodies – equilibrium of connected bodies – simple examples - Moment of a force – Varignon‟s theorem – couple – resultant of non-concurrent force system- x and y intercept of resultant- simple problems. **UNIT - III** **Support Reactions-** introduction – types of supports – types of loading – analytical method for finding out the reactions of a beam – simple problems on simply supported beams, overhanging beams and roller and hinged supports beams. **UNIT- IV** **Center of gravity and centroid –** Determination of areas – First moment of area and the centroid of sections – Rectangle, circle, triangle from integration – T-section, I-section, angle section, hollow sections by using standard formula. **UNIT - V** **Area moment of inertia and mass moment of inertia –** Introduction – radius of gyration – theorem of perpendicular axis – theorem of parallel axis – second moment of area – rectangle, circle, triangle from integration – T-section, I-section, angle section, hollow section by using standard formula – polar moment of inertia – mass moment of inertia. **UNIT - VI** **Friction-** Introduction - Types of friction - laws of Coulomb friction – Frictional force –Angle of repose –Equilibrium of a body lying on rough inclined plane – Analysis of ladder friction – Analysis of wedge friction.
Course Assessment	Continuous Evaluation 25%
	Mid Semester 25%
	End Semester 50%

Course no: ELBB 152	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of Course	Theory			
Course Title	**Electrical Workshop**			
Course Coordinator				
Course objectives:				
POs				
Semester	**Autumn: yes**		**Spring: Yes**	

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	36(L)+24(P)
Prerequisite course code as per proposed course numbers	Nil				
Equivalent course codes as per proposed course andold course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:		
1.	Title	Electrical Installation Estimating & Costing
	Author	Gupta, J.B.
	Publisher	S. K. Kataria & Sons, New Delhi
	Edition	
2.	Title	Electrical Design, estimating & Costing
	Author	Raina, K. B. and Bhattacharya,S.K.
	Publisher	New Age International (p) Limited, New Delhi
	Edition	
Reference Books:		
3.	Title	I.E. rules for wiring, Electricity supply act-1948.
	Author	Bureau of Indian Standards
	Publisher	Electricity supply act-1948
	Edition	
4.	Title	Electrical Workshop: Safety, Commissioning, Maintenance & Testing of Electrical Equipment
	Author	R.P. Singh

	Publisher	wiley
	Edition	3rd
Content	**Electrical Wiring:** I.E. rules on electrical wiring. Types of domestic and industrial wirings. Study of wiring accessories e.g. switches, fuses, relays, MCB, ELCB, MCCB etc. Joints in electrical conductors. Measurement of conductor size using SWG and micrometer. Grading of cables and current ratings. Principle of laying out of domestic wiring. Voltage drop concept. PVC conduit and Casing capping wiring system. Different types of wiring. Wiring circuits planning, permissible load in subcircuit and main circuit. Estimation of load, cable size, bill of material and cost. Inspection and testing of wiring installations. Special wiring circuit e.g. godown, tunnel and workshop etc. **Batteries and solar cell:** Chemical effect of electric current and Laws of electrolysis. Explanation of Anodes and cathodes. Types of cells, advantages / disadvantages and their applications. Lead acid cell: Principle of operation and components. Types of battery charging, Safety precautions, test equipment and maintenance. Grouping of cells for specified voltage and current. Principle and operation of solar cell. **Electrical Earthing:** Importance of Earthing. Plate earthing and pipe earthing methods and IEE regulations. Earth resistance by earth tester / megger. Earth leakage by ELCB and relay. **Electrical illumination:** Laws of Illuminations. Types of illumination system. Illumination factors, intensity of light. Type of lamps, advantages/ disadvantages and their applications. Calculations of lumens and efficiency. **Experiments:** 1. Make simple straight twist and rat-tail joints in single strand conductors, married and 'T' (Tee) joint in stranded conductors, Britannia straight and 'T' (Tee) joint in bare conductors, straight joint in different types of underground cables. 2. Measure insulation resistance of underground cable. 3. Determine the internal resistance of cell and make grouping of cells. 4. Carry out installation and maintenance of batteries. Determine total number of cells required for a given power requirement. 5. Plan work in compliance with solar panel installation norms. Combination of solar cells for given power requirement. Assemble and install solar panel. Check the functionality of solar panel. 6. Prepare and mount the energy meter board. Draw and wire up the consumers main board with ICDP switch and distribution fuse box. Draw and wire up a bank/hostel/jail in PVC conduit. 7. Identify the types of fuses their ratings and applications. Identify the parts of a relay, MCB & ELCB and check its operation. 8. Estimate the cost of material for wiring in PVC channel for an office room having 2 lamps, 1 Fan, one 6A socket outlet and wire up. 9. Estimate the requirement for conduit wiring (3 phase) and wire up. Estimate the

	materials and wire up the lighting circuit for a godown. Estimate the materials and wire up a lighting circuit for a corridor in conduit. 10. Test, locate the fault and repair a domestic wiring installation. 11. Install the pipe and plate earthing and test it. Measure the earth electrode resistance using earth tester. Carry out earth resistance improvement.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: MABB 203	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of Course	Theory			
Course Title	**Numerical and Engineering Optimization Methods**			
Course Coordinator				
Course objectives:	The course aims at building capabilities in the students for analyzing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.			
POs				
Course Outcomes (COs):	**CO1** : Solve linear programming problems using appropriate techniques and Optimization solvers, interpret the results obtained. **CO2** : Determine an optimal strategy for Minimization of Cost of shipping of products from source to Destination/ Maximization of profits of shipping products **CO3** : Optimize the allocation of resources to demand points in the best possible way **CO4** : Formulate network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems **CO5** : Evaluation of real world problem using modern optimization techniques			

Semester	**Autumn: Yes**		**Spring:**		
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	36 (L) + 24 (P)
Prerequisite course code as per proposed course numbers	Nil				
Equivalent course codes as per proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:		
1.	Title	Introduction to Operations Research
	Author	F Hillier and G Lieberman
	Publisher	McGraw Hill
	Edition	9th
2.	Title	Engineering Optimization Theory and Practice
	Author	Singiresu S Rao
	Publisher	Wiley
	Edition	2019
Reference Books:		

<table>
<tr><td rowspan="4">3.</td><td>Title</td><td>Numerical Analysis</td></tr>
<tr><td>Author</td><td>Richard L. Burden and J. Douglas Faires</td></tr>
<tr><td>Publisher</td><td>Richard Stratton.</td></tr>
<tr><td>Edition</td><td>9th</td></tr>
<tr><td>Content</td><td colspan="2">Unit I: Linear Programming
Definition and scope of operations research, Mathematical formulation of the problem, graphical method, Simplex method, Artificial basis technique, Dual Simplex method. Degeneracy, Alternative optima, Unbounded solution, Infeasible solution.

Unit II: Transportation Problem
Introduction to the problem, Linear programming formulation of a transportation problem. The basic feasible solution by north-west corner method, Vogel's approximation method, least cost method. Finding optimal solution by Modified Distribution method, degeneracy, unbalanced transportation problem and Maximization in transportation model.

Unit III: Assignment Problem
Meaning of assignment problem, unbalanced assignment problem, traveling salesman problem, Hungarian method for the optimal solution, maximization in the assignment problem.

Unit IV: Project Planning through Networks
Introduction, Basic steps in Program Evaluation and Review technique (PERT)/ Critical Path Method (CPM) techniques, Network diagram representation, Rules of drawing network diagram, Fulkerson's rule, Time estimates and Critical path in network analysis, floats, Program evaluation and review technique, Application areas of PERT/CPM techniques.

Unit V: Optimization Theory
Introduction, Gauss-Seidel, Newton-Raphson method, Euler, Taylor Series and Runge-Kutta Methods, Genetic algorithm, Particle Swarm Optimization, Ant Colony Optimization, Optimization of Fuzzy Systems, Neural-Network-Based Optimization.

Numerical and Engineering Optimization Methods Laboratory:
(i) Linear Programming Problem - Graphic solution. (ii) Simplex method. (iii) Two phase simplex methods. (iv) Transportation - north-west corner method. (v) Vogel's approximation method. (vi) Assignment problem. (vii) Travelling salesman problems. (viii) Implementation of the Root finding Methods (Newton-Raphson method). (ix) Implementation of the Linear Systems (Gauss Elimination, Gauss Jordan,). (x) Neural-Network-Based Optimization.</td></tr>
<tr><td>Course Assessment</td><td colspan="2">Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%
Lab: Continuous Evaluation 50% End Semester 50%
60% weightage to theory and 40 % weightage to laboratory for overallgrading</td></tr>
</table>

Course no: EELB 201	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	N	Y	N
Type of course	Core			
Course Title	**Electromagnetic Field Theory**			
Course Coordinator				
Course objectives:	• Use different coordinate systems , Coulomb's Law and Gauss Law for the evaluation of electric fields produced by different charge configurations. • Calculate the energy and potential due to a system of charges & Explain the behavior of electric field across a boundary conditions. • Explain the Poisson's, Laplace equations and behavior of steady magnetic fields. • Explain the behavior of magnetic fields and magnetic materials. • Asses time varying fields and propagation of waves in different media.			
POs				

Semester 3	**Autumn:** Yes		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**1**	**0**	**4**	**36(L) + 12(T)**
Prerequisite course code as per proposed course numbers	NA				
Prerequisite credits	NA				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:		
1.	Title	Principles of Electromagnetics
	Author	Mathew N. O. Sadiku
	Publisher	Oxford University Press Inc.

	Edition	6
2.	Title	Electromagnetism – Theory and Applications
	Author	AshutoshPramanik
	Publisher	PHI.
	Edition	
3.	Title	Engineering Electromagnetics
	Author	W H Hayt, J A Buck
	Publisher	McGraw Hill Education
	Edition	8
4.	Title	Fundamentals of Electromagnetics with MATLAB
	Author	Karl E. Longren
	Publisher	Scitech
	Edition	1
Reference Book:		
1.	Title	Theory and Problems of Electromagnetics
	Author	Joseph. A.Edminister
	Publisher	Tata McGraw Hill
	Edition	Second edition
2.	Title	Electromagnetics with Applications
	Author	Kraus and Fleish
	Publisher	
	Edition	McGraw Hill International Editions, Fifth Edition, 1999

Content

Introduction

Vector Algebra, Cartesian, Cylindrical and Spherical Co-ordinate System. Transformation of Variables from Cartesian to Cylindrical and Spherical Coordinate System and Vice-Versa, Gradient, Divergence and Curl.

Electrostatics

Coulomb's Law, Electric field intensity, Field due to point and continuous charges, Gauss's law and application, Electric potential, Electric field and equipotential plots, Electric field in free space, conductors, Dielectric polarization, Dielectric strength, Electric field in multiple dielectrics, Boundary conditions, Poisson's and Laplace's equations, Capacitance- Energy

Magnetostatics

Lorentz Law of force, magnetic field intensity, Biot–savart Law, Ampere's Law, Magnetic field due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials, Magnetization – Magnetic field in multiple media,

	Boundary conditions, Magnetic force, Torque, Inductance. **Time Varying Fields** Faraday's law, Displacement current. Maxwell's equations in point form and integral form. Numerical. **Uniform plane wave** Wave propagation in free space and in dielectrics. Pointing vector and power considerations. Propagation in good conductors, skin effect. Numerical.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEBB 202	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Other Engg. Core			
Course Title	**Electronic Devices and Circuits**			
Course Coordinator				
Course objectives:	To make the Students i. familiar with the structure of basic electronic devices. ii. exposed to the operation and applications of electronic devices.			
POs				

Semester	**Autumn:** Yes		**Spring:** Yes		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers	NA				
Prerequisite credits	NA				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:

1.	Title	Electronic Devices and Circuits
	Author	David A. Bell
	Publisher	Prentice Hall of India
	Edition	
2.	Title	Microelectronic Circuits
	Author	Sedra and smith
	Publisher	Oxford University Press

	Edition	2004
3.	Title	Electronic Devices and Circuit theory
	Author	Robert L.Boylestad
	Publisher	Pearson Education
	Edition	11 edition (2015)
4.	Title	Integrated Electronics
	Author	Millman&Halkias
	Publisher	McGraw Hill Education
	Edition	3 edition (2010)
Reference Book:		
1.	Title	Electronic Devices
	Author	Floyd
	Publisher	Pearson Asia
	Edition	9th Edition, 2012.

Content

Diodes

Review of semiconductors, p-n junction, forward and reverse biased junction, equivalent circuits; Applications - rectifier, clipper, clamper, voltage doubler, transfer characteristics; Zener diode; Power supply, filter, zener regulator; Special purpose diodes.

Bipolar Junction transistors

npn and pnp transistors, input and output characteristics - cut-off, saturation and active regions; CE, CB and CC configurations, small signal model, BJT as amplifier; Biasing circuits; Stability analysis, DC and AC equivalent circuits. Small-signal Analysis:h-parameter model of BJT, analysis of BJT amplifier circuits, cascaded amplifiers, frequency response of RC coupled amplifier.

