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 members and 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.
- To inspire students to become responsible citizens and inculcate value based, socially committed professional ethics to cause of holistic development.
- To enable sustainable and cost-effective innovations, showcasing the importance of green energy technology with a focus on energy efficiency.

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	To imbibe analytical and professional skills in students to succeed in diverse fields.
PEO-2	To create enthusiasts to pursue advanced education supplementing their career growth.
PEO-3	To develop the necessary skill set for industries in students by imparting state of art technology in various areas of electrical engineering.
PEO-4	To promote the culture of problem-solving and design skills for lifelong learning.

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 first principles 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 needs with 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	Students shall be competent, creative and imaginative Electrical Engineering employable in fields of design, research, manufacturing, safety, quality and technical services.
PSO -2	Students shall be able to progress through an advanced degree, certificate programs or participate in continuing education in Electrical Engineering, business and other professionally related fields.
PSO -3	Students should take lead in innovation and entrepreneurship activities with high professional standards and moral ethics and prove themselves beneficial to society at large.

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 Title: Electrical Engineering Materials
Course Code: PHLB 102
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil
Course Objective: To familiarize students with the properties of various types of electrical engineering materials

Course Outcomes:

CO-1	Understand the concepts of dia-, ferro-, anti-ferro, and ferri-magnetic materials and their applications
CO-2	Understand the concepts of metals, semiconductors and fabrication techniques along with thermo-electric effect and superconductivity
CO-3	Understand different concepts (e.g., polarization, ferro-electricity, and piezo-electricity etc.) related to dielectric materials
CO-4	Understand the electrical, thermal, and mechanical properties of insulating materials (e.g., glass, ceramics, and plastic etc.)

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	2	2	-	-	-	-	-	1	-	2	2	1	1
CO-2	2	2	2	1	1	-	-	-	2	-	-	2	3	1	2
CO-3	2	2	3	3	-	-	-	-	-	1	-	2	1	-	-
CO-4	2	2	2	2	-	-	-	-	-	1	-	2	2	-	-
Average	**2.25**	**2**	**2.25**	**2**	**0.25**	**0**	**0**	**0**	**0.5**	**0.75**	**0**	**2**	**2**	**0.5**	**0.75**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-I: 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.

Module-II: 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.

Module-III: Dielectric Materials
Field vectors, polarization, Ferro electricity and Piezo electrics, behavior of polarization under impulse and frequency switching, dielectric loss, spontaneous polarization.

Module-IV: 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.

Learning Resources:

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

Reference Books:

1. Title: Electrical Engineering Materialsb Author: A.J. Dekker, Publisher: Prentice Hall of India Edition: 1st
2. Title: Materials for Electrical Engineering, Author: Ian P. Jones, Publisher: Oxford University Press, Edition: 1st Edition.

Course Title: Basic Electrical Engineering
Course Code: EEBB 102
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective:

- 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

Course Outcomes:

CO-1	Understand basics of electrical components.
CO-2	Appreciate and analyze DC, AC and magnetic circuits using KVL and KCL.
CO-3	Understand the basics of AC Generation and the working principle of transformers
CO-4	Be familiar with the working principals of electrical machines.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	1	1	1	-	1	1	-	-	-	3	3	-	-
CO-2	3	3	3	3	-	-	-	-	1	-	-	3	3	-	-
CO-3	3	2	-	1	-	-	-	-	-	2	-	2	3	-	-
CO-4	3	2	2	2	2	2	-	3	1	-	1	3	3	-	-
Average	**3**	**2.5**	**1.5**	**2.25**	**0.75**	**0.5**	**0.25**	**0.75**	**0.5**	**0.5**	**0.25**	**2.75**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module 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

Module 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

Module 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.

Module IV: Single- Phase Transformer

Principle of operation, construction, emf equation, equivalent circuit, power losses, efficiency, introduction to auto transformer

Electrical Machines

Working principle, construction and applications of DC machines and AC machines.

List of Experiments:

1. Verification of KVL & KCL,
2. Mesh analysis & Nodal Analysis,
3. Star Delta Transformation,
4. Analysis of AC circuit: - RL, RC & RLC,
5. Series resonance analysis,
6. Study of machines: - DC & AC machines,
7. Transformer Analysis.

Learning Resources:

Text Books:

1. Introduction to Electrical Engineering **by** Mulukutla S. Sarma **(**Oxford Press**).**

2. Electrical Engineering Fundamentals **by** V. D. Toro **(**PHI**. 2015).**

Reference Books:

1. Basic Electrical Engineering **by** V.N. Mittle **(**McGraw Hill Education 2017**).**

2. Basic Electrical and Electronics Engineering **by** S.K. Bhattacharya **(**pearson 2nd edition**).**

Course Title: Engineering Visualization
Course Code: MEBB 162
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil
Course Objective:

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:

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.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	2	2	2	-	-	-	-	-	-	2	2	2	2
CO-2	2	2	1	2	3	-	-	-	-	-	-	3	2	3	3
CO-3	3	3	3	2	2	-	-	-	-	-	-	3	3	1	2
CO-4	3	1	3	3	1	-	-	-	-	-	-	3	3	2	3
Average	**2.75**	**2.00**	**2.25**	**2.25**	**2.75**	**0**	**0**	**0**	**0**	**0**	**0**	**2.75**	**2.50**	**2.00**	**2.50**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I:

Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons. Scales: Plain scales, Diagonal scales, Scale of chords.

Module 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.

Module 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.

Module 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.

Module 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.

Learning Resources:

Text Books:

1. Engineering Graphics, N.D. Bhatt and V.M. Panchal, Charotar Publishers.
2. Jolhe, D. A., Engineering drawing, Tata McGraw Hill.

Reference Books:

1. Engineering Drawing, Agarwal, B, McGraw Hill Education, 2015, Second edition.
2. Shah, M. B. and Rana, B. C., Engineering Drawing, Pearson Education, 2009.
3. K.V. Natarajan, A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 2006.
4. AutoCAD 2007 Bible E. Finkelstein,Wiley Publishing Inc.

Course Title: Advanced Calculus
Course Code: MALB 101
L-T-P : 3-1-0
Credits: 4
Pre-requisites: Nil

Course Objective: This course is aimed to cover differential, integral and vector calculus for functions of one and more than one variable. These mathematical tools and methods are used extensively in physical sciences, engineering, and computer graphics.

Course Outcomes:

CO-1	Understand the theory and methods of Differential, Integral and Vector Calculus
CO-2	Apply different methods for solving problems in Differential, Integral and Vector Calculus
CO-3	Analyze sequence and series for its convergence. Analyse function for continuity and differentiability. Analyse curves and surfaces for concavity, inflection points, maxima and minima.
CO-4	Evaluate extreme points for the function of several variables. Evaluate limits. Evaluate limit of sequences and sum of some convergent series. Evaluate multiple integrals in rectangular, polar, cylindrical, and spherical coordinates.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3	3	-	-	-	-	-	-	-	-	-	-	-	–	-	-
CO-4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I:

Differential Calculus [Functions of Single Variable]: Limit and Continuity of functions; differentiability; Jacobian, Rolle's theorem; Mean value theorem; Taylor's and Maclaurin's theorems with remainders, Expansions; Convergence of sequences and series of real numbers; Power series.

Module II:

Differential Calculus [Functions of Several Variables]: Functions of several variables, limit and continuity, Partial Derivatives and Differentiability, Maxima & Minima of two variables, Lagrange method of multiplier.

Module III:

Integral Calculus: Fundamentals theorem of integral calculus, Riemann Integration, Improper Integrals, Double and Triple integrals-computation of surface area and volumes-change of variables in double and triple integrals.

Module IV:

Vector Calculus: Scalar and vector field; Vector differentiation; Level surfaces, Directional Derivatives, Gradient of Scalar field; Divergence and Curl of a vector field; Laplacian, Line and Surface integrals; Green's theorem in plane Gauss Divergence's theorem and Stoke's theorem.

Text Books:

1. Thomas Calculus by G. Thomas, M. Weir, J.Hass (Pearson Publication, 2010).
2. Introduction to Real Analysis by R.G. Bartle, D.R. Sherbert (John Wiley and Sons, 2011).
3. Advanced Engineering Mathematics by E. Kreyszig (John Wiley and Sons)

Course Title: Product Design & Realization Lab
Course Code: MEPB 121
L-T-P : 0-0-2
Credits: 1
Pre-requisites: Nil

Course Objective:

1. To improve the design and realization skills in the context of product life cycle of modern industrial work system.
2. To impart proper understanding of a product design and prototyping.
3. To enable the students with various designing and simulation software in order to become professionally efficient.
4. To redesign tasks and workstations by using ergonomic aspects to fit current industrial aspects.

Course Outcomes:

CO-1	Analysis product life cycle for manage product design and enhancing product quality.
CO-2	Develop a 3D product and simulate by using various software.
CO-3	Assess the effectiveness of different workstation layouts, and equipment placement by the concept of ergonomics.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	1	1	2	2	-	-	-	-	-	-	2	2	3	2
CO-2	2	2	2	3	1	-	-	-	-	-	-	3	2	2	2
CO-3	3	3	2	3	3	-	-	-	-	-	-	2	3	3	3
Average	**2.33**	**2.00**	**1.67**	**2.67**	**2.00**	**0**	**0**	**0**	**0**	**0**	**0**	**2.33**	**2.33**	**2.67**	**2.33**

1 - Slightly; 2 - Moderately; 3 - Substantially

List of Experiments:

1. To study the concept of product life cycle and prototyping aspects.
2. To review the product development and research on various engineering materials for their performance and sustainability.
3. To study of all advanced software tools such as CATIA, ABAQUS, Delmia, and Fusion 360 and simulate the engineering problems.
4. To develop a polymer/metal-based product through 3D printers for rapid prototyping.
5. To optimize the design of a structural component design for maximum performance under specific loading conditions, using ANSYS software.
6. To investigate how ergonomic equipment and optimized work layout impact worker productivity, comfort, and overall performance.
7. To simulate and analyze fluid flow (laminar or turbulent) through a circular pipe using Computational Fluid Dynamics (CFD) software.