Power Amplifiers

DC and AC load lines; Class A operation; Class B operation, push-pull circuit; Biasing circuits, Class C amplifier; Current source

Field Effect Transistors

Operating characteristic, transductance, JFET as amplifier, biasing circuits; Applications.

Active Filters & Oscillators:

Advantages of active filters, classification of filters, response characteristics of butter worth, Chebyshev, causal filters, first order and second order butter worth filters- lowpass and high pass types. Band pass & band reject filters. Oscillator principles, types ofoscillators - phase shift, wein bridge & quadrature, square wave, triangular wave and saw tooth wave generators, voltage-controlled oscillator.
Barkhausen criterion, damped oscillation in LC circuits; Harmonic oscillators- RC- phase shift oscillator, transistor phase shift oscillator; Tuned oscillator- Colpitts oscillator, Hartley oscillator; Crystal oscillator

	Operational Amplifiers: The basic operational amplifier & its characteristics, Block diagram representation ofOP-AMP, Power supply requirements of an OP-AMP, Evolution of OP-AMP. **Voltage Regulators** Zener voltage regulator, emitter follower regulator, series voltage regulator, IC regulator **Laboratory Experiments:** 1. Ripple And Regulation Characteristics Of Full Wave And Half Wave With Filters (C,L,Lc,Clc) 2. Clippers and Clampers 3. Half Wave and Full Wave Voltage Doubler, Tripler. 4. BJT Characteristics NPN & PNP (CB, CC And CE). 5. Biasing Circuits Of BJT 6. Amplifier Class A,B,AB By Using BJT 7. FET Characteristics (N & P Channel) 8. MOSFET Characteristics (N & P Channel) 9. RC Phase Shift Oscillators by Using BJT 10. Operational Amplifiers Characteristics 11. Zener Diode &IC Voltage Regulator 12. Series & Emitter Follower Voltage Regulator
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: **EELB 203**	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of Course	Theory		**Core Engineering Course**	
Course Title	**SIGNALS AND SYSTEMS**			
Course Coordinator				
Course objectives:	Coverage of continuous and discrete-time signals and systems, their properties and representations and methods those are necessary for the analysis of continuous and discrete-time signals and systems. Knowledge of time-domain representation and analysis concepts as they relate to difference equations, impulse response and convolution, etc. Knowledge of frequency-domain representation and analysis concepts using Fourier Analysis tools, Z-transform. Mathematical and computational skills needed in application areas like communication, signal processing and control, which will be taught in other courses			
POs				
Semester	**Autumn: Yes**		**Spring: No**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	None				
Prerequisite Credits	None				
Equivalent course codes as per proposed course and old course	None				
Overlap course codes as per proposed course numbers	None				

Text Books:		
1.	Title	Signals and Systems
	Author	Alan V. Oppenheim, Alan S. Willsky with S. HamidNawab
	Publisher	PHI Publications

	Edition	
2.	Title	Principles of Linear Systems and Signals
	Author	B.P. Lathi
	Publisher	Oxford University Press Publications
	Edition	
3.	Title	Signals and Systems
	Author	Simon Haykin
	Publisher	John Wiley and Sons Publications
	Edition	
Content	**CLASSIFICATION OF SIGNALS AND SYSTEMS** Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_ sampling and quantization, Classification of signals — Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals — Classification of systems- CT systems and DT systems- — Linear& Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable. **ANALYSIS OF CONTINUOUS TIME SIGNALS** Fourier series for periodic signals — Fourier Transform — properties- Laplace Transforms and properties **LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS** Impulse response — convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems — Systems connected inseries / parallel. **ANALYSIS OF DISCRETE TIME SIGNALS** Baseband signal Sampling — Fourier Transform of discrete time signals (DTFT) — Properties of DTFT — Z Transform & Properties **LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS** Impulse response — Difference Equations- Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EELB 204	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	No	No	Yes	No
Course Title	**Electrical Measurements**			
Course Coordinator				
Course objectives:	• To impart knowledge of different errors, their sources from where they arise in measurement of a quantity and their analysis • To explain the basic principle, working and construction of various instruments used for measuring the electrical and magnetic quantities • Learning about various AC bridge methods for the measurement of different range of inductances of a coil and capacitance of a capacitor • To understand various methods for the measurement of different range of resistance. • Understanding the basic principle of working of potentiometers, procedures for measurement of electrical quantities using potentiometer and calibration of instruments • To learn use of instrument transformers for the measurements of high voltage and current in an electrical circuit.			
POs				
Semester	Autumn:		Spring: 3rd SEMESTER	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	2	4
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	A Course in Electrical & Electronic Measurements and Instrumentation
	Author	A.K.Sawhney
	Publisher	Dhanpat Rai
	Edition	19th
Reference Book:		
1.	Title	Electronic Instrumentation and Measurement Techniques
	Author	W.D. Cooper & A.D. Helfrick
	Publisher	Prentice-Hall India
	Edition	
2.	Title	Electrical Measurement & Measuring Instruments

	Author	E.W. Golding
	Publisher	WhELLer Publishing
	Edition	
Content	**Unit I: Vector Errors and Accuracy** Static error, static calibration, error calibration curve, limiting errors, relative limiting errors, types of errors- gross errors, systematic errors, random (residual) errors, accuracy and precision, static sensitivity, linearity, hysteresis, threshold, dead time, resolution of instrument, loading effects, introduction to measurement standards. **Unit II: Ammeters and Voltmeters, Wattmeters** Introduction, D'Arsonval galvanometer, moving iron & moving coil instruments, electrodynamometer, electrostatic instruments, induction type energy-meter, wattmeter, Power Factor meter. **Unit III: Resistance Measurements** Methods of measurement of low, medium and high resistance, measurement of earth resistance, localization of cable faults by Murray and Varley loop test. **Unit IV: Inductance and Capacitance Measurements** Measurement of inductance and capacitance by A.C. Bridge methods, Q-factor and dissipation factor, sources of errors in bridge circuits, methods of reducing bridge errors, Wagner Earthing Device. **Unit V: Potentiometers** Basic D.C. potentiometer circuit, modern form of D.C. potentiometer, measurement of voltage, current, resistance and calibration of voltmeter & ammeter using D.C. potentiometer, volt ratio box, A.C. potentiometers and their applications. **Unit VI: Instrument Transformers** Introduction, use of Instrument transformers, ratios, basic constructional features of C.T. and P.T., ratio and phase angle errors, reduction of errors. **Measurement Laboratory:** Kelvin's double bridge – De-Sauty & Schering bridge : Determination of loss-angle of a capacitor - Calibration : Wattmeter, energy meter- Determination of errors of potential transformer- Determination of hysterisis loss- Maxwell's inductance – capacitance bridge – to measure resistance and inductance of the given unknown impedance- Determination of errors of current Transformers- Anderson's Bridge to measure self-inductance & internal resistance of a coil , Cable Fault Detection-Murray & Varley Loop Test, Hay's bridge.	
Course Assessment	Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%. Lab: Continuous Evaluation 50%, End Semester 50%. 60% weightage to theory and 40 % weightage to laboratory for overall grading. Continuous evaluation shall depend on course coordinator.	

Course no: EEPB 205	Open course (Y/N)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
Type of course	No	No	Yes	No
Course Title	**Technical Report Writing**			
Course Coordinator				
Course objectives:				
POs				
Semester	Autumn:		Spring: 3rd SEMESTER	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	2	4
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Content

1. Explicate Microsoft office for documentation
   - 1.1 Formatting
   - 1.2 Document structure
   - 1.3 Figures and Tables
   - 1.4 MathType Editor for equation
   - 1.5 Review
   - 1.6 References and Citations
2. Explicate the LaTeX for documentation
   - 2.1 Formatting
   - 2.2 Document structure
   - 2.3 Figures and Tables
   - 2.4 Equation
   - 2.5 References and Citations
3. Illustrate Visio software for drawing the figures
4. Explicate about literature review for technical report/research paper/patents
5. Explicate technical product brochure design using Microsoft office

	6. Explicate research paper writing using Microsoft word and LaTeX 7. Explicate Project Report writing using Microsoft word and LaTeX 8. Explicate Patents/IPR Report writing
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEBB 251	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	No	No	Yes	No
Course Title	**Electrical Machines-I**			
Course Coordinator				
Course objectives:	CO-1: Gain comprehensive understanding of the working, operation, and testing of transformers. CO-2: Explain and apply the concepts of electromechanical energy conversion. CO-3: Gain comprehensive understanding of the working, operation, testing, and control of DC Motors and DC Generators CO-4: Comprehend the practical knowledge of transformer and dc machines			
POs				
Semester	Autumn:		Spring: 4TH SEMESTER	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	2	4
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Electrical Machinery
	Author	Dr. P. S. Bimbhra
	Publisher	Khanna Publisher
	Edition	Latest
2.	Title	Electrical Machines
	Author	D. P. Kothari and I. J. Nagrath
	Publisher	Mc. Graw Hill Education
	Edition	Latest
Reference Book:		
1.	Title	The Performance and Design of Alternating Current Machines
	Author	M.G. Say
	Publisher	CBS
	Edition	3rd Edition
2.	Title	Performance & Design of Direct Current Machines
	Author	A .E. Clayton and N.N. Hancock

	Publisher	CBS
	Edition	3rd Edition
3.	Title	Theory of AC Machinery
	Author	A.S. Langsdorf
	Publisher	Tata McGraw Hill Edition
	Edition	Latest
4.	Title	Electric Machinery
	Author	A. E. Fitzerald, C. Kingsley and S. D. Umans
	Publisher	Tata McGraw Hill
	Edition	Latest
Content	**Transformers:** (14 Hours) Construction, theory and operation of ideal and practical transformer, E.M.F. equation, phasor diagram, equivalent circuit. Testing: polarity test, open and short circuit tests, and Sumpner's back to back test. Per-unit transformer values, voltage regulation and efficiency. Parallel operation of single-phase transformers. Autotransformers: working, equivalent circuit, comparison with two-winding transformer. Introduction to three phase transformers. **Basic Concepts of Rotating Electrical Machines:** (6 Hours)) Constructional details of rotating machines. Distributed and concentrated windings, full-pitch and short-pitch windings, EMF and MMF produced by distributed and concentrated winding. **DC Machines**: (16 Hours) Types of dc machines, EMF and Torque equation, armature reaction, methods to limit armature reaction, and commutation process. DC generator: operating principle, voltage build-up, and operating characteristics. DC motor: operating principle, torque development, operating characteristics, starting and speed control. Testing: Swinburne's test, Hopkinson's test. Losses and efficiency calculation: DC generator and motor. Laboratory: (Minimum ten experiments to be performed. List of experiments to be finalized by the course coordinator.) Transformers: 1. Testing of transformers (open-circuit/short-circuit test, polarity, load test), 2. Voltage regulation, 3. Parallel operation, 4. Scott-Connection, 5. Sumpner's test, 6. To convert two winding single-phase transformers into single-phase auto- transformer. DC Machines: 1. To plot different characteristics of dc generators, 2. To plot different characteristics of dc motors, 3. Speed control of different D.C. motors using armature control and field control methods.	
Course Assessment	Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%. Lab: Continuous Evaluation 50%, End Semester 50%. 60% weightage to theory and 40 % weightage to laboratory for overall grading. Continuous evaluation shall depend on course coordinator.	

Course no: EEBB 252	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Core			
Course Title	**Control Systems**			
Course Coordinator				
Course objectives:	This is a first course on feedback control of dynamic systems. It provides basic concepts and principles of modelling, analysis and controller design for continuous linear time-invariant systems with techniques including roots locus and frequency response methods. Laboratory experiments are designed so that the theory learnt in the class can be applied to real physical systems.			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers	NA				
Prerequisite credits	NA				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:

1.	Title	Control Systems Engineering
	Author	I.J. Nagarath& M. Gopal
	Publisher	New Age Pub. Company
	Edition	
2.	Title	Automatic Control Systems
	Author	B.C. Kuo
	Publisher	PHI

	Edition	
3.	Title	Modern Control Engineering
	Author	Kotsuhiko Ogata
	Publisher	Prentice Hall of India
	Edition	

Content	**Introduction** Concepts of control systems, open loop and closed loop control systems and their differences, different examples of control systems. **Mathematical Modelling and Transfer Function of Physical Systems** Mathematical modeling of electrical and mechanical systems, transfer function of DCservo motor, AC servo motor, block diagram representation of systems considering electrical systems as examples, block diagram reduction technique and signal flow graph, mason's gain formula. **Time Response Analysis** Standard test signals, time response of first order systems, characteristic equation of feedback control systems, transient response of second order systems, time domain specifications, steady state response, steady state errors and error constants, effects of proportional derivative, proportional integral systems. **Stability Analysis in S-Domain** The concept of stability- Routh's stability criterion, absolute, relative, conditional and bounded input, bounded output stability, limitations of Routh's stability. **Root Locus Technique** The root locus concept, construction of root loci, effects of adding poles and zeros to G(s)H(s) on the root loci. **Frequency Response Analysis** Introduction, frequency domain specifications, bode diagrams-determination of frequency domain specifications and transfer function from the bode diagram, phase margin and gain margin, stability analysis from bode plots, polar plot, nyquist plots, stability analysis. **Classical Control Design Techniques** Compensation techniques – Lag, Lead, Lead-Lag controllers design in frequency domain, PID controllers.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory foroverall grading

Course no: EELB 253	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	No
Type of Course	Theory			
Course Title	**Power Transmission and Distribution**			
Course Coordinator				
Course objectives:	To familiarize students with the infrastructure of power systems and to introduce the design aspects of power system distribution and transmission.			
POs				
Semester	**Autumn: yes**		**Spring: Yes**	

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36(L)
Prerequisite course code as per proposed course numbers	Nil				
Equivalent course codes as per proposed course andold course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:		
1.	Title	Power System Analysis & Design.
	Author	J. D. Glover, M. S. Sharma, T. J. Overbye
	Publisher	Cengage
	Edition	
2.	Title	A Text Book on Power System Engineering
	Author	M. L. Soni, P. V. Gupta, U. S. Bhatnagar and A. Chakraborti
	Publisher	Dhanpat Rai & Co. Pvt. Ltd
	Edition	
3.	Title	Generation Distribution and Utilizationof Electrical Power,., 2005.
	Author	C. L. Wadhwa
	Publisher	New Age International Ltd
	Edition	
4.	Title	Power System Analysis
	Author	J. J. Grainger and W. D.Stevenson
	Publisher	McGraw-Hill International Book Company
	Edition	2008
5.	Title	Electrical Power Distribution Systems by Turan Gonen,
	Author	Turan Gonen
	Publisher	Mc. Graw-hill
	Edition	
Content	**Introduction:** General Structure of Electrical Power System- Introduction to Power System, Generation, Transmission, Distribution and Utilization- Overview	

	Single Line Diagram representation. **Transmission of Electrical Power:** Brief introduction to AC and DC transmission systems. AC Transmission line parameters: Types of conductors – ACSR, Bundled and Stranded conductors- Skin Effect- Calculation of inductance and capacitance for single phase and three phase, Single and double circuit lines, Concept of GMR & GMD, Symmetrical and asymmetrical conductor configuration with and without transposition. Effect of ground on Capacitance. **Performance of AC transmission line:** Short, Medium and Long lines and their exact equivalent circuits- Nominal- T, Nominal-π. Regulation and Efficiency of transmission lines. Long transmission line-Rigorous solution. A, B, C, D parameters of transmission lines. Surge impedance and Surge impedance loading - Wavelengths and Velocity of propagation, Ferranti effect. **Mechanical design of transmission lines:** Overhead line insulators: Types of Insulators, String efficiency and methods for improvement. Phenomenon of corona, Factors affecting corona. **Distribution of Electric power:** Classification of distribution systems, DC and AC distribution systems, Underground and Overhead Distribution Systems. Design considerations of distribution feeders: Radial and loop, Primary feeders, Voltage levels, Feeder loading.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEBB 254	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	NO	NO	NO
Type of course	**Other Engineering Courses**			
Course Title	**DIGITAL ELECTRONICS & LOGIC DESIGN**			
Course Coordinator				
Course objectives:	This course is aimed to provide an introduction to digital logic design and its ability to understand number system representations, binary codes, binary arithmetic and Boolean algebra, its axioms and theorems, and its relevance to digital logic design. It also introduces combinational circuits, synchronous sequential logic and Asynchronous sequential logic.			
POs				

Semester	**Autumn:**		**Spring: Yes**		
IV	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total teaching hours**
Contact Hours	3	0	2	4	36(L) + 24(P)
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes asper proposed course numbers	NIL				

Text Books:		
1	Title	Digital Design
	Author	Mano, M. Morris
	Publisher	Pearson Education
	Edition	Third Edition, 2002
Reference Book:		
1	Title	Digital Fundamentals
	Author	Floyd, Thomas L.
	Publisher	Pearson Education, Singapore
	Edition	Seventh Edition, 2002
2	Title	Digital Electronics
	Author	Gothmann, William H.
	Publisher	PHI, New Delhi
	Edition	Second Edition 2000
3	Title	Jain, R.P.
	Author	Modern Digital Electronics

	Publisher	TMH, New Delhi
	Edition	Third Edition 2003
Content	**Number system and codes:** Analog versus digital, merits of digital system, number systems, base conversions, complements of numbers weighted and unweighted codes and error detecting and correcting codes, Alpha numeric code (ASCII), Error detecting and correcting codes. **Switching algebra and switching functions:** Boolean algebra, postulates, theorems and switching algebra, completely and incompletely specified switching functions, Representation of Booleanfunctions in sum of products form and product of sums form, minimizationof Boolean functions using Karnaugh map and Quine McCluskey methods. Problem solving. **Combinational logic circuits:** Logic gates, Logic gates operation using discrete components, Universal Logic gates, Logic design of combinational circuits: adders, Code converters, Comparators, multiplexers, de-multiplexers, encoders, decoders, buffers, tri-state buffers. **Logic Families:** Transistor as an inverter/switch. Classification of logic families and their developments. TTL NAND gate analysis, ECL and CMOS logic family. Comparison TTL CMOS and ECL logic families. **Flip-Flops:** RS Flip flop, Clocked RS flip-flop, JK flip-flop, T-flip-flop, JK flip-flops and M/S JK flip flop, Conversion of flip-flops. **Registers:** Buffer Register, Controlled buffer register, Shift Registers (Left shift and Right shift register), Universal shift register: SISO, SIPO, PISO, PIPO, Ring counter and twisted ring counter **Counters:** Design of Asynchronous and Synchronous counters. **Comparators & Converters:** Basic comparator & its characteristics, zero crossing detector, voltage limiters, clippers & clampers, small signal half wave & full wave rectifiers, absolute value detectors, sample and hold circuit.	
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overallgrading	

Course no: EEBB 255	Open course(YES /NO)	HM Course(Y/N)	DC(Y/N)	DE(Y/N)
Type of course			Y	
Course Title	**Internet of Things**			
Course Coordinator				
Course objectives:	1. To study the characteristics and architecture of IoT. 2. To understand different technologies and protocols used for IoT. 3. To study different sensors, actuators and microcontrollers. 4. To study about the platforms used for building IoT applications. 5. To perform experiments on the interfacing and controlling using IoT.			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	2	0	2	3	24 (L) + 24 (P)
Prerequisite course Code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and Old course					
Overlap course codes as per proposed Course numbers					

TextBooks:

1.	Title	Smart Grid Security
	Author	Gilbert N. Sorebo and Michael C. Echols
	Publisher	CRC Press
	Edition	1st
2.	Title	Smart Grid Applications, Communications and Security
	Author	Lars T. Berger and Krzysztof Iniewski
	Publisher	Wiley
	Edition	1st

Content

Introduction to IoT

Overview of IoT, Characteristics and Implementation of IoT, Components, Architecture, IoT Technologies and Protocols: BLE, Zigbee, LPWAN, RFID, 6LoWPAN, Cellular Networks, WiFi, 5G.

Sensors, Actuators and Microcontrollers

Classification of Sensors, Types of Sensors, Criteria for selecting sensor, Classification of Actuators, Microcontroller, Components and Types of Microcontroller, Embedded system.

Building IoT Applications

	Introduction to Arduino and Raspberry Pi, Installation, Interfaces (serial, SPI, I2C), Types of Arduino Boards, Arduino IDE: Features and Parts, Programming for IoT. **Experiments:** Controlling the LED, blink rate of LED, Detection of light using photo resistor, Interfacing of temperature sensor, servo motor, Active buzzer, relay etc. with Arduino, Building intrusion detection system, Directional control of DC motor, Air pollution measurement, etc.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: HMPB 256	**Open course**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course		YES	NO	NO
Course Title	**Professional Ethics**			
Course Coordinator				
Course objectives:	By studying this course, the students will be able to understand the key issues in engineering ethics and the professional world. They will inculcate the sense of the right ethical foundation to be adopted in their personal lives and professional domains. The students will learn their professional rights and codes of conduct as employees specifically and overall social responsibility as global citizens. They will get the basic understanding of intellectual property rights that would help them file patents nationally and internationally. In the end, they will be acknowledged with the global issues of concerns related to technological progress and relevant to the engineering profession.			

Semester	Autumn:		Spring: 4th	
	Lecture	Tutorial	Practical	Credits
Contact Hours	0	0	2	1
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:

1.	Title	Professional Ethics
	Author	Subramanian. R.
	Publisher	Oxford Publication, 2013
	Edition	
2.	Title	Professional Ethics and Values
	Author	D R Kiran
	Publisher	McGraw Hill Education India Publications
	Edition	Second Edition
3.	Title	Ethics in Engineering
	Author	Martin. MW and Schinzinger. R.
	Publisher	McGraw Hill Education India Publications
	Edition	Fourth Edition

Content	**Unit I: Introduction: Professional, Personal and Engineering Ethics** Introduction to Professional Ethics: Basic Concepts, Governing Ethics, Personal & Professional Ethics, Indian Constitution: Rights & Duties, Engineering Ethics. **Unit II: Value Education: Moral Values and Moral Development** Moral Development, Codes of Ethics, Ethical Decision Making, Ethical Dilemmas, Applying Moral Philosophy to Ethical decision Making, Cognitive Moral Development, White – Collar Crime, Lessons from Ancient Indian Education system **Unit III: Engineering as Social Experimentation and Commitment to Safety** Engineering as experimentation, Engineers as Responsible Experimenters, Codes of Ethics-IEEE, Safety and Risk –Concept and Assessment of Safety and Risk, Risk Benefit Analysis and Reducing Risk, Public Risk and Acceptance- Case studies **Unit IV: Workplace Ethics: Responsibilities and Rights** Confidentiality- definitions, changing jobs and management policies, Conflicts of Interest, Rights of Engineers- Professional Rights and Employee Rights , Whistleblowing, Intellectual Property Rights (IPR). **Unit V: Global issues in Professional Ethics** Technology: Value neutral or Value laden and Globalization of MNCs, World Summits, Issues, Corporate Governance, Sustainable Development Ecosystem, Ozone Deflection, Pollution, Ethics in Manufacturing and Marketing, Media Ethics; War Ethics.
Course Assessmen	Continuous Evaluation 50%, End Semester 50%

Course no: EEBB 301	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	No	No	Yes	No
Course Title	**Electrical Machines-II**			
Course Coordinator				
Course objectives:	CO-1: Gain comprehensive understanding of the working, operation, testing, and control of three-phase induction motor. CO-2: Gain comprehensive understanding of the working and operation of synchronous motor and generator. CO-3: Illustrate the power flow and parallel operation of synchronous generators CO-4: Comprehend the practical knowledge of induction motor and synchronous machines			
POs				
Semester	Autumn: 5th Semester		Spring:	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	2	4
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Electrical Machinery
	Author	Dr. P. S. Bimbhra
	Publisher	Khanna Publisher
	Edition	Latest
2.	Title	Electrical Machines
	Author	D. P. Kothari and I. J. Nagrath
	Publisher	Mc. Graw Hill Education
	Edition	Latest
3	Title	Electrical Machinery and Transformers
	Author	B. S. Guru and R. Hiziroglu
	Publisher	Oxford
	Edition	Latest
Reference Book:		
1.	Title	The Performance and Design of Alternating Current Machines
	Author	M.G. Say
	Publisher	CBS
	Edition	3rd Edition
2.	Title	Performance & Design of Direct Current Machines

	Author	A .E. Clayton and N.N. Hancock
	Publisher	CBS
	Edition	3rd Edition
3.	Title	Theory of AC Machinery
	Author	A.S. Langsdorf
	Publisher	Tata McGraw Hill Edition
	Edition	Latest
4.	Title	Electric Machinery
	Author	A. E. Fitzerald, C. Kingsley and S. D. Umans
	Publisher	Tata McGraw Hill
	Edition	Latest

Content

Three-Phase Induction Machines: (15 Hours)
Construction, theory and principle of operation, emf equation, slip, equivalent circuit, expressions for power (air gap power, output power etc.) and losses, torque (full load torque, maximum torque, starting torque, etc.), torque-slip/torque-speed characteristics. Testing: no load and blocked rotor test, starting of induction motors, speed control of induction motor, cogging & crawling, deep bar and double cage rotor. Introduction to induction generators.

Single Phase Induction Motors: (5 Hours)
Principle of operation, double revolving field theory and types of motors.

Synchronous Machines: (16 Hours)
Construction, principle of operation as motor and generator. Alternator operation under different power factor loads. Circuit model of synchronous machines. Determination of synchronous reactance, open and short circuit characteristics. Armature reaction and its effects. Determination of regulation by MMF/Potier triangle methods for non-salient pole machines. Rating of synchronous machines. Operating characteristics of synchronous generator and synchronous motor (variable excitation with constant load and constant excitation with variable load). Steady-state power flow transfer equations and Power-angle/Torque-angle characteristics. V-curves and inverted V-curves. Efficiency calculation. Synchronization of alternators and operation on infinite bus-bar. Parallel Operation of Alternators. Hunting and its suppression, starting of synchronous motor, synchronous condenser. Two reaction model for salient pole machines. Determination of X_d and X_q- slip test.