Learning Resources:

Text/References Books:

1. Fiksel, J., Design for Environment: A Guide to Sustainable Product Development, 2nd Edition, The McGraw-Hill Companies, Inc.
2. Redwood, B., The 3D Printing Handbook: Technologies, design and applications, Kindle Edition.
3. Kroemer, K.H.E., Fitting the Human: Introduction to Ergonomics, CRC Press.

Course Title: Communication Skills
Course Code: HMLB 101
L-T-P : 2-0-0
Credits: 2
Pre-requisites: Nil
Course Objective: To course aims to provide the field of electrical & electronics engineering, laws and principles of electrical/electronic engineering and to acquire fundamental knowledge in the relevant field.

Course Outcomes:

CO-1	To prepare engineering students to perform well in technical writing and presentation skills.
CO-2	To prepare engineering students for core engineering skills through soft skills
CO-3	To equip engineering students with writing skills
CO-4	To equip engineering students with presentation skills
CO-5	To equip engineering students with discussion and interview skills

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2
CO-2	-	-	-	-	-	-	-	-	-	3	-	1	-	-	-
CO-3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO-4	-	-	-	-	-	-	-	-	-	3	2	-	-	-	-
CO-5	-	-	-	-	-	-	-	-	-	3	-	1	-	-	-
Average	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0.4**	**0.4**	**0**	**0**	**0.4**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I:
Written Communication: Writing Resume, Curriculum Vitae, and Bio-data (Design, Style); Writing Cover letter, Job Applications, Statement of Purpose (SoPs), Life Essay etc. Writing Technical Correspondences: Report Writing, Process Writing, Technical Description: Instructions, manuals etc. Proposals writing, Journal Articles and Conference Papers, Review and Research Articles. (Focus would be given to Grammar, Foreign Words &Phrases, Appropriate use of Prepositions and other aspects).

Module II:
Organisational Skills: Samples of technical letters (Letter of Inquiry, Replies to Inquiry Letters, Letters Placing Orders, Instruction Letters, Letters Urging Action, Complaint Letters, and Adjustment Letters), E-mail Correspondences: Format, Standard Practices and Strategies

Module III:
Presentation Skills: Oral presentation Skills: How to make presentation (Focus on Paralinguistic features of speech: Pause, Voice, Stress, and Intonation etc. and Non-verbal cues: Body-language etc.). Preparing the Presentation: Develop the central idea, main ideas and supporting materials, visual aids. Rehearsing the presentation: Improving Delivery and handling stage Fright

Module IV:
Group Discussion Skills: Techniques for Group Discussion Subject Knowledge, Communication Skills, Leadership Skills, Group Behaviour, Group Contribution: Contributing Systematically; Creating Cooperative Environment, Optimal Participation, Handling Conflict, Effective Closure Individual Contribution: Topic analysis; Discussing Opinion, Problems, Case Studies, Exchanging Opinions, Suggestions and Proposals.

Module V:
Job Interviews: Pre-interview Presentation Techniques Self-Analysis, Research the Organisation Job Analysis, Revise your Subject Knowledge, Develop your Interview file. Interview questions: types, Answering Strategies.

Text Books:

1. Effective Technical Communication by Rizvi, M. A. (McGraw HillsEducation, 2005).
2. New International Business English by Jones, L &R. Alexander (CUP, 2006).
3. Spoken English: A Manual of Speech and Phonetics by R. K. Bansal & J. B. Harrison (Orient Blackswan, 2013).
4. English Pronunciation in Use - Advanced by Hewings, M (Cambridge, 2009).
5. English Pronunciation in Use. Elementary by Marks, J (Cambridge, 2009).
6. Speaking Accurately. A Course in International Communication by Nambiar, K.C. (Foundation, 2011).
7. Basics of Communication in English by Soundararaj, Francis (Macmillan, 2012).

Course Title: Environmental Sciences
Course Code: CELB 101
L-T-P : 2-0-0
Credits: 2
Pre-requisites: Nil

Course Objective: Create the awareness about environmental problems among people and imparting basic knowledge about the environment and its allied problems.

Course Outcomes:

CO-1	Gain a comprehensive understanding of the Environmental Science aspects.
CO-2	Develop awareness of environment related issues.
CO-3	Learn about the ethical and moral responsibilities of the engineers towards environment.
CO-4	Learn remedial measures to solve environmental issues.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	-	-	-	-	-	-	3	-	-	-	-	-	-	-	2
CO-2	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-3	-	-	-	-	-	-	3	-	-	-	-	3	-	-	1
CO-4	-	-	-	-	-	-	-	3	-	-	-	3	-	-	-
Average	**0**	**0**	**0**	**0**	**0**	**0**	**2.25**	**0.75**	**0**	**0**	**0**	**1.5**	**0**	**0**	**0.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I:

Multidisciplinary nature of environmental studies: Definition, scope and importance, need for public awareness.

Module II:

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.

Module III:

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 mega-diversity 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.

Module IV:

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

Module V:

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.

Text Books:

1. Environmental Science: Toward a Sustainable Future by Richard T. Wright & Dorothy F. Boorse.

2. Environmental Science: Earth as a Living Planet byDaniel B. Botkin & Edward A. Keller.

3. Principles of Environmental Science byWilliam P. Cunningham & Mary Ann Cunningham.

Course Title: Ordinary Differential Equation and Transforms
Course Code: MALB 153
L-T-P : 3-1-0
Credits: 4
Pre-requisites: Nil
Course Objective: To impart knowledge of matrices and applications closed form and series solutions of Differential equations, Laplace Transform, Fourier series, Fourier Transform & their applications.
Course Outcomes:

CO-1	Apply mathematical tools for the solutions of differential equations that model physical processes.
CO-2	Understand the concept of Fourier Series and Series solution.
CO-3	Analyze the different form of Laplace and Fourier Transformations.
CO-4	Determine the solutions of IVP and BVP using these transformations.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-	2	-	-
CO-3	3	3	2	3	-	-	-	-	-	-	-	-	2	-	-
CO-4	3	-	2	2	-	-	-	-	-	-	-	-	2	-	-
Average	**3**	**2.25**	**1.5**	**2.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 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.

Module-II Special Functions

Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel functions of first kind, Orthogonal property.

Module-III 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.

Module-IV 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).

Learning Resources:

Text Books:

1. Advanced engineering mathematics by Kreyszig (9th edition, Wiley-India).
2. Advanced engineering mathematics by Jain/Iyenger (2nd edition, Narosa).
3. Engineering Mathematics through Applications by Paras Ram (CBS Publication).

Reference Books:

1. Advanced engineering mathematics by Taneja (I K international).
2. Advanced engineering mathematics by Alan Jeffery (Academic Press).

Course Title: Network Analysis
Course Code: EELB 151
L-T-P: 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: To equip students with a fundamental understanding of electrical circuit theories, network theorems, and analysis techniques to model, analyze, and solve complex electrical networks for practical engineering.

Course Outcomes:

CO-1	Understanding of electrical network topology, graph theory, network theorems and two port networks.
CO-2	Application of network theorems and graph theory in various electrical circuits.
CO-3	Analysis of two port networks & their interconnections and first & second order circuits using differential equations and Laplace transform.
CO-4	Design and development of electrical network under different combination of electrical elements.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	**03**	**-**	**-**	**-**	**03**	-	-	-	-	-	-	-	-	-	-
CO-2	**03**	**03**	**-**	**-**	**03**	-	-	-	-	-	-	-	-	-	-
CO-3	**03**	**03**	**-**	**03**	**03**	-	-	-	-	-	-	-	-	-	-
CO-4	**03**	**03**	**03**	**03**	**03**	-	-	-	-	-	-	-	-	-	-
Average	**03**	**2.25**	**0.75**	**1.5**	**03**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1

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

Module-II

Two Port Networks:

z, y, h, g, ABCD, inverse ABCD parameters, their inter conversion, interconnection of two 2-port networks

Module-III

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

.

Module-IV

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

Text Books:

1. Network Analysis by M.E. Van Valkenbur (PHI).
2. Network Analysis and Synthesis by F.F. Kuo, (John Wiley and Sons).
3. Engineering Circuit Analysis by Hayt, Kemmerly & Durbin (Tata McGraw Hill Publishing Company Ltd).

Reference Books:

1. Linear circuit Analysis: Time Domain, Phasor, and Laplace Transform Approaches, Decarlo & Lin, Oxford.

Course Title: PROBLEM SOLVING AND COMPUTER PROGRAMMING
Course Code: CSBB181
L-T-P: 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective: This course aims to provide the students with a foundation in computer Programming. The goal of the course is to develop the basic programming skills in students.

Course Outcomes:

CO-1	Explain the syntax structure of C programming language and familiarization with basics of C programming including Basic data type used, Arithmetic and logical operators, Flow of Control, Conditional statements, different types of loops
CO-2	Problem solving by dividing large problems into smaller problems. Familiarization with concepts of functions in C, user defined functions, library functions, Parameter passing between functions
CO-3	To understand One dimensional, Multi-Dimensional Arrays and Strings used in programming.
CO-4	To understand the concept of Structures used in C Programming including its Declaration, Initialization, passing structure to function, Pre-processors, Macros.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	2	2	-	3	-	-	-	-	-	1	-	3	3	-
CO-2	2	2	2	-	3	-	-	-	-	-	-	-	3	3	-
CO-3	2	2	2	-	3	-	-	-	-	-	-	-	3	3	-
CO-4	2	2	2	-	3	-	-	-	-	-	-	-	3	3	-
Average	**2**	**2**	**2**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I:
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.

Module II: (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.

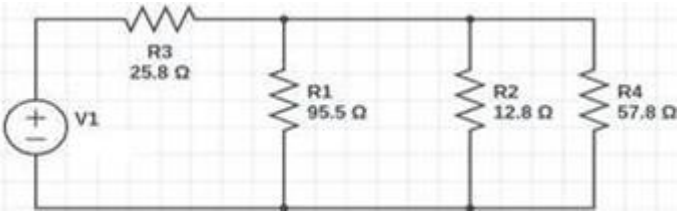
Module III: (7 Hours)
Function – User defined functions, library functions, Parameter passing – call by Value, call by reference, recursion.