Laboratory:

Induction Machine: (i) Determination of equivalent circuit parameters of three phase induction motor, no-load and block-rotor test, (ii) study the starting of 3-phase induction motor, (iii) speed control of 3-phase induction motor by voltage control, rotor resistance control, V/f control etc., (iv) study the single-phase operation of 3-phase induction motor,

Synchronous Machine: (v), to plot characteristics of 3-phase alternator (vi) determination of V and inverted V curves of 3-phase synchronous machine, (vii) circuit parameters estimation of single-phase induction motor, (viii) synchronization of alternator using dark-lamp method, (ix) parallel operation of alternators, (x) to perform load test of 3-phase alternator.

Course Assessment

Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%.
Lab: Continuous Evaluation 50%, End Semester 50%. 60% weightage to theory and 40 % weightage to laboratory for overall grading.
Continuous evaluation shall depend on course coordinator.

Course no: EELB 302	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of Course	Theory			
Course Title	**Power System Analysis**			
Course Coordinator				
Course objectives:	To familiarize the students with the techniques for analyzing a power System during normal operation and abnormal conditions.			
POs				
Course Outcomes:	**CO1:** Analyze and understand per unit system **CO2:** Perform load flow computations and analyze the load flow results. **CO3:** To analyze and understand economic load dispatch **CO4:** To analyze a network under both balanced and unbalanced fault conditions **CO5:** To develop the knowledge of power system stability			
Semester	**Autumn: yes**		**Spring: Yes**	

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	1	0	4	36(L)+12(T)
Prerequisite course code as per proposed course numbers	Nil				
Equivalent course codes as per proposed course andold course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:		
1.	Title	Power System Analysis
	Author	H.Saadat
	Publisher	Tata McGraw-Hill Publishing Company Limited
	Edition	2008
2.	Title	Computer Techniques in Power System Analysis
	Author	M. A.Pai
	Publisher	Tata McGraw-Hill Publishing Company Limited
	Edition	2nd Ed.,2008
3.	Title	Reactive Power Control in Electric Systems
	Author	T. J. E.Miller
	Publisher	John Wiley and Sons

	Edition	2010
4.	Title	Power System Analysis
	Author	J. J. Grainger and W. D.Stevenson
	Publisher	McGraw-Hill International Book Company
	Edition	2008
5.	Title	Power System Analysis and Design
	Author	J. D. Glover and M. S.Sarma
	Publisher	Cengage Learning
	Edition	4th Ed.
Content	**Per Unit Representation of Power Systems:** The one-line diagram, impedance and reactance diagrams, per unit quantities,changing the base of per unit quantities, advantages of per unit system. **Load flow analysis:** Numerical techniques for solving algebraic equations, matrix representation of the power system, load flow equations, application of Gauss-Seidel method forsolving load flow equations, application of Newton-Raphson method for solving load flow equations, fast decoupled solution for load flow equations. **Economic load dispatch:** Introduction to constrained optimization, optimal scheduling of generators, network loss modelling. **Short circuit analysis:** System representation for short circuit analysis, balanced short circuit analysis, Significance of positive, negative and zero sequence components, sequence impedances and sequence networks, fault calculations, single line to ground fault, line to line fault, double line to ground fault, three phase faults **Stability analysis:** Basic concept of stability, Classification of stability, Swing equation, power angle equation, synchronizing power coefficient, basic concepts of steady state, dynamic and transient stability, equal area criterion, solution of the swing equation.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EEBB303	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory and Practical			
Course Title	Microprocessors and Micro Controllers			
Course Coordinator				
Course objectives:	To introduce the 8086 microprocessors and their interfacing, Develop assembly level programs on the 8051 and PIC 18F-microcontrollerplatforms.			
POs				
Semester	Autumn: Yes		Spring: No	

	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	3	0	2	4	36(L) + 24(P)
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:

1.	Title	Microprocessors and Interfacing
	Author	Douglas V. Hall, SSSP Rao
	Publisher	Mc Graw Hill
	Edition	3rd Edition, 2012
2.	Title	Advanced Microprocessor and Peripherals
	Author	Ray A.K., Bhurchandi K.M
	Publisher	McGraw Hill Education Publications
	Edition	3rd Edition, 2017.
3.	Title	The 8051 Microcontroller
	Author	Kenneth J Ayala
	Publisher	Cengage Learning Publications
	Edition	3rdEdition, 2007

Content

Introduction:

Overview of the course, Functional elements of a microprocessor, overview of architecture of a general-purpose microprocessor.

8086 Microprocessor:

Internal Architecture of 8086, BIU and EU- Registers in of 8086- Memory segmentation- Addressing modes-register related and memory related- Instruction formats, Instruction set of 8086- Assembler directives,Tutorial-

	Problems on assembly language programming- Pin diagram of 8086, Modes of operation- Timing diagrams of typical instructions- Fundamentals of I/O data transfer, Polling, Handshaking, interrupts-Stepsin an interrupt process, Interrupt structure in 8086 **Fundamentals of interfacing peripheral chips**: Interfacing memory & I/O devices- Interfacing I/O- Programmable peripheral interface-8255, Modes of operation of 8255, Interfacing examples with 8255- Interfacing 8254 timer, Interfacing Digital to analog converters, Analog to Digital converters- Interfacing USART 8251. **8051 Microcontroller:** 8051 architecture, memory organization, addressing modes & port structure, external memory access, counters and timers, Interrupts, serial communication, Microcontroller instructions, moving data, logical operations, arithmetic operations, jump and call instructions –subroutines - Interrupts and returns. Microcontroller programming – Assembly Language Programming, timer and counter programming, Interrupt programmingInterfacing examples. **PIC Microcontrollers (PIC 18F):** Introduction - Architecture – Memory organization – Assembly Language Programming and programming with Embedded C – simulation using Integrated Development Environment (IDE) - Programming of I/O ports – Addressing modes. Bank switching – Look-up Table and Table processing – Timers and its programming – Interrupt sources- analog-to-digital converter (ADC) module-Brown-out-reset (BOR), Power on-reset (POR), Capture/Compare/PWM modules, USART, Master Synchronous Serial Port (MSSP) Module -Interfacing examples. **Advanced Microprocessors:** Multi-User/Multi-Tasking Operating System, Memory **Laboratory:** Experiments follow the contents of the course covered during the lectures.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overallgrading

Course no: EEBB 304	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**Yes**	**No**
Type of Course	Theory and Practical			
Course Title	**Power Electronics**			
Course Coordinator				
Course objectives:	The course aims at familiarizing the students with the operating characteristics of semiconductor devices, triggering circuits and their applications for power control. The course also deals with the detailed analysis and operation of power controllers.			
POs				
Semester	**Autumn:** No		**Spring:** Yes	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:		
1.	Title	Modern Power Electronics
	Author	B. K. Bose
	Publisher	IEEE Press
	Edition	
2.	Title	Power Electronics-Circuits, Devices & Applications
	Author	M.H. Rashid

	Publisher	Pearson Education
	Edition	
Content	**Characteristics of Various Solid State Devices** Introduction, power semiconductor devices: power diode, power transistor, MOSFET, Thyristor & its two-transistor model, Triac, Gate turn off thyristor (GTO), insulated gate bipolar transistor (IGBT), comparison of switching power devices, turn on & turn off characteristics, driver circuits. **AC to DC Converters** Commutation, single phase and three phase bridge rectifiers, semi controlled & fully controlled rectifiers, dual converters, effect of load and source inductance. **DC to DC Converters** Principle of operation, control strategies, step-up, step-down choppers, types of chopper circuits, steady state analysis, multiphase chopper. **DC to AC Inverters** Voltage source inverters, single phase inverter, three phase inverter, harmonic reduction techniques and PWM techniques, current source inverter. **AC to AC Converters** Single phase & 3-phase AC voltage controllers using thyristors , phase control and integral cycle control, AC choppers, single phase cyclo-converters, applications, effects of harmonics. **Power Electronics Laboratory:** 1. Study of characteristics of power semiconductor switching devices (SCR, Triac, MOSFET, IGBT), 2. Study of two-pulse fully controlled rectifier, feeding R, RL and RLC (DC-motor) loads 3. Study of a six-pulse half controlled rectifier feeding R, RL and RLE loads 4. Study of a six-pulse fully controlled rectifier feeding R and RL loads 5. Closed-loop control of a six-pulse fully controlled rectifier 6. Study of a 1- phase inverter with square wave, quasi-square wave and SPWM control 7. Speed control of induction motor with V/f control method using 3-phase inverter 8. Open –loop control of a separately excited DC motor drive with a 6-phase fully controlled rectifier 9. Study of characteristics of a step-down chopper 10. Study of AC chopper with R and RL loads to achieve power control 11. Study of performance of a PWM controlled AC-DC converter 12. Study of performance of a 1-phase cyclo-converter.	
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading	

Course no: EEBB 351	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Theory and Practical			
Course Title	**Electrical Drives**			
Course Coordinator				
Course objectives:	To understand basic of DC/AC electrical drives, their speed control and braking techniques			
POs				

Semester	**Autumn:** Yes		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposedcourse numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codesas per proposed course numbers	---				

Text Books:

1.	Title	Power Electronics and Motor Control
	Author	Shepherd, Hulley, Liang
	Publisher	Cambridge University Press
	Edition	2nd Ed.
2.	Title	Modern power Electronics and AC drives
	Author	B.K.Bose
	Publisher	pearson publications
	Edition	
3.	Title	Control of Electric Drives
	Author	Werner Leonhard
	Publisher	Springer
	Edition	

Content	**Fundamentals of Electric Drives** Electric drive – Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods: Dynamic – Plugging – Regenerative methods. **Controlled Converter Fed DC Motor Drives** 1-phase half and fully controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics – Principle of operation of dual converters and dual converter fed DC motor drives -Numerical problems. **DC–DC Converters Fed DC Motor Drives** Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current operation – Output voltage and current waveforms – Speed–torque expressions – Speed–torque characteristics – Four quadrant operation – Closed loop operation (qualitative treatment only). **Stator side control of 3-phase Induction motor Drive** Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop v/f control of induction motor drives (qualitative treatment only). **Rotor side control of 3-phase Induction motor Drive** Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics – Advantages – Applications. **<u>Laboratory:</u>** 1. Measurement of Moment of Inertia of a 3-phase induction motor using retardation Test 2. To perform rheostat braking of a DC Shunt motor and observe the impact of increasing resistance on braking time 3. To perform counter-current braking of a DC –Shunt type motor and observe the impact of plugging resistance on braking time 4. To validate armature and flux control of a DC – shunt type motor using rheostats 5. To validate two-quadrant operation of a DC– shunt type motor using Ward-Leonard Method of speed control 6. To validate the speed control of a DC-shunt type motor by using DC-DC chopper circuit 7. To perform DC-dynamic braking of a 3-phase induction motor and observe the impact of DC current on braking time 8. To perform counter-current braking of a 3-phase induction motor and observe the impact of braking resistance on braking time 9. To validate V/F control of a3-phase induction motor using 3-phase Voltage Source Inverter 10. To perform speed control of a 3-phase slip-ring Induction motor by rotor resistance variation.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: EELB 353	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**Yes**	**No**
Type of Course	Theory			
Course Title	**Switchgear and Protection**			
Course Coordinator				
Course objectives:	• Identify various types of faults in Power system • Explain working of different types of relays in power system. • Maintain the protection of transmission line and feeder from various faults • Protect transformer, alternator, motor and bus bar • Explain working of different types of circuit breakers in power system.			
POs				
Semester	**Autumn:** No		**Spring:** Yes	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	**3**	**0**	**0**	**3**	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:

1.	Title	Fundamentals of power system protection
	Author	Y. G. Paithankar and S. R. Bhide
	Publisher	Prentice Hall
	Edition	
2.	Title	Switchgear and Power System Protection
	Author	Ravindra P.Singh
	Publisher	PHI Learning Private Ltd
	Edition	
3.	Title	Power System Protection and Switchgear
	Author	Badri Ram, D N Vishwakarma
	Publisher	TMH
	Edition	

Content	**Unit I: Protection Schemes** Principles and need for protective schemes, nature and causes of faults, types of faults, methods of neutral grounding, zones of protection and essential qualities of protection. **Unit II: Protective Relays** Operating principles of relays, universal relay, torque equation, R-X diagram, electromagnetic relays, over current, directional, distance, differential, negative sequence, thermal relays, distance protection- impedance relay, reactance relay, mho relay, input quantities for various types of distance relays, effect of arc resistance, power swings, line length and source impedance on the performance of distance relays, selection of distance relays. Static relay, Construction and types. Principle and working of Microprocessor based relay **Unit III: Protection of Transmission Line and Feeder** Transmission line protection scheme: -Overload protection, Over-current and earth fault protection, Time graded and current graded protection, Current balance differential protection, Carrier aided protection, Carrier inter-tripping, acceleration and blocking scheme, Distance /Impedance protection, types of Auto reclosing, Protection of parallel feeders and Ring Mains **Unit IV: Protection of Transformer, Alternator, Motor and Busbar**Over current, Percentage differential and restricted earth fault protection of Transformers, Inrush phenomenon and over fluxing phenomenon in Transformer, Buchholz Relay, analysis of trapped gases, Various faults and abnormal operating conditions in Alternator and its protection schemes. Various faults and abnormal occurring in the Motor and its protection schemes Differential Protection of Bus bars **Unit V: Circuit Breakers** Physics of arcing phenomenon and arc interruption, DC and AC circuit breaking, re-striking voltage and recovery voltage, rate of rise of recovery voltage, resistance switching, current chopping, interruption of capacitive current, types of circuit breakers – air blast, air break, oil, SF6 and vacuum circuit breaker, comparison of different circuit breakers, rating and selection of circuit breakers.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: HMLB 352	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	Yes	Yes	No
Type of course	Theory			
Course Title	**Engineering Economics and Accountancy**			
Course Coordinator				
Course objectives:	By studying this course, the students will be able to understand the Key issues in managerial economics as applied by the managers at the firm level. The students will be able to evaluate the capital budgeting and costing decisions in investment projects in the real business world. They will understand the key basic concepts of macroeconomics and accountancy helpful in understanding how the Indian economy works. The course will help them to develop an economic sense at the micro as well the macro level of different economic activities.			
POs				

Semester	**Autumn:** Yes		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**0**	**3**	**36(L)**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codesas per proposed course numbers	---				

Text Books:

1.	Title	Engineering Economics
	Author	R. Paneerselvam
	Publisher	PHI Learning
	Edition	Second Edition
2.	Title	Fundamentals of Engineering Economics
	Author	Pravin Kumar
	Publisher	Wiley Publications
	Edition	Engineering Economics

Content

Unit I: Engineering Economics

Introduction to Engineering Economics – Fundamental concepts-Time value of money – Cash flow and Time Diagrams – Choosing between alternative investment proposals. (6 hours)

Unit II: Capital Budgeting

Methods of Economic analysis (Pay back, ARR, NPV, IRR and B/C ratio). Depreciation and methods of calculating depreciation (Straight line, Sum of the years digit method, Declining Balance Method, Annuity Method, Sinking Fund method.) (7 hours)

	Unit III: Indian economy and Economic Development National Income Accounting – Methods of Estimation – Various Concepts of National Income – Significance of National Income Estimation and its limitations. Inflation: Definition- Measures to Control (Monetary and Fiscal policy). New Economic Policy 1991 Breakeven Analysis – Meaning and its application, Limitation. (8 hours) **Unit IV: Financial Accounting:** Accounting Principles, procedure-Double entry system – Journal, ledger, Trial balance – Cash Book – Preparation of Trading and Profit and Loss account – Balance Sheet. Cost Accounting - Introduction-Classification of costs – Methods of Costing-Techniques of Costing. E-commerce: Importance and Need. (8 hours) **Unit V: Managerial Economics** Scope of Managerial Economics: Theory of Demand and Theory of Supply. Law of demand and Law of Supply. Techniques of Managerial Economics; Theory of firm, Theory of Market Structure. Applications of Managerial Economics. (7 hours)
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EELB 391	**Open Course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	Yes	N0	N0	No
Course Title	**Fundamentals of Renewable Energy Systems**			
Course Coordinator				
Course Outcomes:	Comprehensive knowledge of the renewable energy system and their applications.			
POs				
Semester	Autumn: **No**		Spring: Yes	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Non-Conventional Energy Resources
	Author	B H Khan
	Publisher	McGraw Hill Education
	Edition	
2.	Title	Non-Conventional Energy Resources
	Author	S. N. Singh
	Publisher	Pearson
	Edition	
Reference Book:		
1.	Title	Power Electronics for Renewable and Distributed Energy Systems
	Author	Sudipta Chakraborty, Marcelo G. Simoes, William E Kramer
	Publisher	Springer
	Edition	
2.	Title	Wind Power Technology
	Author	Joshua Earnest
	Publisher	PHI
	Edition	
3.	Title	Renewable Energy, Power for Sustainable Future
	Author	Godfrey Boyle
	Publisher	Oxford

	Edition	
Content	**Unit I: Introduction** (3 Lecture Hours) Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment. Qualitative study of different renewable energy resources: Solar, wind, ocean, Bio-energy, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems. **Unit II: PV Cell** (12 Lecture Hours) Fundamentals of PV cell, I-V characteristics, equivalent circuit, technologies, design considerations, Effect of variation of insolation and temperature, losses and efficiency, cell size, classification, PV cell technologies, array construction and working, Interconnecting modules in series and parallel, protection of cells, concept of maximum-power, maximum-power point tracking algorithms. **Unit III: Wind Power Generation** (12 Lecture Hours) Introduction to wind turbine, construction, working, principle, different types turbine blades, their structure, horizontal and vertical wind turbine system, power in the wind, various factors affecting the power in the wind, impact of tower height, Betz experiment, coefficient of performance, tip speed ratio, Weibull distribution function **Unit IV: Hydro Power Generation** (5 Lecture Hours) Introduction to hydro power plant, overview of micro, mini and small hydro power plants, hydraulic turbines, Selection and design criteria of pumps and turbines, Brief theory, design and analysis of hydro power plants **Unit V: Hydrogen energy** (3 Lecture Hours) Basic principle and design of different types of fuel cells and their applications, future prospects.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EELM 401	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				
Course Title	Smart Grid			
Course Coordinator				
Course objectives:				
POs				
Semester	Autumn: I Semester		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Smart Grid: Fundamentals of Design and Analysis
	Author	James A. Momoh
	Publisher	Wiley-IEEE Press, ISBN-13: 978-0470889398
	Edition	1st
2.	Title	Smart Power Grids
	Author	Ali Keyhani, Muhammad Marwali
	Publisher	Springer Berlin, Heidelberg
	Edition	1st
Reference Book:		
1.	Title	Computer Relaying for Power Systems
	Editors	Dr. Arun G. Phadke, Dr. James S. Thorp
	Publisher	Wiley
	Edition	
2.	Title	Microgrids: Architectures and Control
	Author	Nikos Hatziargyriou
	Publisher	Wiley
	Edition	
3.	Title	Renewable Energy Systems: Advanced Conversion Technologies and Applications
	Editors	Fang Lin Luo and Ye Hong

	Publisher	CRC Press
	Edition	
Content	**Unit I: Introduction:** Architecture of smart grid system, Standards. **Unit II: Elements and Technologies: -** Distributed Generation Resources, Wide Area Monitoring, Phasor Estimation. **Unit III: Smart Grid Protection:** Digital Relays for Smart Grid Protection, Islanding Detection Techniques, Smart Grid Protection. **Unit IV: Modelling of Smart Grid System Elements: -** Modelling of Storage Devices, Modelling of DC Smart Grid Components, Operation and Control of AC Microgrid, Operation and Control of DC Microgrid, Operation and Control of AC-DC hybrid Microgrid. **Unit V: Energy Management:** Demand Side Management in Smart Grid, Energy Management, System Analysis of AC/DC Smart Grid.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EEPB 403	**Open course**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				
Course Title	**Power System Lab**			
Course Coordinator				
Course Outcomes:				
POs				
Semester	Autumn: VII Semester		Spring:NA	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Power system analysis
	Author	Hadi Sadat
	Publishe	Tata Mcgraw Hill Education
	Edition	
2.	Title	Modern Power System Analysis
	Author	D. P. Kothari and I. J. Nagrath
	Publishe	Tata McGraw-Hill Education
	Edition	
Reference Book:		
1.	Title	Modern Power system Analysis
	Author	Grainmger and Stevenson
	Publishe	Tata McGraw-Hill Education
	Edition	

Content	**Hardware:** 1. To Calculate Positive, Negative and Zero sequence Impedance of Transformer. 2. To draw Fault current time characteristics of Electromechanical based Overvoltage Relay. 3. To determine positive, negative and zero sequence impedance of Alternator. 4. To analyse and calculate different fault currents that occur due to introduction og faults (L-G) in transmission Line using three phase fault analyser trainer. 5. To calculate Dielectric strength of an insulating oil. **Software:** 6. To determine the bus admittance and impedance matrices for the given power system network. 7. To determine the following parameter of transmission line Calculate the corona loss of transmission line. Calculate sag and tension of transmission line. Calculate string efficiency of an insulator of transmission line. 8. To find load flow solution of the given power system using gauss-seidel method theoretically for one iteration and obtain full solution using MATLAB. 9. Design a Microgrid system for a specific location considering various renewable energy resources (solar, wind, hydro, etc.) and conventional generators (diesel, natural gas, etc.) using HOMER Pro software. 10. Analysis of the small signal stability in a balanced and unbalanced power network using an eigenvalue analysis. 11. Investigate the impact of nonlinear loads, harmonics, and power quality issues on system performance and equipment operation. Software: MATLAB / DIGSILENT/HOMER Pro
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EELB312	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**Distributed Power Generation**			
Course Coordinator				
Course objectives:	To impart knowledge about distributed generation technologies, their interconnection in grid, to understand relevance of power electronics in DG, to understand concept of microgrid.			
POs				
Semester	**Autumn:** YES		**Spring:** NO	

	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	**3**	**0**	**0**	**3**	**36(L)**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:

1.	Title	Operation of Restructured Power Systems
	Author	K. Bhattacharya, MHT Bollen and J.C Doolder
	Publisher	Kluwer Academic Publishers, USA, 2001
	Edition	
2.	Title	Power System restructuring and deregulation
	Author	Lei Lee Lai
	Publisher	John Wiley and Sons
	Edition	UK. 2001

Content

Unit I: Distributed Generation (DG) Technologies

Comparative study between conventional and non-conventional methods of power generation: energy crisis due to scarcity of fossil fuel, distributed generation (DG) overview and technology trend. Renewable DG technologies: Solar PV, bioenergy, wind energy, hydroelectricity, tidal power, wave energy, geothermal energy etc. Non-conventional technology based DGs: Fuel cells, CHP based microturbine, IC engines, etc. Storage based DGs: Storage technology: Battery, super capacitor, flywheel etc.

Unit II: Interconnection Issues and Standards of DGs

Topologies, selection of source, dependence on storage facilities, regulatory standards/ framework, standards for interconnecting DGs to electric power systems, DG installation classes, security issues in DG implementations. Grid code and islanding & non-islanding system.

	Unit III: Operational Features of Grid Connected DGs Grid interconnection issues for grid connected operation of various types of DG systems. Constraints on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Reliability, stability and power quality issues involved in grid connected operation of various DGs. **Unit IV: Power Electronics and DG Systems** Relevance of power electronics in DG applications, Power quality requirements and source switching using SCR based static switches, Distribution system loading, line drop model, series voltage regulators and on-line tap changers, power converter topologies, model and specifications for DG applications. **Unit V: Operation, Control and Modelling of Microgrid** Concept and definition of microgrid, review of sources of microgrids, typical structure and configuration of a microgrid, microgrid implementation in Indian and international scenario, AC and DC microgrids.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: EELB 361	Open Course (Y/N)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
Type of course	No	No	No	Yes
Course Title	**Switch-Mode DC-DC Converters**			
Course Coordinator				
Course objectives:	1. Gain comprehensive understanding of linear and switched -mode power supplies with UPS 2. Gain comprehensive understanding of non-isolated and isolated dc-dc converters 3. Develop mathematical models and controller for dc-dc converters 4. Design the switch-mode converters for various applications			
POs				
Semester	Autumn:		Spring: NA	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers	Power Electronics			
Prerequisite credits	3			
Equivalent course codes as per proposed course and old course	Nil			
Overlap course codes as per proposed course numbers	Nil			

Text Books:

1.	Title	Power Electronics, Controller Application and Design
	Author	Ned Mohan
	Publisher	Wiley
	Edition	3rd Edition
2.	Title	Power Electronics: Circuit, Analysis, and Design
	Author	Issah Batarseh
	Publisher	Springer
	Edition	2018
3	Title	Fundamentals of Power Electroni
	Author	Robert Erickson and Dragan Maksimovic
	Publisher	Springer
	Edition	2nd Edition

Reference Book:

1.	Title	Switching Power Converters: Medium and High Power

	Author	Dorin O. Neacsu
	Publisher	CRC Press
	Edition	2nd
2.	Title	Switching Power Supply Design
	Author	Abraham I. Pressman and Taylor Morey
	Publisher	The McGraw-Hill Companies
	Edition	3rd

Content	**Unit I: Introduction to Power Supplies and UPS** (6 Hours) Basic concepts, conventional approaches for voltage regulation, zener diode, linear voltage regulators, switching power supplies. UPS: offline, line-interactive, online, modular etc. **Unit II: Non-Isolated DC-DC Converters** (8 Hours) Basic Concepts like inductor volt-sec balance, charge-sec balance, flux walking, small-ripple approximations etc., DC-DC Converter Topologies: Buck converter, Boost converter, Buck-Boost, Cuk, SEPIC. Operation, voltage-gain expressions, steady-state analysis, time-domain analysis, energy storage, magnetics and converter design. CCM and DCM operation. PWM schemes: Leading Edge, Trailing Edge, Triangular. **Unit III: Isolated DC-DC Converters** (8 Hours) Need of isolation, HF transformer, Input side and output side transformer configurations. Isolated dc-dc converter topologies: Forward converter, Single-Ended converter, Push-Pull converter, Flyback converters etc. Issues due to HF transformer, core-resetting, operation and voltage-gain. **Unit IV: Mathematical Modelling and Control** (8 Hours) Modeling of dc-dc converters, state-space representation, circuit-averaging approach, dynamics of dc-dc converters, small-signal linearization, derivation of transfer-functions. Basics of controller design. Control structure: Voltage-Mode and Current-Mode control. Implementation of analog and digital control. **Unit V: Application of DC-DC Converters** (6 Hours) LED drivers, Battery chargers, renewable energy integration etc.
Course Assessment	Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%. Lab: Continuous Evaluation 50%, End Semester 50%. Continuous evaluation shall depend on course coordinator.