Module IV: (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 array.

Module V: (8 Hours)
Structure: Declaration, Initialization, 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.

List of Experiments:

1. Familiarization with Linux Environment – How to do Programming in C with Linux.
   a) Navigating the Linux Environment: Basic Commands, File Operations
   b) Setting Up the C Programming Environment
2. Familiarization with Console I/O and operators in C
   a) Display "EE Department , N.I.T. Delhi"
   b) Read two numbers, add them and display their sum
   c) Read the radius of a circle, calculate its area and display it
   d) Evaluate the arithmetic expression (a-b/c *d + e)*(f + g)) and display solution. Read the values of the variables from the user through console.
3. Write a program
   a) Calculate simple and compound interest
   b) Find the roots of quadratic equation.
   c) Write a C program to calculate current in following circuit. User will enter value of Voltage through the keyboard. Display current in each Resistances, and Voltages across it.



4. Understand assignment to variables
   a) Write a program to swap values of two variables using third variables and, without using third variables.
   b) Write a program to find the largest of three numbers with and without ternary Operators.
5. Familiarization with concept of Loop
   a) Write program to print integer number for 0 to N, where N is input number provided by user
   b) Write program that counts the number of digits in a given number.
   c) Write program that calculates the sum of even and odd numbers within a given range
6. Write a program to plot a graph of the function $f(t)=b*e^{-at}$ using asterisks * in C.
   a) For value b=20, a=0.2 ,t=0 to 20 with time step 1
   b) For value b=25, a=0.5 ,t=0 to 15 with time step 0.1
7. C program that converts the local time of one country to another country based on the user-provided time difference. The program will take inputs from the user: the local time (hours and minutes), the time zone difference, and convert it to the foreign time (assume 24 hour clock system in both country)
   a) User will always provide time difference in integer hours
   b) User may provide time difference in hours , and minutes
8. Write a program that calculates the number of months required to complete a project based on the input of total work hours, number of workers, and the amount of rest and break time each worker needs daily.
9. C program that simulates a traffic light controller. The program will print "Red Signal", "Green Signal", and "Yellow Signal", each for a specified amount of time.
10. To simulate the operation of an automatic washing machine in C, we can implement various stages such as soaking, washing, rinsing, and spinning, along with a menu for selecting different wash modes. The program will use functions to represent each stage of the washing process, and delays (sleep()) can simulate the time required for each stage.
11. Write C programme for the 21 Number Winning Game. In this game two players take turns adding numbers to a running total, starting from 0. Each player may add 1, 2, 3, or 4 to the current total on their turn, and the player who makes the total reach 21 or more, loses the game. The human player plays first, the computer follows a strategy that ensures it will win.

    Game Rules:

    1. The initial total is set to 0.
    2. On each turn, a player must add 1, 2, 3, or 4 to the current total.
    3. The players alternate turns, and the computer player always goes second.

4. The player, whose move causes the total to reach 21 or more, loses the game.

12. For the following set of sample data, compute the standard deviation and the mean using C program.
-6, -12, 8, 13, 11, 6, 7, 2, -6, -9, -10, 11, 10, 9, 2
The formula for standard deviation is: $\sqrt{\frac{\sum_0^n (x_i - \bar{x})^2}{n}}$

Learning Resources:

Text Books:

1. **"**Programming in ANSI C" by E. Balagurusamy **(**TATA McGraw Hill)
2. **"**Let Us C" by Yashavant Kanetkar **(**Infinity Science Press**).**
3. **"**The C Programming Language" by Brian Kernighan & Dennis Ritchie **(**Prentice Hall**).**

Course Title: Engineering Mechanics
Course Code: MELB 151
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective:

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.

Course Outcomes:

CO-1	Apply the various laws of engineering mechanics for solving simple and complex problems.
CO-2	Apply analytical skills for analysing statically equilibrium problems.
CO-3	Calculate and analyse the properties (C.G and M.I) of the rigid bodies and also solve problems related to friction.
CO-4	Plan and conduct appropriate experimentation and interpret the data.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	3	2	-	-	-	-	-	-	-	3	-	2	2
CO-2	2	3	3	2	-	-	-	-	-	-	-	3	-	3	3
CO-3	3	2	2	3	-	-	-	-	-	-	-	2	-	1	2
CO-4	3	2	3	3	-	-	-	-	-	-	-	2	-	2	3
Average	**2.75**	**2.25**	**2.75**	**2.50**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2.50**	**0**	**2.00**	**2.50**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module 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.

Module 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.

Module 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.

Module 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.

Module 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.

Learning Resources:

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.

Course Title: Electrical Workshop
Course Code: EEBB152
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective: To provide hands-on experience and practical knowledge of electrical concepts, components, and systems. It aims to enhance skills in wiring, circuit design, troubleshooting, and the use of electrical instruments.

Course Outcomes:

CO-1	Study of different types of wiring and load calculation
CO-2	Operation, principle and application of different types of batteries
CO-3	Methods and importance of earthing in electrical systems
CO-4	Working and application of various types of artificial lighting sources

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	2	3	--	2	--	--	--	--	--	--	--	3	2	1
CO-2	3	1	2	--	2	--	2	--	--	--	--	--	3	2	1
CO-3	3	2	3	--	2	--	--	--	--	--	--	--	3	2	1
CO-4	3	3	2	--	2	--	--	--	--	--	--	--	3	2	1
Average	**3**	**2**	**2.5**	**0**	**2**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**3**	**2**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

MODULE I: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 - Power, control, Communication and entertainment 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.

MODULE II: 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.

MODULE III: 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.

MODULE IV: 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.

List of 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

Learning Resources:

Text Books:

1. Electrical Installation Estimating & Costing Edition Gupta, J.B, S. K. Kataria & Sons, New Delhi Reference Books:
2. Electrical Design, estimating & Costing, by S.K. Raina, and K. B. Bhattacharya New Age International (p) Limited, New Delhi.

Reference Books:

1. I.E. rules for wiring, Electricity supply act-1948. Bureau of Indian Standards, Electricity supply act-1948, Electrical Workshop: Safety,
2. Commissioning, Maintenance & Testing of Electrical Equipment by R.P. Singh, Wiley publishers

Course Title: Holistic Health & Sports
Course Code: HSPB 150
L-T-P : 0-0-2
Credits: 1
Pre-requisites: Nil

Course Objective:

This course aims to provide a comprehensive understanding of the interconnections between physical fitness, mental well-being, and overall health. It integrates principles of exercise science, nutrition, psychology, and holistic health practices to enhance performance, prevent injuries, and promote lifelong well-being.

Course Outcomes:

CO-1	Demonstrate an understanding of the interrelationship between physical fitness, mental well-being, and lifestyle choices for overall health improvement
CO-2	Utilize knowledge of biomechanics, exercise physiology, and injury prevention to enhance athletic performance and promote safe training methods.
CO-3	Create tailored fitness, nutrition, and recovery strategies that align with individual goals and health needs.
CO-4	Implement stress management, mindfulness, and psychological techniques to support mental health and optimize sports performance.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-
CO-2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
CO-3	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-4	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-
Average	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0.75**	**0**	**0**	**0.25**	**0**	**0**	**0.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I:
Fundamentals of Holistic Health & Wellness: Introduction to holistic health: Physical, mental, and emotional well-being; Principles of health and fitness: Importance of exercise, nutrition, and rest
Role of lifestyle choices in overall well-being; Stress management techniques: Meditation, yoga, and breathing exercises; Impact of sleep, hydration, and recovery on performance
Module II:
Sports Science & Performance Enhancement: Basics of exercise physiology: Muscle function, energy systems, and endurance; Biomechanics in sports: Movement analysis and injury prevention; Strength and conditioning principles for athletes and general fitness; Role of flexibility, mobility, and posture in injury prevention; Sports-specific training methods and techniques
Module III:
Nutrition & Recovery Strategies: Fundamentals of sports nutrition: Macronutrients and micronutrients; Hydration and electrolyte balance for optimal performance; Meal planning for athletes and active individuals; Recovery strategies: Active recovery, massage, and cold/hot therapy; Supplementation in sports: Benefits and risks
Module IV:
Mental Resilience & Social Aspects of Sports: Psychological aspects of sports performance and motivation; Mindfulness, visualization, and goal-setting techniques; Coping with competition stress and mental fatigue; Team dynamics and leadership in sports; Role of sports in community building and personal development

Text Books:

1. Foundations of Sport and Exercise Psychology by Robert S. Weinberg & Daniel Gould.
2. Sports Nutrition: A Handbook for Professionals by Christine Karpinski & Melissa W. Kaye.

Course Title: Project
Course Code: EEPB 153
L-T-P : 0-0-2
Credits: 1
Pre-requisites: NA

Course Objectives:

- To inculcate culture of handling all aspects of solution of a practical problem
- To develop ability to work in group with peers
- To understand, formulate and analyze the problem resulting into a novel solution

Course Outcomes:

CO-1	Apply engineering principles to real-world projects
CO-2	Plan and monitor project tasks individually or as a team
CO-3	Demonstrate practical experience in project execution
CO-4	Communicate project findings clearly through reports and presentations

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	3	-	-	-	2	1	1	3	2	2	**2**
CO-2	2	2	2	2	2	-	-	-	3	2	3	3	3	3	**3**
CO-3	2	2	2	2	2	-	-	-	3	2	3	3	3	3	**2**
CO-4	1	1	1	1	1	-	-	-	3	3	3	3	3	3	**2**
Average	**2**	**2**	**2**	**2**	**2**	**0**	**0**	**0**	**2.75**	**2**	**2.5**	**3**	**2.75**	**2.75**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Course Contents:

1. Initiate the work on the topic in areas of electrical and electronics engineering as propose by Project supervisor in terms of following
2. Literature Survey
3. Problem Definition
4. Preliminary investigation
5. Prepare plan of action based on above
6. Present seminars based on the work done at end of semester.