Course no: EELB 362	Open course (Y/N)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
Type of course				Y
Course Title	Special Electrical Machines			
Course Coordinator				
Course objectives:	To impart knowledge on Construction, principle of operation and performance of synchronous reluctance motors. To impart knowledge on the Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors. To impart knowledge on the Construction, principle of operation and performance of permanent magnet synchronous motors. To explain the performance and control of stepper motors, and their applications.To explain theory of operation and control of switched reluctance motor. To explain the theory of travelling magnetic field and applications of linear motors			
POs				

Semester	**Autumn: I Semester**		**Spring**	
	Lecture	**Tutorial**	**Practical**	**Credits**
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course				
Prerequisite credits				
Equivalent course codes as per proposed course				
Overlap course codes as per proposed course				

Text Books:

1.	Title	Generalized Theory of Electrical Machines
	Author	P.S. Bimbhra
	Publisher	Khanna Publishers

	Edition	2008
2.	Title	Principles of Electrical Machines and Power Electronics
	Author	P.C. Sen
	Publisher	Johnwilley&Sons
	Edition	2001
Content	**Unit I: Synchronous Reluctance Motors** Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance Motors – Voltage and Torque Equations - Phasor diagram - performance characteristics –Applications **Unit-II: Permanent Magnet Machines:** Types of permanent magnets and their magnetization characteristics, demagnetizing effect, permanent magnet dc motors, sinusoidal PM A C motors, brushless dc motors and their important features and applications, introduction to permanent magnet generators and applications **Unit-III: Stepper Motors:** Principle of operation, variable reluctance, permanent magnet and hybrid stepper motors, characteristics, drive circuits and applications. **Unit IV: Switched Reluctance Motors**: Construction; principle of operation; torque production, modes of operation, drive circuits. **Unit V: Linear motors** Linear induction motor: Construction– principle of operation– applications. Linear synchronous motor: Construction – principle of operation– applications.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EELB 414	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Fundamental of Electric Vehicles**			
Course Coordinator				
Course Outcomes:	After completing the course, the students will be able to:: CO1: Comprehend the basics concepts of electric vehicles, their architecture, and technologies. CO2: Able to understand the operation of battery driven and designing of Battery Pack. CO3: Able to interpret the working of different electrical machines in electric vehicles and their control technique. CO4: Ability to understand the control and configurations of EV chargers and charging stations.			
POs				
Semester	Autumn: NA		Spring: II	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Electric and Hybrid Vehicles
	Author	Iqbal Husain
	Publisher	Routledge Taylor & Francis Group
	Edition	3rd Edition
2.	Title	Electric Vehicle Engineering
	Author	Per Enge, Nick Enge, and Stephen Zoepf
	Publisher	McGraw Hill
	Edition	1st Edition
Reference Book:		
1.	Title	Electric and Hybrid Vehicles
	Author	Tom Denton, Hayley Pells
	Publisher	Routledge Taylor & Francis Group

	Edition	3rd Edition
2.	Title	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles
	Author	Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi
	Publisher	Routledge Taylor & Francis Group
	Edition	3rd Edition

Content	**Unit I: Vehicle Dynamics**: Forces and aerodynamic drag, rolling resistance and uphill resistance, power and torque to accelerate, concept of drive cycles and energy, design of EV drive train. **Unit II: EV Battery Pack:** Introduction to battery parameters, Type of battery cells, SoH and SoC estimation and self-discharge, battery pack development, computation of effective cost of battery and batteries charging. **Unit III: Battery Pack Electrical Design:** Hierarchy of battery pack, modules assembling, busbar design, short circuits scenarios, efficient power delivery, cell testing & characterization. **Unit IV: Battery Management System:** BMS parameters**,** architecture**,** sensors, battery pack protection and interfacing, battery pack performance management, management controller unit, cell balancing- Active and Passive, Insulation monitoring device, BMS algorithm, software architecture. **Unit V: EV Chargers:** Introduction, slow or fast chargers, battery swapping, standardization and on-board chargers, public chargers, bulk chargers/swap stations.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EELB 415	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Power Quality**			
Course Coordinator				
Course Outcomes:	The objectives of the course include introduction of the power quality definitions, voltage sags, interruptions, harmonic problems and mitigation.			
POs				
Semester	Autumn: NA		Spring: II	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Electrical Power Systems Quality
	Author	Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H.Wayne Beaty
	Publisher	McGraw Hill Education
	Edition	3rd Edition
2.	Title	Power Quality: Problems and Mitigation Techniques
	Author	Bhim Singh, Ambrish Chandra, and Kamal Al-Haddad
	Publisher	Wiley India
	Edition	1st Edition
Reference Book:		
1.	Title	Power System Harmonic Analysis
	Author	Arrillaga J., Smith B. C., Watson N. R. and Wood A. R
	Publisher	Wiley India
	Edition	2nd Edition
2.	Title	Power System Analysis
	Author	Arthur R.B.
	Publisher	Pearson Education
	Edition	2nd Edition
3.	Title	Power Quality
	Author	Sanskaran
	Publisher	C.R.C. Press

	Edition	2nd Edition
Content	**Unit I: Concept of Power Quality:** Frequency variations, voltage variations- sag and swell, waveform distortion –dc offset, harmonics, inter-harmonics, notching and noise. **Unit II: Fundamentals of Harmonics:** Representation of harmonics, waveform, harmonic power, measures of harmonic distortion; Current and voltage limits of harmonic distortions: IEEE, IEC, EN, NORSOK **Unit III: Causes and Effect of Harmonics:** Converter configurations, input current waveforms and their harmonic spectrum; Input supply harmonics of AC regulator, integral cycle control, cycloconverter, transformer, rotating machines, ARC furnace, TV and battery charger. Parallel and series resonance, effect of harmonics on static power plant – transmission lines, transformers, capacitor banks, rotating machines, harmonic interference with ripple control systems, power system protection, consumer equipments and communication systems, power measurement. **Unit IV: Filters:** Passive Filters: Types of passive filters, single tuned and high pass filters, filter design criteria, double tuned filters, damped filters and their design. Active Power Filters: Compensation principle, classification of active filters by objective, system configuration, power circuit and control strategy. **Unit V: DSTATCOMs:** State of art on DSTATCOMs, Classification, principle of operations of DSTATCOMs,	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: EELB411	Open Course (Y/N)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
Type of course	No	No	No	Yes
Course Title	Power Converters for Renewable Energy Sources			
Course Coordinator				
Course objectives:	1. To appreciate the role of renewable energy for sustainable development and economy. 2. To develop understanding of Solar PV generation and role of power converters. 3. To develop understanding of wind power generation and role of power converters. 4. To design cogeneration system with energy storage.			
POs				
Semester	Autumn:		Spring:	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers	Power Electronics			
Prerequisite credits	3			
Equivalent course codes as per proposed course and old course	Nil			
Overlap course codes as per proposed course numbers	Nil			

Text Books:		
1.	Title	Power Electronics for Renewable and Distributed Energy Systems
	Author	Sudipta Chakraborty, Marcelo G. Simoes, William E Kramer
	Publisher	Springer
	Edition	-
2.	Title	Non-Conventional Energy Resources
	Author	B H Khan
	Publisher	Mc Graw Hill
	Edition	3rd
Reference Book:		
1.	Title	Wind Power Technology
	Author	Joshua Earnest
	Publisher	PHI
	Edition	2nd
2.	Title	Renewable Energy, Power for Sustainable Future
	Author	Godfrey Boyle
	Publisher	Oxford

	Edition	3rd
Content	**Unit I: Introduction (5 Hours)** Environmental aspects of electric energy conversion, need and impacts of renewable energy generation on economy & environment. Qualitative study of different renewable energy resources: Solar, Wind, Tidal, Biomass, Geothermal, Hydrogen energy systems (Fuel cell), Small-hydro, and Hybrid renewable energy systems. **Unit II: Solar PV Systems (11 Hours)** Basics of solar energy. Construction and working of solar PV cells and systems, Types of solar cells, various losses, series & parallel connections, partial shading etc. Mathematical models (single-diode and two-diode), I-V and P-V characteristics. Concept of maximum-power, maximum-power point tracking algorithms (P&O and InC). Power converter configurations and their selection for solar PV applications: dc-dc converters and dc-ac inverters. Block diagram of grid connected and off-grid PV systems with and without storage. PV array and battery sizing. **Unit III: Wind Power Generations (11 Hours)** Basics of wind energy. On-shore and Off-shore wind farms. Wind turbines and generators: types of wind turbines-HAWT, VAWT: construction and operation. Control of wind turbines: pitch control, stall control, yaw control, and speed variation. Power electronics for wind power: power converter and inverter configuration, partial rated power electronics, soft-starters etc. Introduction to IG, PMSG, SEIG, and DFIG. **Unit IV: Energy Storage (6 Hours)** Energy-storage solutions for renewable energy systems and converters for integration of energy storage. Fuel cells: construction, working, types, and characteristics. Power converter configurations for integrating fuel cells. **Unit V: Solar PV/Wind/Fuel Cell Based Cogeneration (3 Hours)** Concept of cogeneration, architectures, cogeneration issues and challenges. Introduction to AC/DC microgrids.	
Course Assessment	Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%. Lab: Continuous Evaluation 50%, End Semester 50%. Continuous evaluation shall depend on course coordinator.	

Course no: EELB322	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**Power System Deregulation**			
Course Coordinator				
Course objectives:	To understand the electricity power business and technical issues in a restructured power system in both Indian and world scenario.			
POs				
Semester	**Autumn:** YES		**Spring:** NO	

	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	**3**	**0**	**0**	**3**	**36(L)**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:

1.	Title	Operation of Restructured Power Systems
	Author	K. Bhattacharya, MHT Bollen and J.C Doolder
	Publisher	Kluwer Academic Publishers, USA, 2001
	Edition	
2.	Title	Power System restructuring and deregulation
	Author	Lei Lee Lai
	Publisher	John Wiley and Sons
	Edition	UK. 2001

Content

Unit I: Deregulation of the Electricity Supply Industry

Deregulation, Reconfiguring Power systems, unbundling of electric utilities, Background to deregulation and the current situation around the world, benefits from a competitive electricity market, after-effects of deregulation.

Unit II: Power System Operation in Competitive Environment

Role of the independent system operator, Operational planning activities of ISO: ISO in Pool markets, ISO in Bilateral markets, Operational planning activities of a GENCO: Genco in Pool and Bilateral markets, market participation issues, competitive bidding

Unit III: Transmission/Distribution Open Access and Pricing Issues
Power wheeling, Transmission open access, pricing of power transactions, security management in deregulated environment, and congestion management in deregulation

	Unit IV: Ancillary Services Management General description of some ancillary services, ancillary services management in various countries, and reactive power management in some deregulated electricity markets **Unit V: Reliability and Deregulation** Reliability analysis: interruption criterion, stochastic components, component models, calculation methods, Network model: stochastic networks, series and parallel connections, minimum cut sets, reliability costs, Generation, transmission and distribution reliability, Reliability and deregulation: conflict, reliability analysis, effects on the actual reliability, regulation of the market.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EELB 323	**Open Course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N0	N0	N0	Yes
Course Title	**Renewable Energy Systems**			
Course Coordinator				
Course Outcomes:	Comprehensive knowledge of the renewable energy system and their applications.			
POs				
Semester	Autumn: **V Semester**		Spring: NA	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Non-Conventional Energy Resources
	Author	B H Khan
	Publisher	McGraw Hill Education
	Edition	
2.	Title	Non-Conventional Energy Resources
	Author	S. N. Singh
	Publisher	Pearson
	Edition	
Reference Book:		
1.	Title	Power Electronics for Renewable and Distributed Energy Systems
	Author	Sudipta Chakraborty, Marcelo G. Simoes, William E Kramer
	Publisher	Springer
	Edition	
2.	Title	Wind Power Technology
	Author	Joshua Earnest
	Publisher	PHI
	Edition	
3.	Title	Renewable Energy, Power for Sustainable Future
	Author	Godfrey Boyle
	Publisher	Oxford

	Edition	
Content	**Unit I: Introduction** (3 Lecture Hours) Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment. Qualitative study of different renewable energy resources: Solar, wind, ocean, Bio-energy, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems. **Unit II: PV Cell** (12 Lecture Hours) Fundamentals of PV cell, I-V characteristics, equivalent circuit, technologies, design considerations, Effect of variation of insolation and temperature, losses and efficiency, cell size, classification, PV cell technologies, array construction and working, Interconnecting modules in series and parallel, protection of cells, concept of maximum-power, maximum-power point tracking algorithms. **Unit III: Wind Power Generation** (12 Lecture Hours) Introduction to wind turbine, construction, working, principle, different types turbine blades, their structure, horizontal and vertical wind turbine system, power in the wind, various factors affecting the power in the wind, impact of tower height, Betz experiment, coefficient of performance, tip speed ratio, Weibull distribution function **Unit IV: Hydro Power Generation** (5 Lecture Hours) Introduction to hydro power plant, overview of micro, mini and small hydro power plants, hydraulic turbines, Selection and design criteria of pumps and turbines, Brief theory, design and analysis of hydro power plants **Unit V: Hydrogen energy** (3 Lecture Hours) Basic principle and design of different types of fuel cells and their applications, future prospects.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EELB 371	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory			
Course Title	**Power System Operation & Control**			
Course Coordinator				
Course objectives:	To provide students the knowledge of the engineering and economic aspects of planning, operation, security, controlling power generation and transmission systems in electric utilities.			
POs	Upon completion of this course, students will be able to develop generation dispatching schemes, apply control and selection methods on a power system.			
Semester	**Autumn:** Yes		**Spring**	

	Lecture	Tutorial	Practical	Credits	Teaching Hours
Contact Hours	3	0	0	3	36(L)
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	---				

Text Books:

1.	Title	Power System Analysis
	Author	Grainger J. J. and Stevenson W. D.
	Publisher	McGraw-Hill International Book Company, 2008.
	Edition	1st Ed.
2.	Title	Power System Analysis Operation and Control
	Author	A. Chakrabarti, S. Halder
	Publisher	PHI, 2010.
	Edition	3rd Ed.

3.	Title	Power System operation and Control
	Author	K. Uma Rao
	Publisher	Wiley India.
	Edition	1st Ed.

Contents

Unit I: Economic Load Dispatch

Economic dispatch of thermal units and methods of solution, Transmission losses, B matrix loss formula, Composite generation production cost function-solution by gradient search techniques, Nonlinear function optimization

Unit II: Automatic generation and Voltage Control

Load frequency problem-Megawatt frequency (or P-f) control channel, MVAR-voltages (or Q-V) control channel-Dynamic interaction between P-f and Q-V loops. Mathematical model of speed-governing system.

Unit III: Methods of Voltage Control

Reactive power and its relation to voltage control, location of voltage control equipment, methods of voltage control, excitation control, voltage regulators, tap changing transformers, booster transformers, induction regulators, reactive power injection and voltage control by synchronous condenser

Unit IV: Unit Commitment and Hydro Thermal Scheduling

Unit commitment: Constraints in Unit commitment, Spinning reserve, Thermal and hydro constraints, Unit commitment solution methods- Priority list methods, Dynamic programming solution, Short and long range hydro-thermal scheduling.

Unit V: Power System Security

Factors affecting power system security, Contingency analysis: Detection of network problems, Correcting the generation approach: Sensitivity methods, compensated factors, correcting the generation dispatch using linear programming.

Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EELB 372	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Energy Auditing and Management**			
Course Coordinator				
Course Outcomes:	After completing the course, the students will be able to: CO1: Comprehend the basics concepts of energy auditing, management and technologies. CO2: Apply the procedure of energy auditing procedure along with relevant technologies/tools CO3: Analytics the energy performances assessment for equipment and utilities systems. CO4: Design the energy audit report and interpretable in energy auditing in the industry.			
POs				
Semester	Autumn: NA		Spring: II	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course				
Prerequisite credits				
Equivalent course codes as per proposed course				
Overlap course codes as per proposed course				

Text Books:		
1.	Title	Industrial Energy Management and Utilization
	Author	LC Witte, PS Schmidt and DR Brown
	Publish	Hemisphere Publishing Corporation, Washington
	Edition	1st
Reference Book:		
1.	Title	Handbook on Energy Audit and Environment Management
	Author	YP Abbi and Shashank Jain
	Publish	TERI Press
	Edition	2006
2.	Title	Guide book on General Aspects of Energy Management and Energy Audit
	Author	R. Virendra, J. Nagesh Kumar et. al

	Publish	Bureau of Energy Efficiency
	Edition	4th 2015
3.	Title	Guide book on energy performance assessment for equipment and utility systems
	Author	R. Virendra, J. Nagesh Kumar et. al
	Publish	Bureau of Energy Efficiency
	Edition	4th 2015
4.	Title	Guide book on energy efficiency in Electrical Utilities
	Author	R. Virendra, J. Nagesh Kumar et. al
	Publish	Bureau of Energy Efficiency
	Edition	4th 2015
Content	**Unit I: Introduction to Energy Management:** Introduction to energy management, energy conservation and its importance, energy conservation act and related policies, basic of electricity and thermal energy. **Unit II: Energy Audit Basics:** Definition and objectives energy audit, types of energy audit, benchmarking, energy performances, maximizing system efficiencies, bureau of energy efficiency regulations **Unit III: Energy Audit Procedure:** Energy Audit Procedure Tools/ Techniques/ Equipment Energy Audit Report Financing Activities. **Unit IV: Energy Analytics:** Energy performances assessment of heating loads, electric motor and variable speed drives, fans & blowers, lighting system, HVAC system and its applications for building and commercial establishments. **Unit V: Case Studies / Best Practices:** Large Industries: Cement/ Iron & Steel/ Thermal Power Plants, small and medium-sized enterprises Units: Power Distribution Utilities / Railways Buildings/ Hotel/ Other Sectors. **Assignment: -** Industrial Visit and submit an Energy Audit Report.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EELB 373	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Theory			
Course Title	**Utilization of Electrical Energy**			
Course Coordinator				
Course objectives:	• Discuss different methods of electric heating • Discuss different methods of welding. • Discuss the laws of illumination, different types of lamps, lighting schemes and design of lighting systems. • Analyze systems of electric traction, speed time curves and mechanics of train movement. • Explain the motors used for electric traction, their control & braking and power supply system used for electric traction.			
POs				
Semester	**Autumn:** Yes		**Spring**	

	Lecture	Tutorial	Practical	Credits	Teaching Hours
Contact Hours	**3**	**0**	**0**	**3**	**36(L)**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	---				

Text Books:

1.	Title	Utilization of Electric Energy
	Author	E. Openshaw Taylor and Orient Longman
	Publisher	Orient Longman Pvt Ltd
	Edition	1st Ed. Reprints
2.	Title	Utilization of Electrical Power including Electric drives and Electric traction
	Author	N. V. Suryanarayana
	Publisher	New Age International (P) Limited
	Edition	1st Revised Ed. Reprints
3.	Title	Electric Drives
	Author	Ion boldea and S. A. Nasar
	Publisher	CRC press
	Edition	3rd Ed.

Content	**Unit I: Electrical Heating** Advantages of electrical heating, Heating methods: Resistance heating – direct and indirect resistance heating, electric ovens, their temperature range, properties of resistance heating elements, domestic water heaters and other heating appliances and thermostat control circuit, Induction heating; principle of core type and coreless induction furnace, Electric arc heating; direct and indirect arc heating, construction, working and applications of arc furnace **Unit II: Electric Welding:** Advantages of electric welding, Welding method, Principles of resistance welding, types, Principle of arc production, electric arc welding, characteristics of arc; carbon arc, metal arc, hydrogen arc welding method of and their applications. **Unit III: Illumination** Definition – Laws of Illumination – Polar Curves – Calculation of MHCP and MSCP. Lamps: Incandescent lamp, Sodium vapour lamp, fluorescent lamp, CFL and LED. Requirement of good lighting scheme – Types, Design and calculation of illumination. Street lighting and factory lighting – Numerical problems – Energy conservation methods **Unit IV: Electric Traction-1** System of electric traction and track electrification– Review of existing electric traction systems in India– Special features of traction motor– Mechanics of train movement– Speed–time curves for different services – Trapezoidal and quadrilateral speed time curves. **Unit IV: Electric Traction-2** Calculations of tractive effort– power –Specific energy consumption for given run– Effect of varying acceleration and braking retardation–Adhesive weight and braking retardation adhesive weight and coefficient of adhesion– Principles of energy efficient motors.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EELB 425	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**Power System Stability**			
Course Coordinator				
Course objectives:	To impart knowledge to the students about real time security monitoring and control (computer and operator) of power system for economic and reliable operation. The student will be able to understand about supervisory control and data acquisition, real time software and state estimation and security management			
POs				
Semester	**Autumn:** No		**Spring:** Yes	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**0**	**3**	**36(L)**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:

1.	Title	Power system stability and control
	Author	P. Kundur,
	Publisher	Tata- McGraw Hill.
	Edition	Second Edition
2.	Title	Power System Stability
	Author	Kimbark
	Publisher	Vol-I,II,III, Wiley India
	Edition	First
3.	Title	Topics on small signal stability analysis
	Author	K. R. Padiyar, M. A. Pai, K. Sen gupta

	Publisher	Tata-McGraw Hill
	Edition	First
Reference Books:		
1.	Title	Power system stability
	Author	M. A. Pai and Peter W. Sauer
	Publisher	Pearson Education.
	Edition	Third
2.	Title	Power system dynamics
	Author	K. R. Padiyar
	Publisher	BSP publications
	Edition	Second
Content	**Unit I: Introduction to Power System Stability Problems** Definition of stability, classification of stability, rotor angle stability, frequency stability, voltage stability, mid-term and long term stability, classical representation of synchronous machine in a single machine infinite bus system. **Unit II: Modeling of Power System Components for Stability Analysis** Synchronous machine modeling: sub-transient model, two axis model, one axis (flux decay) model, classical model, excitation systems modeling: DC excitation, AC excitation and static excitation, prime mover and energy supply systems modeling. **Unit III: Small Signal Stability** Fundamental concepts, state space representation, modal analysis: eigen properties, participation factors, stability assessment, effects of excitation system on stability, Fundamentals of transient stability. **Unit V: Voltage Stability** Classification of voltage stability, modeling requirements, voltage stability analysis: static and dynamic, sensitivity analysis, modal analysis, voltage collapse, prevention of voltage collapse.	
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%.	

Course no: EELB 331	Open Course (Y/N)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
Type of course	N0	N0	Yes	No
Course Title	**Advanced Applications of IOT**			
Course Coordinator				
Course objectives:	• Understand the basics of IoT. • Implement the state of the Architecture of an IoT. • Understand design methodology and hardware platforms involved in IoT. • Understand how to analyze and organize the data. • Compare IOT Applications in Industrial & real world.			
POs				
Semester			Spring: NA	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	2	4
Prerequisite course code as per proposed course numbers	Nil			
Prerequisite credits	Nil			
Equivalent course codes as per proposed course and old course	Nil			
Overlap course codes as per proposed course numbers	Nil			

Text Books:		
1.	Title	IoT Fundamentals: Networking Technologies, Protocols and Use Cases
	Author	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and
	Publisher	Cisco Press,
	Edition	2017
2.	Title	Internet of Things – A hands-on approach
	Author	Arshdeep Bahga, Vijay Madisetti,
	Publisher	Universities Press,
	Edition	2015
Reference Book:		
1.	Title	The Internet of Things – Key applications and Protocols
	Author	Olivier Hersent, David Boswarthick, Omar Elloumi
	Publisher	Wiley,
	Edition	2012
2.	Title	From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence
	Author	,Jan Ho¨ ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle

	Publisher	Elsevier,
	Edition	2014.
Content	**UNITI: FUNDAMENTALS OF IoT-** Evolution of Internet of Things, Enabling Technologies, M2M Communication, IoT World Forum (IoTWF) standardized architecture, Simplified IoT Architecture, Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators. **UNIT II: IoT PROTOCOLS-** IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks,6LoWPAN, Application Transport Methods: SCADA. **UNIT III: DESIGN AND DEVELOPMENT-** Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks IoT Platform overview: Overview of IoT supported Hardware platforms such as:Raspberry pi, Arduino Board details **UNIT IV: DATA ANALYTICS AND SUPPORTING SERVICES:** Data Analytics: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M, Supporting Services. **UNIT V: CASE STUDIES/INDUSTRIAL APPLICATIONS:** IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipments, Industry 4.0 concepts.	
Course Assessment	Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%. 100% weightage to theory for overall grading. Continuous evaluation shall depend on course coordinator.	