Course Title: Numerical and Engineering Optimization Methods
Course Code: MABB 203
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective: 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.
Course Outcomes:

CO-1	Solve linear programming problems using appropriate techniques and Optimization solvers, interpret the results obtained.
CO-2	Determine an optimal strategy for Minimization of Cost of shipping of products from source to Destination/ Maximization of profits of shipping products
CO-3	Optimize the allocation of resources to demand points in the best possible way
CO-4	Formulate network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems
CO-5	Evaluation of real world problem using modern optimization techniques

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	3	-	-	-	-	-	-	-	-	3	-	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO-3	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-4	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
Average	**3**	**3**	**1.5**	**2.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 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.

Module-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.

Module-III Assignment Problem

Meaning of assignment problem, unbalanced assignment problem, traveling salesman problem, Hungarian method for the optimal solution, maximization in the assignment problem.

Module-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.

Module-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:

1. Linear Programming Problem - Graphic solution.
2. Simplex method.

3. Two phase simplex methods.
4. Transportation - north-west corner method.
5. Vogel's approximation method.
6. Assignment problem.
7. Travelling salesman problems.
8. Implementation of the Root finding Methods (Newton-Raphson method).
9. Implementation of the Linear Systems (Gauss Elimination, Gauss Jordan,).
10. Neural-Network-Based Optimization.

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

Learning Resources:

Text Books:
1. Operational Research Theory and Application by J K Sharma (6^{th} edition, Trinity Press).
2. Numerical Analysis by Richard L. Burden and J. Douglas Faires (9^{nd} edition, Richard Stratton).

Reference Books:
1. Introduction to Operational Research by F Hillier and G Lieberman (McGraw Hill).
2. Engineering Optimization Theory and Practice by Singiresu S Rao (Wiley).

Course Title: Electromagnetic Field Theory
Course Code: EELB 201
L-T-P : 3-1-0
Credits: 4
Pre-requisites: Nil

Course Objective: Understand the fundamentals of vector calculus, Electrostatics, Magneto statics, Maxwell's Equations.

Course Outcomes:

CO-1	Explain the concepts of vector calculus to solve complex problems and relate among different coordinate systems for electromagnetic fields
CO-2	Analyse the behaviour of conductors in electric fields, electric dipole, the capacitance and energy stored in dielectrics.
CO-3	Calculate the magnetic field intensity due to current carrying conductor and understanding the application of Ampere's law, Maxwell's second and third law
CO-4	Analyse the concepts of Faraday's laws, Displacement current, Poynting theorem and Poynting vector.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO-3	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO-4	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
Average	**3**	**3**	**1.5**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 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.

Module-II 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.

Module-III 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.

Module-IV Time Varying Fields

Faraday's law, Displacement current. Maxwell's equations in point form and integral form. Numerical.
Wave propagation in free space and in dielectrics. Pointing vector and power considerations. Propagation in good conductors, skin effect. Numerical.

Learning Resources:

Text Books:

1. Engineering Electromagnetics by W H Hayt, J A Buck (McGraw Hill Education).
2. Principles of Electromagnetics by Mathew N. O. Sadiku (Oxford University Press Inc.).
3. Fundamentals of Electromagnetics with MATLAB by Karl E. Longren (Scitech).

Reference Books:

1. Theory and Problems of Electromagnetics by Joseph. A.Edminister (Tata McGraw Hill).
2. Electromagnetics with Applications by Kraus and Fleish (McGraw-Hill).

Course Title: Electronic Devices and Circuits
Course Code: EEBB 202
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective:

- Familiar with the structure of basic electronic devices.
- Exposed to the operation and applications of electronic devices

Course Outcomes:

CO-1	Understand basics electronic circuits.
CO-2	Comprehend the operation of different power amplifier.
CO-3	Appreciate concepts of small signal analysis.
CO-4	Know high frequency analysis and voltage regulators

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	3	-	-	2	-	-	-	3	3	-	2
CO-2	3	3	3	3	3	-	-	2	-	-	-	3	3	-	2
CO-3	3	3	3	3	3	-	-	2	-	-	2	3	3	-	2
CO-4	3	3	3	3	3	-	-	2	-	-	1	3	3	-	2
Average	**3**	**3**	**3**	**3**	**3**	**0**	**0**	**2**	**0**	**0**	**0.75**	**3**	**3**	**0**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I: 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.

Module II: 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.

Module III: 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

Module IV: Operational Amplifiers:

The basic operational amplifier & its characteristics, Block diagram representation of OP-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

List of 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

Learning Resources:

Text Books:

1. Electronic Devices and Circuits by David A. Bell, Prentice Hall of India
2. Microelectronic Circuits by Sedra and smith, Oxford University Press, 2004.
3. Electronic Devices and Circuit theory by Robert L.Boylestad, Pearson Education, 11 edition (2015).
4. Integrated Electronics by Millman & Halkias, McGraw Hill Education, 3 edition (2010).

Reference Books:

1. Electronic Devices by Floyd, Pearson Asia, 9th Edition, 2012.

Course Title: Signal and Systems
Course Code: EELB 203
L-T-P: 3-0-0
Credits: 3
Pre-requisites: None

Course Outcomes:

CO-1	To describe signals and systems mathematically and evaluate the response of LTI system using convolution.
CO-2	To calculate the Fourier series and Fourier transform of continuous and discrete time signals.
CO-3	To understand the sampling process and the sampling of continuous-time and discrete time signals.
CO-4	To evaluate and analyse various signals in terms Laplace transform and z-transform.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	2	-	-	-	-	-	-	-	-	-	-	3	3	-
CO-2	3	3	-	-	-	-	-	-	-	-	-	-	3	3	-
CO-3	3	3	-	-	-	-	-	-	-	-	-	-	3	3	-
CO-4	3	3	-	-	-	-	-	-	-	-	-	-	3	3	-
Average	**2.75**	**2.75**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-I: Fundamentals of Signals and Systems
Continuous-time and Discrete-time signals**,** Periodic signals, Exponential and sinusoidal signals, Even and odd signals, Continuous-time and Discrete-time systems, Linear time invariant system, Properties of LTI system: causality, stability, invertibility, Convolution integral and convolution sum.

Module-II: Fourier Series and Fourier Transform of CT and DT Signals
Fourier series representation of CT and DT periodic signals, Properties of CT and DT Fourier series, Representation of Aperiodic signals: CT Fourier transform and DT Fourier transform, Properties of CT Fourier transform and DT Fourier transform, Fourier transform for periodic signals.

Module-III: Sampling and Reconstruction of Signals
Representation of a Continuous-Time Signal by Its Samples, Sampling theorem, Reconstruction of a signal from Its samples, Aliasing, Quantization, Discrete-time processing of CT signals, Sampling of DT signals.

Module-IV: Laplace Transform and z-Transform
Introduction to Laplace transform and z-transform, Region of convergence, Properties of Laplace and z-transform, Analysis of LTI system using Laplace transform and z-transform.

Learning Resources:

Text Books:
1.A.V. Oppenheim, A.S. Willsky and S. H. Nawab, "Signals and Systems", Prentice Hall India, 2nd Edition.

Reference Books:
1.M. J. Robert, "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.
2. Simon Haykin and Van Veen,Wiley, "Signals & Systems", Wiley, 2nd Edition

Course Title: Electrical Measurements
Course Code: EEBB 204
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective:

- Understand the necessity and importance of electrical measurement.
- To know about various kinds of measurement techniques, and instruments.

Course Outcomes:

CO-1	Appreciate various aspects of the art and science of measurement and instrumentation.
CO-2	Know about different measurement methods
CO-3	Know about different measurement methods of R, L and C
CO-4	Apply proper method, sensors and transducers for specific applications and measurement.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	2	-	-	-	-	-	-	-	2	3	-	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	2	3	-	-
CO-3	3	3	2	2	-	-	-	-	-	-	2	2	3	-	-
CO-4	3	3	2	2	-	-	-	-	-	-	2	2	3	-	-
Average	**3**	**3**	**1.5**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module 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.

Module 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.

Module 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.

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.

Module IV: 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.

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:

1. Measurement of Inductance by Maxwell Inductance Bridge
2. Measurement of Inductance by Maxwell Inductance capacitance Bridge
3. Measurement of Inductance by Hay's Bridge

4. Measurement of Inductance by Anderson Bridge
5. Measurement of capacitance by De Sauty's Bridge
6. Measurement of capacitance by Schering Bridge
7. Measurement of Resistance by Wheatstone Bridge
8. Measurement of Resistance by Keivin's double Bridge
9. Measurement of power by voltmeter- Ammeter (VI) and Ammeter- voltmeter (IV) method
10. Measurement of energy-by-Energy meter
11. Power factor measurement & power factor improvement by using shunt capacitor
12. Identify cable fault by Murray loop method

Learning Resources:

Text Books:

1. A course in Electrical & Electronics Measurement and Instrumentation by A.K. Sawhney, Dhanpat rai & Sons, 2015

Reference Books:

1. Electronic Instrumentation and Measurement Techniques **by** W.D. Cooper & A.D. Helfrick, Prentice-Hall India
2. Electrical Measurement & Measuring Instruments by E.W. Golding, WhELLer Publishing

Course Title: Technical Report Writing
Course Code: EEPB 205
L-T-P: 0-0-2
Credits: 1
Pre-requisites: Nil

Course Objective: To equip students with practical skills in using documentation tools like MS Office, LaTeX, and Visio for effective technical communication, including writing research papers, project reports, brochures, and patent/IPR documents.