Course no: EELB 332	Open course(YES/NO)	HM Course(Y/N)	DC(Y/N)	DE(Y/N)
Type of course				YES
Course Title	Industrial Automation and Control			
Course Coordinator				
Course objectives:	To introduce the importance of automation techniques in industries. To impart the role of PLC in industry automation. To expose to various components and control techniques used in automation.			
POs				

Semester	Autumn: Yes		Spring:		
	Lecture	Tutorial	Practical	Credits	Teaching Hours
Contact Hours	3	0	0	3	36
Prerequisite course Code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and Old course					
Overlap course codes as per proposed Course numbers					

Text Books and Reference Books:

1.	Title	Industrial Automation and Process Control
	Author	Jon Stenerson
	Publisher	Pearson
	Edition/ Year	2002
2.	Title	Fundamentals of Industrial Instrumentation and Process Control
	Author	William Dunn
	Publisher	McGraw-Hill Education
	Edition	2nd Edition

Content	**Introduction** Overview and requirement of industrial automation, control devices, feedback devices, Design of systems. **Programmable Logic Controllers**

	PLC components, Input and output modules, Programming, Ladder diagram, sequential flow chart, Communication and networking, Timer and Counter functions, Advantages and disadvantages, Applications. **Sensors and Actuators** Sensor types, Digital sensors, Sensor wiring, Analog sensors, Installation considerations, Types of Actuators, Pressure controllers, Flow control actuators, Power control, Motors, **Signal Processing and Control** Electrical signal conditioning**,** A/D conversion, Analog and Digital transmission, D/A conversion, Telemetry, Modulation. Control modes: On/OFF control, differential action, proportional, derivative, integral, PID action, Digital controllers. **IoT and Industry 4.0** IoT for plant automation, Industrial IoT, History of industrial revolutions, Concept of I4.0, Architecture of I4.0, Key features and technology enablers of I4.0, Design principles and major challenges.
Course Assessment	Continuous Evaluation: 25% Mid-Semester Examination: 25% End-Semester Examination: 50%

Course no: EELB 381	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course	Elective			
Course Title	**Digital Image Processing**			
Course Coordinator				
Course objectives:	• To understand the sensing, acquisition and storage of digital images. • To study the image fundamentals and mathematical transforms necessary for • image processing. • To study the image enhancement techniques. • To study image compression procedures. • To study image segmentation and representation techniques.			
POs				

Semester	**Autumn:** Yes		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**0**	**3**	**36(L)**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	---				

Text Books:,

1.	Title	Digital Image Processing
	Author	R. Gonzalez and R. E. Wood
	Publisher	Pearson Education
	Edition	3rd Edition, 2016
2.	Title	Introductory Computer Vision and Image Processing
	Author	Adrian Low
	Publisher	McGraw Hill
	Edition	
3.	Title	Fundamentals of Digital Image Processing
	Author	A. K. Jain
	Publisher	Pearson Education
	Edition	2015
4.	Title	Pattern Recognition
	Author	William Gibson
	Publisher	Berkley
	Edition	2005

Content	**Unit I: Introduction** Digital image representation, fundamental steps in image processing, elements of digital image processing systems, elements of visual perception, image model, sampling and quantization, relationship between pixels, imaging geometry. **Unit II: Image Enhancement** Enhancement by point processing, sample intensity transformation, histogram processing, image subtraction, image averaging, spatial filtering, smoothing filters, sharpening filters, frequency domain: low-pass, high-pass, homomorphic filtering. **Unit III: Image Transformations** *Geometric transformations*: Translation, rotation, scaling and shearing. *Frequency transformation*: Discrete Fourier transform (DFT), fast Fourier transform (FFT), short-time Fourier transform (STFT), *Multi-resolution Expansions*: Wavelet Transforms in 1-D and 2-D., Wavelet Packets Transform. **Unit IV: Image Compression** Coding redundancy, Inter-pixel redundancy, fidelity criteria, image compression models, error-free compression, variable length coding, bit-plane coding, loss-less predicative coding, lossy compression, image compression standards, Real-Time image transmission, JPEG and MPEG. **Unit V: Image Segmentation** Detection of discontinuities, edge linking and boundary detection, thresholding, region-oriented segmentation, use of motion in segmentation, spatial techniques, frequency domain techniques.
Curse Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EELB 382	Open course(YES/NO)	HM Course(Y/N)	DC(Y/N)	DE(Y/N)
Type of course				YES
Course Title	**Intelligent Control**			
Course Coordinator				
Course objectives:	To understand the concepts of ANN, fuzzy systems, learning control and expert systems, to enable to design intelligent control system.			
POs				

Semester	**Autumn: Yes**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course Code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and Old course					
Overlap course codes as per proposed Course numbers					

Text Books and Reference Books:

1.	Title	Intelligent Control: Principles, Techniques And Applications
	Author	Zixing Cai
	Publisher	World Scientific Publishing Co Pte Ltd
	Edition/ Year	1997
2.	Title	Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence
	Author	Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani
	Publisher	Pearson Education India
	Edition/ Year	2015

Content

Introduction

Definition and features of intelligent control**,** Structural theories of intelligent control**.** General structure of intelligent controller, Classification of intelligent control methods.

Expert Control Systems

Features of expert systems, Architectures and types of expert systems, Control requirements and design principle of expert control systems, Structures and types of expert control system, Features and requirements for real-time expert control system.

Fuzzy Control Systems

Fuzzy sets and their operations, Structure of fuzzy logic controller, PID fuzzy controller, Self-tuning fuzzy controller, Expert fuzzy controller,

	Design requirements for fuzzy controllers, Properties of fuzzy controllers, Application examples of fuzzy controllers. **Neurocontrol Systems** Introduction to artificial neural networks (ANN), ANN for control, Structure of ANN, Examples of ANN: Multilayer Perceptron, Adaptive Resonance Theory Network, Kohonen Network, Hopfield Network, NN based learning control, NN based adaptive control, NN based internal model control. **Learning Control Systems** Introduction to learning control, Basic strategies and structure of machine learning, Schemes of learning control: iterative learning control, repetitive learning control, NN-based, Stability and convergence issues, Examples of learning control.
Course Assessment	Continuous Evaluation: 25% Mid-Semester Examination: 25% End-Semester Examination: 50%

Course no: EELB 431	Open Course (Y/N)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
Type of course	N0	N0	Yes	No
Course Title	**Biomedical Instruments and Data Interpretation**			
Course Coordinator				
Course objectives:	• To introduce an fundamentals of transducers as applicable to physiology • To explore the human body parameter measurements setups • To make the students understand the basic concepts of forensic techniques. • To give basic ideas about how multimedia evidences are useful in crime investigation.			
POs				
Semester			Spring: NA	

	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	2	4
Prerequisite course code as per proposed course numbers	Nil			
Prerequisite credits	Nil			
Equivalent course codes as per proposed course and old course	Nil			
Overlap course codes as per proposed course numbers	Nil			

Text Books:		
1.	Title	Hand Book of Bio-Medical instrumentation’
	Author	R.S.Khandpur
	Publisher	Tata McGrawHill PublishingCo
	Edition	2003
2.	Title	Bio-Medical InstrumentationandMeasurements
	Author	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer,
	Publisher	Pearson Education,
	Edition	2002
Reference Book:		
1.	Title	Medical Instrumentation
	Author	J.Webster
	Publisher	John Wiley & Sons,
	Edition	1995.
2.	Title	Principles of Applied Bio-Medical Instrumentation
	Author	L.A. Geddes and L.E.Baker
	Publisher	John Wiley & Sons,

	Edition	1975
Content	**Unit-I Physiology and transducers** Cell and its structure, Resting and Action Potential, Nervous system: Functional organization of the nervous system, Structure of nervous system, neurons, synapse, transmitters and neural communication, Cardiovascular system, respiratory system. **Unit-II Electro – Physiological measurements** Electrodes: Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes, Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier. ECG, EEG, EMG, ERG, Lead systems and recording methods, Typical waveforms. **Unit-III Physiological parameter measurements** Measurement of blood pressure, Cardiac output, Heart rate, Heart sound, Pulmonary function measurements, spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analyzers : pH of blood, measurement of blood pCO2, pO2, finger-tipoximeter, ESR, GSR, measurements, Standard HL **Unit-IV Medical Imaging** Radiographic and fluoroscopic techniques, X rays, Computer tomography, Mammography, MRI, fMRI, Ultrasonography, Endoscopy, Thermography, Different types of biotelemetry systems and patient monitoring **Unit-V Assisting and therapeutic equipment's** Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart Lung machine, Audio meters, Dialyzers,	
Course Assessment	Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%. 100% weightage to theory for overall grading. Continuous evaluation shall depend on course coordinator.	

Course no: EELB 432	Open Course (Y/N)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
Type of course	N0	N0	Yes	No
Course Title	**Sensor Design and System Development**			
Course Coordinator				
Course objectives:	• Understanding Sensor Principles and Design: This objective focuses on imparting knowledge of fundamental principles underlying sensor technologies, including sensing mechanisms, transduction techniques, and sensor characteristics. Students will learn to design sensors tailored to specific applications, considering factors such as sensitivity, accuracy, selectivity, and robustness. Integration and • System Development: This objective emphasizes the integration of sensors into larger systems and the development of complete sensor-based systems. Students will learn to interface sensors with microcontrollers or other processing units, perform data acquisition and processing, and develop control strategies. Additionally, they will gain skills in system-level design considerations such as power management, communication protocols, and real-time operation.			
POs				
Semester			Spring: NA	

	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	2	4
Prerequisite course code as per proposed course numbers	Nil			
Prerequisite credits	Nil			
Equivalent course codes as per proposed course and old course	Nil			
Overlap course codes as per proposed course numbers	Nil			

Text Books:

1.	Title	Sensors and Transducers
	Author	Patranabis.D
	Publisher	Wheeler publisher,
	Edition	1994.
2.	Title	Hand Book of Modern Sensors: Physics, Designs and Application
	Author	Jacob Fraden
	Publisher	Springer,
	Edition	2010

Reference Book:

1.	Title	The Mechatronics Hand Book
	Author	Robert H Bishop

	Publisher	CRC Press,
	Edition	2002
2.	Title	Shape Memory Actuators
	Author	Manfred Kohl
	Publisher	Springer
	Edition	first edition

Content

UNIT – I SENSORS

Difference between sensor, transmitter and Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band. Types of signal: Pneumatic signal; Hydraulic signal; Electronic Signal. Principle of operation, construction details, characteristics and applications of potentiometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photoresistive sensor.

UNIT- II INDUCTIVE & CAPACITIVE TRANSDUCER

Inductive transducers: Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn. Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning-

UNIT III ACTUATORS

Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria.

UNIT IV MICRO SENSORS

Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors.

UNIT V SENSOR MATERIALS AND PROCESSING TECHNIQUES

Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials Processing techniques: Vacuum deposition, sputtering, chemical vapour deposition, electro plating, photolithography, silicon micro machining, Bulk silicon micro machining, Surface silicon micro machining, LIGA process.

Course Assessment

Theory: Continuous Evaluation 25%, Mid Semester 25%, End Semester 50%.

100% weightage to theory for overall grading.

Continuous evaluation shall depend on course coordinator.

Course no: EELB 433	Open course(YES/NO)	HM Course(Y/N)	DC(Y/N)	DE(Y/N)
Type of course				YES
Course Title	**Embedded Control Systems**			
Course Coordinator				
Course objectives:	To understand the basics of embedded control systems and the use of control theory in embedded systems.			
POs				

Semester	**Autumn: Yes**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course Code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and Old course					
Overlap course codes as per proposed Course numbers					

Text Books and Reference Books:

1.	Title	Handbook of Networked and Embedded Control Systems
	Author	Dimitrios Hristu-Varsakelis
	Publisher	Springer
	Edition/ Year	2007
2.	Title	Computer Controlled Systems: Theory and Design
	Author	Karl Johan Astrom and Bjorn Wittenmark
	Publisher	Dover Publications
	Edition/ Year	2011

Content	**Introduction** Definition and architecture of embedded control system, Communication networks in embedded systems, Multi-tasking, Planning embedded system development. **Control System Design** Requirements for control system design: safety issues, specifications, Mathematical modeling for control, Characteristics and limitations of control system, stability, Performance specifications. **Approximation of Continuous-Time Controllers** Approximation based on transfer function, Selection of sampling interval, Approximation based on State Models, Frequency-response design methods, Digital PID Controllers. **Implementation of Digital Controllers** Different representations of controller, Realization of digital controllers, Implementation of computer-controlled system, Analog prefiltering and computational delay, Measurement errors, nonlinear actuators, Roundoff and Quantization. **Real-Time Scheduling** Fixed-priority scheduling: task interaction, Aperiodic tasks, overload management, Dynamic-priority scheduling: processor demand criterion, Resource sharing, Challenges.
Course Assessment	Continuous Evaluation: 25% Mid-Semester Examination: 25% End-Semester Examination: 50%