Course Outcomes:

CO-1	Apply Microsoft Office tools to create and format structured technical documents including figures, tables, equations, references, and citations.
CO-2	Utilize LaTeX for professional technical documentation with appropriate formatting, structure, figures, tables, equations, and references.
CO-3	Create professional-quality technical illustrations using Microsoft Visio.
CO-4	Conduct literature reviews and draft technical reports, research papers, and patent/IPR documents using suitable documentation tools and methodologies.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	-	-	-	-	3	-	-	-	3	2	2	-	-	-	-
CO-2	-	-	-	-	3	-	-	-	3	2	2	-	-	-	-
CO-3	-	-	-	-	3	-	-	-	3	2	2	-	-	-	-
CO-4	-	-	-	-	-	-	-	3	3	3	2	-	-	-	-
Average	**0**	**0**	**0**	**0**	**2.25**	**0**	**0**	**0.75**	**3**	**3**	**2**	**0**	**0**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

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

Learning Resources:

Text Books:

1. How to Write Technical Reports - Heike Hering, Springer press
2. Microsoft Word 2019 Step by Step – Joan Lambert, Microsoft Press.
3. LaTeX: A Document Preparation System – Leslie Lamport, Addison-Wesley.
4. *The Craft of Research* – Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams.
5. *How to Write and Publish a Scientific Paper* – Barbara Gastel & Robert A. Day, Bloomsbury Publishing.
6. *Intellectual Property Rights: Text and Cases* – N K Acharya, Asia Law House

Course Title: Electrical Machines-I
Course Code: EEBB 251
L-T-P : 3-0-2
Credits: 4
Pre-requisites:

Course Objective:

Providing students with a comprehensive understanding of the fundamental principles, construction, operation, characteristics, and testing of basic DC machines (generators and motors) and Transformers, enabling them to comprehend the knowledge for designing and operating such machines.

Course Outcomes:

CO-1	Gain comprehensive understanding of the working, operation, and testing of different types 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

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**3**	**3**	**-**	**-**
CO-2	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**3**	**3**	**-**	**-**
CO-3	**3**	**3**	**3**	**1**	**-**	**-**	**3**	**2**	**1**	**1**	**-**	**3**	**3**	**2**	**-**
CO-4	**3**	**-**	**1**	**-**	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**
Average	**3.00**	**2.25**	**2.25**	**0.75**	**3**	**1**	**2.5**	**2.5**	**1.5**	**1.5**	**3**	**3**	**2.75**	**1.5**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I: 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.

Module II: 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.

Module III: 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.

List of Experiments:

1. To perform the polarity test of single-phase transformer.
2. To perform the routine test of single-phase transformer.
   (a) Voltage Ratio test
   (b) Insulation test

3. To measure the voltage regulation of single-phase transformer.
4. To perform open circuit (OC) and short circuit (SC) test of single-phase transformer and develop the equivalent circuit.
5. To perform load test on single-phase transformer and determine efficiency.
6. To perform Scott connection using two single-phase transformers.
7. To convert a two winding transformer into an autotransformer.
8. To perform speed control of DC separately excited motor using-
   (a) Armature Voltage Control
   (b) Field Flux control.
9. To plot different characteristics of DC shunt generator.
10. To plot magnetization curve of DC shunt generator.
11. To study No load characteristics of DC separately excited generator.

Learning Resources:

Text Books:

1. Dr. P. S. Bimbhra, "Electrical Machinery", Khanna Publisher
2. D. P. Kothari and I. J. Nagrath, "Electrical Machines" Mc. Graw Hill Education

Reference Books:

1. M.G. Say, "The Performance and Design of Alternating Current Machines" CBS Publication, 3rd Edition
2. A. E. Clayton and N.N. Hancock, "Performance & Design of Direct Current Machines" CBS Publication, 3rd Edition
3. A.S. Langsdorf, "Theory of AC Machinery", Tata McGraw Hill Edition,
4. A. E. Fitzerald, C. Kingsley and S. D. Umans, "Electric Machinery", Tata McGraw Hill

Course Title: Control Systems
Course Code: EEBB 252
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective:

1. The lessons in basic concepts and principles of modelling, analysis and controller design for continuous linear time-invariant systems with techniques including roots locus and frequencyresponse methods.
2. Introduction to various techniques used in analysis of the dynamical system.

Course Outcomes:

CO-1	Do mathematical modelling and derivation of transfer function of various systems
CO-2	Determine the stability of system and analyse the system in time domain.
CO-3	Analyse the systems in frequency domain
CO-4	Do the design and analysis compensation technique

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1	2	1	2	1	1	-	-	-	-	-	-	3	-	-
CO-2	2	2	2	2	3	-	-	-	-	2	1	3	3	1	1
CO-3	3	3	2	2	-	-	-	-	-	-	1	3	3	-	-
CO-4	2	2	3	3	-	-	-	-	-	2	1	3	3	-	-
Average	**2**	**2.25**	**2**	**2.25**	**1**	**0.25**	**0**	**0**	**0**	**1**	**0.75**	**2.25**	**3**	**0.25**	**0.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-I 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 consideringelectrical systems as examples, block diagram reduction technique and signal flow graph, mason's gain formula.

Module-II Time Response Analysis

Standard test signals, time response of first order systems, characteristic equation offeedback control systems, transient response of second order systems, time domainspecifications, steady state response, steady state errors and error constants, effects of proportional derivative, proportional integral systems.

Module-III 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 toG(s)H(s) on the root loci.

Module-IV 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, nyquistplots, stability analysis.

Classical Control Design Techniques

Compensation techniques – Lag, Lead, Lead-Lag controllers design in frequency domain, PID controllers.

List of Experiments:

1. To verify the time response of a first and second-order linear system on linear system simulator.
2. To verify the performance characteristics of AC position control.
3. To verify the performance characteristics of DC speed control with motor unit.
4. To verify the performance characteristic of an angular position error detection using potentiometer error detector.
5. To verify the operation of the stepper motor.
6. Performance characteristics of the relay control system.
7. To perform the control using PID controller.
8. To verify the performance characteristics of synchro transmitter and receiver.
9. To verify the operation of a temperature control system.
10. To verify the operation of the light intensity control system.
11. To perform the compensator design.

Learning Resources:

Text Books:

1. I.J. Nagrath, & M.Gopal "Control Systems Engineering" ,New Age International Ltd. , 2000 .
2. Benjamin C Kuo, "Automatic Control Systems", Prentice Hall of India.
3. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India

Reference Books:

1. D'AzzoHoupis, Logakusha, Huelsoman, "Linear System Analysis", McGraw Hill.
2. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson Education Inc.
3. Norman S Nise, "Control System Engineering", John Wiley & Sons.

Course Title: Power Transmission and Distribution
Course Code: EELB 253
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil
Course Objective: To familiarize students with the infrastructure of power systems and tointroduce the design aspects of power system distribution and transmission.

Course Outcomes:

CO-1	Understanding the fundamentals of power system for economic operation
CO-2	Calculation of Line Parameters involved in Electrical Design and its effects
CO-3	Understanding the Mechanical Design involved in building Power System Structure
CO-4	Develop design involvement of power system that prepares for engineering practice

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	2	-	-	-	-	-	-	-	-	3	1	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
CO-3	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO-4	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
Average	**3**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1.25**	**0**

1 – Slightly; 2 – Moderately; 3 – Substantially

Syllabus:

Module-1 Introduction

General Structure of Electrical Power System- Introduction to Power System, Generation, Transmission, Distribution and Utilization- Overview**,** Single Line Diagram representation.

Module-II Transmission of Electrical Power Mechanical design of transmission lines

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. Overhead line insulators: Types of Insulators, String efficiency and methods for improvement. Phenomenon of corona, Factors affecting corona.

Module-III 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.

Module-IV 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.

Learning Resources:

Text Books:

1. Power System Analysis & Design.by J. D. Glover, M. S. Sharma, T. J. Overbye (Cengage).
2. A Text Book on Power SystemEngineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagarand A. Chakraborti (Dhanpat Rai & Co. Pvt. Ltd.).
3. Generation Distribution and Utilizationof Electrical Power, 2005 by C. L. Wadhwa Longren (New Age International Ltd).

4. Power System Analysis, 2008 by J. J. Grainger and W. D.Stevenson (McGraw-Hill International Book Company).
5. Electrical Power Distribution Systemsby Turan Gonen (McGraw-Hill).

Course Title: DIGITAL ELECTRONICS & LOGIC DESIGN
Course Code: EEBB 254
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective: To provide an introduction to digital logic design and its ability to understand number system representations

Course Outcomes:

CO-1	To understand common forms of number representation in digital electronic circuits and to be able to convert between different representations
CO-2	To implement simple logical operations of Boolean functions using Karnaugh map
CO-3	To design combinational logic circuits, sequential logic circuits.
CO-4	To impart to student the concepts of sequential circuits, enabling them to analyse sequential systems in terms of logic families.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	1	2	1	1	2	1	1	2	3	3	2
CO-2	3	3	3	3	3	2	2	2	3	1	2	2	3	3	3
CO-3	3	2	3	3	3	2	1	1	2	1	2	1	3	2	2
CO-4	3	3	3	3	3	2	1	1	2	1	1	2	3	3	2
Average	**3**	**2.75**	**3**	**3**	**2.5**	**2**	**1.25**	**1.25**	**2.25**	**1**	**1.5**	**1.75**	**3**	**2.75**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 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.

Module-II Switching algebra and switching functions

Boolean algebra, postulates, theorems and switching algebra, completely and incompletely specified switching functions, Representation of Boolean functions in sum of products form and product of sums form, minimization of Boolean functions using Karnaugh map and Quine McCluskey methods. Problem solving.

Module-III 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.

Module-IV 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, Registers, Counters, Comparators & Converters.

List of Experiments:

1. Study the operations of AND, OR and NOT logic gates using LED with the introduction of ICs.
2. Verification of truth tables AND, OR and NOT logic gates.
3. Verification of truth tables NAND, NOR, EX-OR, EX-NOR logic gates.
4. Implementation of AND, OR, NOT, EX-OR and EX-NOR gates using NAND gates.
5. To implement binary to gray code and gray to binary code conversions using k map and
6. verify truth tables.
7. To implement BCD to Excess-3 code conversion
8. To implement half adder and half subtractor using control input.
9. To implement Full adder and Full subtractor using control input.
10. To implement 4 bit adder and 4 bit subtractor using IC-7483 AND XOR gates.
11. To implementation of J-K FLIP FLOP using IC-741573.
12. To implementation of counters circuits.
13. To implement 2*1 MUX using NAND gate IC-7400

Learning Resources:

Text Books:

1. Digital Design **by** Mano, M. Morris **(**Pearson Education**).**

Reference Books:

1. Digital Fundamentals **by** Floyd, Thomas L. **(**Pearson Education, Singapore**).**

2. Digital Electronics **by** Gothmann, William H. **(PHI).**

Course Title: Internet of Things
Course Code: EEBB 255
L-T-P : 2-0-2
Credits: 3
Pre-requisites: Nil
Course Objective: To learn the basic principles and components of IoT, including sensors, actuators, and communication protocols.

Course Outcomes:

CO-1	To Understand the characteristics and architecture of IoT
CO-2	To understand different technologies and protocols used for IoT.
CO-3	To study different sensors, actuators and microcontrollers.
CO-4	To study about the platforms used for building IoT applications.
CO-5	Analyze applications of IoT in real time scenario.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2	1	1	1	-	-	-	-	-	-	-	-	-	2	-	-
CO-3	2	-	-	-	2	-	-	-	-	-	-	-	2	-	-
CO-4	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5	1	1	2	3	2	2	-	-	-	-	-	-	2	-	-
Average	**1.6**	**1**	**1.5**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I: 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.

Module II: 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.

Module III: 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.

List of Experiments:

1. Controlling the LED,
2. Blink rate of LED,
3. Detection of light using photo resistor,
4. Interfacing of temperature sensor, servo motor, Active buzzer, relay etc. with Arduino,
5. Building intrusion detection system,
6. Directional control of DC motor,
7. Air pollution measurement, etc.

Learning Resources:

Text Books:

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

Reference Books:

1. Dieter Uckelmann, "Architecting the Internet of Things", Springer, 2011
2. Pethuru Raj and Anupama C.Raman, "The Internet of Things: Enabling Technologies and Use Cases" CRC Press.

Course Title: Professional Ethics
Course Code: HMPB 256
L-T-P: 0-0-2
Credits: 1
Pre-requisites: Nil

Course Objective: To understand the key issues in engineering ethics and the professional world. To learn the professional rights and codes of conduct as employees. Acknowledgment of global issues of concerns related to technological progress and relevant to the engineering profession.

Course Outcomes:

CO-1	Understand the key issues in human values and engineering ethics relevant to organizational behavior and in professional domains for engineers.
CO-2	Apply the various engineering code of ethics, ethical decision-making philosophies and moral development theories of ethics in real-world moral dilemmas.
CO-3	Understand the role of the engineering profession as a social experimenter and workplace roles and responsibilities towards public safety.
CO-4	Examine and evaluate the global issues of ethics that are related to technological progress and relevant to the engineering profession.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	-	-	-	-	-	**3**	-	**3**	**2**	**2**	**1**	**1**	-	**3**	**3**
CO-2	**1**	-	-	**1**	-	**3**	**1**	**3**	**3**	**2**	-	**1**	**1**	**2**	**3**
CO-3	**1**	-	**3**	-	-	**3**	**1**	**3**	**2**	**2**	-	-	**3**	**1**	**3**
CO-4	**1**	-	**1**	-	-	**3**	**3**	**3**	-	**3**	**2**	**3**	**2**	**1**	**3**
Average	**0.75**	**0**	**1**	**0.25**	**0**	**3**	**1.25**	**3**	**1.75**	**2.25**	**0.75**	**1.25**	**1.5**	**1.75**	**3**

1 – Slightly ; 2 - Moderately; 3 - Substantially

Syllabus:

Module I: Introduction: Professional, Personal and Engineering Ethics

Introduction to Professional Ethics: Basic Concepts, Governing Ethics, Personal & Professional Ethics, Indian Constitution: Rights & Duties, Engineering Ethics.

Module 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.

Module 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

Module 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).

Module 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.

Learning Resources:

Text Books:

1. Professional Ethics by Subramanian. R. Oxford Publication, 2013, Second Edition.
2. Professional Ethics and Values by D R Kiran, McGraw Hill Education India Publications, Second Edition
3. Ethics in Engineering by Martin MW & Schinzinger R (2005), McGraw Hill Education India Publications Fourth Edition
4. Organizational Behaviour: Text and Cases by A.K. Chitale, R. P. Mohanty and N.R. Dubey PHI Learning, Second Edition.

Course Title: Project
Course Code: EEPB 257
L-T-P : 0-0-2
Credits: 1
Pre-requisites: Nil

Course Objective: Demonstrate the ability to identify, define, complex problems and derive engineering solutions through a systems-based approach

Course Outcomes:

CO-1	Acquire the ability to work in a responsible and professional manner
CO-2	Engage in work practices that emphasize continuous growth and development
CO-3	Expand students' understanding and proficiency in a selected technological domain
CO-4	Learn to be more empathetic, think about how systems work, explore new ideas, and solve problems
CO-5	Develop project management skills.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-2	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-3	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-4	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-5	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
Average	**3**	**2**	**2**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Note:- Project work titles for students will be finalized by their concerned supervisors. The Final Presentation will be assessed by a Evaluation Committee established by the department.

Course Title: Electrical Machines-II
Course Code: EEBB 301
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Electrical Machine-I (EEBB 251)

Course Objective:
Providing students with a comprehensive understanding of the operation, analysis, and performance characteristics of AC machines like three-phase induction motors, synchronous machines, and single-phase induction motors, enabling them to analyze and design electrical systems utilizing these machines, including aspects like starting, speed control, and braking mechanisms, while emphasizing practical applications and problem-solving skills aligned with industry standards.

Course Outcomes:

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

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	**3**	**3**	**2**	**3**	**-**	**-**	**1**	**-**	**1**	**1**	**-**	**3**	**3**	**1**	**-**
CO-2	**3**	**3**	**2**	**3**	**1**	**-**	**1**	**1**	**1**	**1**	**-**	**3**	**3**	**1**	**-**
CO-3	**3**	**3**	**3**	**2**	**1**	**-**	**1**	**1**	**1**	**1**	**2**	**3**	**2**	**1**	**-**
CO-4	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**3**	**3**	**1**	**2**	**1**	**1**	**-**
Average	**3**	**2.5**	**2**	**2.25**	**1.33**	**1**	**1**	**1.33**	**1.5**	**1.5**	**1.5**	**2.75**	**2.25**	**1**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I:Three-Phase Induction Machines:
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.

Module II: Single Phase Induction Motors:
Principle of operation, double revolving field theory and types of motors.

Module III: Synchronous Machines:
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 Xd and Xq- 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.

List of Experiments:

1. To perform no load and blocked rotor test on 3-phase induction motor and determine equivalent circuit parameters.
2. To perform no load and blocked rotor test on 1-phase induction motor and determine equivalent circuit parameters.
3. To conduct load test on 3-phase induction motor and to plot its performance characteristics.
   (a) output power versus efficiency
   (b) output power Vs torque
   (c) output power versus slip
   (d) output power versus power factor
   (e) torque versus speed
4. Speed control of a 3-phase induction motor by variable voltage control and rotor resistance control.
5. Speed control of 3-phase induction motor by variable voltage and variable frequency control.
6. To study and verify the starting method of three-phase induction motor.
7. To study and perform speed control of single-phase induction motor.
8. To study speed characteristics of universal motor by voltage control.
9. To synchronize 3-phase alternator by-
   (a) Three dark lamp method
   (b) Two Bright one dark lamp method
10. To plot the V-curve and inverted V-curve of a synchronous motor.
11. To perform no load and short circuit test on the alternator.

Learning Resources:

Text Books:

1. Dr. P. S. Bimbhra, “Electrical Machinery”, Khanna Publisher
2. D. P. Kothari and I. J. Nagrath, “Electrical Machines” Mc. Graw Hill Education

Reference Books:

1. M.G. Say, “The Performance and Design of Alternating Current Machines” CBS Publication, 3rd Edition
2. E. Clayton and N.N. Hancock, “Performance & Design of Direct Current Machines” CBS Publication, 3rd Edition.
3. A.S. Langsdorf, “Theory of AC Machinery”, Tata McGraw Hill Edition,
4. E. Fitzerald, C. Kingsley and S. D. Umans, “Electric Machinery”, Tata McGraw Hill

Course Title: Power System Analysis
Course Code: EELB 302
L-T-P : 3-1-0
Credits: 4
Pre-requisites: Nil

Course Objective: To familiarize the students with the techniques for analyzing a power System during normal operation and abnormal conditions.

Course Outcomes:

CO-1	To analyse and understand Power Systems.
CO-2	Perform load flow computations and analyse the load flow results.
CO-3	To analyse a network under both balanced and unbalanced fault conditions.
CO-4	To develop the knowledge of power system stability.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
CO-3	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
CO-4	3	3	2	2	-	-	-	-	-	-	-	-	3	1	-
Average	**3**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1.25**	**0**

1 - Slightly; 2 - Moderately; 3-Substantially;

Syllabus:

Module I: 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.

Module II: Load flow analysis and Economic Load Dispatch:

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. Introduction to constrained optimization, optimal scheduling of generators, network loss modelling.

Module III: 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

Module IV: Stability analysis:

Basic concept of stability, Classification of stability, Swing equation, power angleequation, synchronizing power coefficient, basic concepts of steady state, dynamic and transient stability, equal area criterion, solution of the swing equation.

Learning Resources:

Text Books:

1. Power System Analysis by H.Saadat (Tata McGraw-Hill Publishing Company Limited).
2. Computer Techniques in Power System Analysis by M. A.Pai (Tata McGraw-Hill Publishing Company Limited).
3. Reactive Power Control in Electric Systems by T. J. E.Miller (John Wiley and Sons).

4. Power System Analysis by J. J. Grainger and W. D.Stevenson (McGraw-Hill International Book Company)
5. Power System Analysis and Design by J. D. Glover and M. S.Sarma (Cengage Learning)

Course Title: Microprocessors and Micro Controllers
Course Code: EEBB 303
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective: To introduce the 8086 microprocessors and their interfacing, Develop assembly level programs on the 8051 and PIC 18F-microcontroller platforms.

Course Outcomes:

CO-1	Assess and solve basic binary math operations using the microprocessor and explain the microprocessor's and Microcontroller's internal architecture.
CO-2	Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions.
CO-3	Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices.
CO-4	Evaluate microcontroller programs and machine code that will provide solutions real-world control problems.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	1	2	1	1	2	1	1	2	3	3	2
CO-2	3	3	3	3	3	2	2	2	3	1	2	2	3	3	3
CO-3	3	2	3	3	3	2	1	1	2	1	2	1	3	2	2
CO-4	3	3	3	3	3	2	1	1	2	1	1	2	3	3	2
Average	**3**	**2.75**	**3**	**3**	**2.5**	**2**	**1.25**	**1.25**	**2.25**	**1**	**1.5**	**1.75**	**3**	**2.75**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 Introduction:

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

Module-II 8086

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-Steps in an interrupt process, Interrupt structure in 8086
Fundamentals of interfacing peripheral chips:

Module-III Interfacing:
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.

Module-IV 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 programming Interfacing examples.

Introduction PIC Microcontrollers (PIC 18F):
- 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.

List of Experiments:

1. Write a Program Using 8086 & Verify for Addition of Two 8-Bit Numbers.
2. Write a Program Using 8086 & Verify for Addition of Two 16-Bit Numbers. (With Carry)
3. Write a Program Using 8086 & Verify for Subtraction of Two 8-Bit Numbers. (Display Of
4. Borrow)
5. Write a Program Using 8086 & Verify for Subtraction of Two 16-Bit Numbers. (Display
6. Of Borrow)
7. Write a Program Multiplication of Two 8-Bit Numbers By Bit Rotation Method
8. Write a Program Division of Two 8-Bit Numbers by Repeated Subtraction Method
9. Write a Program Using 8086 for Finding Square-Root of a Number & Verify.
10. Write a Program to Move a Block of Data Using 8085 & Verify.
11. Write a Program to Arrange Number in Ascending Order Using 8085 & Verify.
12. Write a Program to Check Number of 1’s and 0’s in Given Number Using 8085 & Verify.
13. Write a Program to Find GCD Of Two Numbers Using 8086 & Verify.

Learning Resources:

Text Books:

1. Microprocessors and Interfacing **by** Douglas V. Hall, SSSP Rao **(**Mc Graw Hill**).**
2. Advanced Microprocessor and Peripherals by Ray A.K., Bhurchandi K.M **(**Mc Graw Hill**).**
3. The 8051 Microcontroller **by** Kenneth J Ayala. **(**Cengage Learning Publications **).**

Course Title: Power Electronics
Course Code: EEBB 304
L-T-P : 3-0-2
Credits: 4

Pre-requisites: fundamental understanding of circuit theory, semiconductor devices, control systems, and basic mathematics, particularly differential equations and Fourier analysis.

Course Objective: To impart fundamental and advanced knowledge of power semiconductor devices, converters, and their applications in efficient energy conversion and control, enabling students to analyze, design, and implement power electronic systems in real-world applications.

Course Outcomes:

CO-1	Understanding of basics of power electronic switching devices and their characteristics
CO-2	Application of power electronic switching devices in various power converters-based systems
CO-3	Analysis of various power converters including AC/DC, DC/DC, AC/AC
CO-4	Design and development of AC/DC, DC/DC, AC/AC power converters

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-2	3	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-3	3	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-4	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**1.5**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1
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.

Modul-II

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.

Modul-1II

DC to AC Inverters Voltage source inverters, single phase inverter, three phase inverter, harmonic reduction techniques and PWM techniques, current source inverter.

Modul-1V

DC to DC Converters Principle of operation, control strategies, step-up, step-down choppers, types of chopper circuits, steady state analysis, multiphase chopper.

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.

List of Experiments:

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.

Learning Resources:

Text Books:

1. Power Electronics: Converters, Applications, and Design by Ned Mohan (Wiley)
2. Power Electronics-Circuits, Devices & Applications by M.H. Rashid (Pearson Education).

Reference Books:

1. Modern Power Electronics by B. K. Bose (IEEE Press).

Course Title: Summer Training -I
Course Code: EEPB 305
L-T-P : 0-0-0
Credits: 1
Pre-requisites: Nil

Course Objective: Develop the ability to identify key aspects of real-time working environments and build readiness for future employment

Course Outcomes:

CO-1	Utilize foundational knowledge in Mathematics, Science, and Engineering to solve real-world problems in the workplace.
CO-2	Demonstrate proficiency in professional communication, technical writing, and the effective use of multimedia tools
CO-3	Demonstrate the ability to work independently and collaboratively as an effective team member
CO-4	Learn to act responsibly and ethically in your role as an engineer
CO-5	Compile a comprehensive report based on practical experiences and project work in a professional environment.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-2	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-3	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-4	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-5	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
Average	**3**	**2**	**2**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially
Note:- Final presentation evaluation would be done by the Evaluation Committee formed by the Department.

Course Title: Electric Drives
Course Code: EEBB 351
L-T-P : 3-0-2
Credits: 4
Pre-requisites: Nil

Course Objective: To understand basic of DC/AC electrical drives, their speed control and braking techniques.

Course Outcomes:

CO-1	Understand the various drive mechanisms and methods for energy conservation
CO-2	Analyze the operation of the converter, chopper fed dc drive.
CO-3	Develop closed loop control strategies of drives
CO-4	Select the drives for any particular application

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	**3**	**1**	-	-	**2**	**3**	**2**	-	-	-	-	**1**	**3**	**3**	**2**
CO-2	**3**	**2**	-	-	**2**	**2**	-	-	-	-	-	**1**	**3**	**3**	**3**
CO-3	**2**	**2**	**1**	-	**1**	**1**	-	-	-	-	-	**1**	**3**	**2**	**2**
CO-4	**2**	**1**	**1**	-	**1**	**1**	-	-	-	-	-		**3**	**3**	**2**
Average	**2.5**	**1.5**	**0.5**	**0**	**1.5**	**1.75**	**0.5**	**0**	**0**	**0**	**0**	**0.75**	**3**	**2.75**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-I: 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.

Module-II: 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.

Module-III: 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).

Module-IV:
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.

List of Experiments:

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 a 3-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.

Text Books:

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

Course Title: Electrical Simulation Lab
Course Code: EEPB 352
L-T-P : 0-0-2
Credits: 1
Pre-requisites: Nil

Course Objective: To develop knowledge of software packages to model and program electrical and electronics systems

Course Outcomes:

CO-1	Understand and apply simulation tools to model basic electrical and electronic circuits.
CO-2	Demonstrate the ability to work independently and in teams to solve real-world electrical engineering problems using simulation tools.
CO-3	Interpret simulation results to validate theoretical concepts and support decision-making in circuit design.
CO-4	Demonstrate the ability to work independently and in teams to solve real-world electrical engineering problems using simulation tools.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	3	3	2	-	-	-	-	-	-	-	-	2	-	-
CO-2	3	3	3	2	-	-	-	-	-	-	-	-	2	-	-
CO-3	3	3	3	2	-	-	-	-	-	-	-	-	2	-	-
CO-4	3	3	3	2	-	-	-	-	1	-	-	-	2	-	-
Average	**3**	**3**	**3**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Simulation of various electrical systems, including circuits, power electronics, and power systems, using software like MATLAB, Dig Silent Power Factory, Homer Pro, PSim, Lab View and Ansys.

Course Title: Switchgear and Protection
Course Code: EELB 353
L-T-P : 3-1-0
Credits: 4
Pre-requisites: Nil
Course Objective: To introduce all kinds of circuit breakers and relays for protection of Generators, Transformers and feeder bus bars from various faults.

Course Outcomes:

CO-1	Design overcurrent protection for different elements of power system.
CO-2	Implement different protection scheme for transmission lines.
CO-3	Design protection Schemes for transformer, alternator, motor and Busbar.
CO-4	Analyse the quenching mechanisms used in circuit breakers for different applications

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	**3**	**3**	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**1**	**-**	**3**	**3**	**1**	**2**
CO-2	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**3**	**1**	**3**
CO-3	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**3**	**1**	**3**
CO-4	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**-**	**-**	**1**	**-**	**3**	**3**	**1**	**2**
Average	**3**	**3**	**3**	**2.25**	**1.25**	**1**	**0.5**	**0**	**0**	**1**	**0**	**3**	**3**	**1**	**2.5**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 Introduction to Protection Schemes and Protective Relays

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. 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.

Module-II 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.

Module-III 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.

Module-IV 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.

Learning Resources:

Text Books:

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

Course Title: Engineering Economics and Accountancy
Course Code: HMLB 352
L-T-P: 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: To understand the key issues in the managerial economics and business world specifically related to the equilibrium of different market structures, production processes, consumer theory, investment, and costing decisions and certain macro issues.

Course Outcomes:

CO-1	Develop and understand the basic concepts of economics and business firms' working at the organizational level.
CO-2	Analyse the capital budgeting with possible engagement between investment decision-making and economic efficiency.
CO-3	Understand the foundational concepts of financial accounting and the role of entrepreneurship at the firm level for engineers.
CO-4	Evaluate and understand the broad economic role of the government sector, investors, and market structure in the working of the overall economy and more specifically internal markets.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	**1**	**-**	**-**	**2**	**-**	**2**	**1**	**-**	**-**	**-**	**3**	**1**	**1**	**3**	**2**
CO-2	**3**	**1**	**-**	**2**	**-**	**2**	**1**	**1**	**-**	**-**	**3**	**2**	**1**	**3**	**3**
CO-3	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**1**	**-**	**3**	**1**
CO-4	**1**	**1**	**-**	**1**	**-**	**1**	**1**	**1**	**-**	**-**	**3**	**3**	**2**	**3**	**2**
Average	**1.25**	**0.5**	**0**	**1.25**	**0**	**1.75**	**0.75**	**0.5**	**0**	**0**	**3**	**1.75**	**1**	**3**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Unit I: Engineering Economics

Introduction to Engineering Economics, Time value of money –compounding and discounting. Cash flow and Time Diagrams, Choosing between alternative investment proposals.

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. Breakeven point Analysis – Meaning and its application, Limitation**.**

UNIT III: Macroeconomics and its Economic Issues

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), Stagflation

UNIT IV: Financial Accounting:

Accounting Principles, procedure entry system – Journal, ledger, Trial balance – Cash Book – Preparation of Trading and Profit and Loss account – Balance Sheet. Strategic Entrepreneurship and Entrepreneur, Techno Entrepreneurship.

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.

Learning Resources:

Text Books:

1. Engineering Economics by R. Paneerselvam, PHI Learning, Second Edition.
2. Fundamentals of Engineering Economics by Pravin Kumar,Wiley Publications, First Edition.
3. Advanced Economic Theory: Microeconomic Analysis by H.L. Ahuja S.Chand 20th Revised Edition.

Other Suggested Readings:

1. Principles of Engineering Economics with Applications by Zahid A.Khan, Arshad, Brajesh Kumar, Mustafa H. Abidi, Cambridge Press, Second Edition.

Course Title: Project
Course Code: EEPB 354
L-T-P : 0-0-4
Credits: 2
Pre-requisites: NA
Course Objectives:

- To inculcate culture of handling all aspects of solution of a practical problem
- To develop ability to work in group with peers
- To understand, formulate and analyse the problem resulting into a novel solution

Course Outcomes:

CO-1	Apply engineering principles to real-world projects
CO-2	Plan and monitor project tasks individually or as a team
CO-3	Demonstrate practical experience in project execution
CO-4	Communicate project findings clearly through reports and presentations

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	3	-	-	-	2	1	1	3	2	2	**2**
CO-2	2	2	2	2	2	-	-	-	3	2	3	3	3	3	**3**
CO-3	2	2	2	2	2	-	-	-	3	2	3	3	3	3	**2**
CO-4	1	1	1	1	1	-	-	-	3	3	3	3	3	3	**2**
Average	**2**	**2**	**2**	**2**	**2**	**0**	**0**	**0**	**2.75**	**2**	**2.5**	**3**	**2.75**	**2.75**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Course Contents:

1. Initiate the work on the topic in areas of electrical engineering as propose by Project supervisor in terms of following
2. Literature Survey
3. Problem Definition
4. Preliminary investigation
5. Prepare plan of action based on above

Present seminars based on the work done at end of semester.

Course Title: Fundamental of Renewable Energy Systems
Course Code: EELB 391
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil
Course Objective: To enrich students with the working and application of various renewable energy systems

Course Outcomes:

CO-1	Understand the concept of various renewable energy resources
CO-2	In depth knowledge of solar cell working and its applications
CO-3	Explain the principle of wind energy conversion systems and their control mechanisms.
CO-4	Working of Hydro power plant and its components
CO-5	Summarize the working principle of fuels cells and its types

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	-	-	2	2	-	2	2	-	-	-	3	3	2	1
CO-2	3	2	2	2	2	-	2	2	-	-	-	3	3	2	1
CO-3	3	2	2	2	2	-	2	2	-	-	-	3	3	2	1
CO-4	3	2	2	2	2	-	2	2	-	--	-	3	3	2	1
CO-5	3	2	2	2	2	-	2	2	-	-	-	3	3	2	1
Average	**3**	**2**	**2**	**2**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**3**	**3**	**2**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

MODULE I: INTRODUCTION

Environmental aspects of electrical 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.

MODULE II: PV CELL

Fundamental 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 algorithm.

MODULE III: WIND POWER GENERATION

Introduction to wind turbine, construction, working, principle, different types turbine blades, their structure, horizontal and vertical wind turbine system. Power in the wind, various factor affecting the power in wind, impact of tower height. Betz experiment, coefficient of performance, tip speed ratio, Weibull Distribution function.

MODULE IV: HYDRO POWER GENERATION

Introduction to hydro power plant, overview of micro, mini and small hydro plants, hydraulic turbines, Selection and design criteria of pumps and turbines, Brief theory, design and analysis of hydro power plant.

MODULE V: HYDROGEN ENERGY

Basic principle of design and of different types of fuel cells and their applications, future prospects.

Learning Resources:

Text Books:

1. Non Conventional Energy Sources by G.D.Rai, Khanna Publisher

Reference Books:

1. Non Conventional Energy Sources BY B.H.Khan, McGraw Hill Publisher

Course Title: Smart Grid
Course Code: EELB 401
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: To enable students to understand the concepts, architecture, technologies, and communication systems of Smart Grids for efficient, reliable, and sustainable power delivery.

Course Outcomes:

CO-1	Understand the architecture, standards, and key technologies of smart grid systems, including distributed generation, wide area monitoring, and phasor estimation.
CO-2	Analyze and apply protection techniques in smart grids using digital relays and islanding detection methods.
CO-3	Develop models for key smart grid components including storage devices, DC/AC microgrids, and hybrid systems, and evaluate their operation and control strategies.
CO-4	Evaluate demand-side management and energy management techniques in AC/DC smart grids through system analysis.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	-	3	1	1	-	-	-	-	-	1	1	-
CO-2	3	3	3	3	3	1	1	-	-	-	-	-	1	1	-
CO-3	3	3	3	3	3	1	1	-	-	-	-	-	1	1	-
CO-4	3	3	3	3	3	1	1	-	-	-	-	-	1	1	-
Average	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 Introduction

Architecture of smart grid system, Standards, Distributed Generation Resources, Wide Area Monitoring, Phasor Estimation.

Module-II Smart Grid Protection

Digital Relays for Smart Grid Protection, Islanding Detection Techniques, Smart Grid Protection.

Module-III 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.

Module-IV Energy Management:

Demand Side Management in Smart Grid, Energy Management, System Analysis of AC/DC Smart Grid.

Learning Resources:

Text Books:

1. Smart Grid: Fundamentals of Design and Analysis by James A. Momoh (Wiley-IEEE Press).
2. Smart Power Grids by Ali Keyhani, Muhammad Marwali (Springer Berlin, Heidelberg).

Reference Books:

1. Computer Relaying for Power Systems by Dr. Arun G. Phadke, Dr. James S. Thorp (Wiley).
2. Microgrids: Architectures and Control by Nikos Hatziargyriou (Wiley).
3. Renewable Energy Systems: Advanced Conversion Technologies and Applications by Fang Lin Luo and Ye Hong (CRC Press).

Course Title: Fundamentals of Machine Learning
Course Code: EELB 402
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: To provide an introduction to machine learning and its ability to understand data interpretation.

Course Outcomes:

CO-1	Understand machine-learning concepts
CO-2	Understand Optimization theory and concepts.
CO-3	Understand and analyze different method and Techniques
CO-4	Use of Different datasets to analyze the data. And apply different algorithms.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	1	1	3	2	1	1	1	1	1	1	1	1	3	3	2
CO-2	3	2	3	2	3	1	2	2	1	1	2	3	3	3	1
CO-3	1	2	3	2	3	1	1	1	1	1	2	1	3	2	1
CO-4	1	2	3	2	3	1	1	1	1	1	1	1	3	3	2
Average	**1.5**	**1.75**	**3**	**2**	**2.5**	**1**	**1.25**	**1.25**	**1**	**1**	**1.5**	**1.5**	**3**	**2.75**	**1.5**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul – I Linear Algebra for Machine learning

Basic introduction to linear algebra and Mathematics equations for Machine learning, Matrices, vectors in linear algebra.

Modul - II Machine learning Introduction

Whatis machine learning and classification, Machine learning lifecycle, Different applications of ML.Difference between AI and machine learning Machine Learning and deep learning? Data Processing in machine learning.

Modul - III Supervised learning

How supervised learning works. Types of Supervised learning. Advantage and disadvantage of supervised learning, Regressions-Linear regression, regression trees, on-linear regression and polynomial regression. Classification –random forest, Decision tree, Logistic regression, support vector machine.

Modul - IV Unsupervised learning

What is unsupervised learning and working of unsupervised learning? Types of unsupervised learning. Clustering algorithm k-means and KNN (k-nearest neighbors).Hierarchical clustering, anomaly's detection, neural network, component analysis and Apriori algorithm. Basics of reinforcement learning.

Learning Resources:

Text Books:

- Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995

Reference Books:

- Duda, Richard, Peter Hart, and David Stork, "Pattern Classification" Second Edition, New York, NY: WileyInterscience, 2000.
- Hastie, T., R. Tibshirani, and J. H. Friedman, "The Elements of Statistical Learning: Data Mining, Inference and Prediction", New York, Springer, 2001.

Course Title: Power System Lab
Course Code: EEPB 403
L-T-P : 0-0-2
Credits: 1
Pre-requisites: Power System Analysis

Course Objective: To analyze a Power System during normal operation and abnormal conditions.

Course Outcomes:

CO-1	To understand the modelling of transmission lines in impedance and admittance forms.
CO-2	To analyse iterative techniques for power flow analysis and to carry out short circuit and stability studies on power system.
CO-3	To understand the operation of relays, characteristics, and applications.
CO-4	To develop the design of Microgrid

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	2	-	-	-	-	-	-	-	-	3	1	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
CO-3	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO-4	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
Average	**3**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1.25**	**0**

1 – Slightly; 2 – Moderately; 3 – Substantially

Syllabus:

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 analyze and calculate different fault currents that occur due to introduction of faults (L-G) in transmission Line using three phase fault analyzer trainers.
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.

Learning Resources:

Text Books:

1. Hadi Saadat, "Power system Analysis", Tata McGraw Hill Publishing Company, 3rd Edition, 2011.

2. Nagarath, I.J. and Kothari, D.P., "Modern Power System Analysis", 4th Edition, Tata McGraw Hill Publishing Company, 2011.
3. John J. Grainger and W.D. Stevenson Jr., 'Power System Analysis', 1st Edition, McGraw Hill International. Book Company, July 2017.

Course Title: Summer Training -II
Course Code: EEPB 404
L-T-P : 0-0-4
Credits: 2
Pre-requisites: Nil

Course Objective: Develop the ability to identify key aspects of real-time working environments and build readiness for future employment

Course Outcomes:

CO-1	Utilize foundational knowledge in Mathematics, Science, and Engineering to solve real-world problems in the workplace.
CO-2	Demonstrate proficiency in professional communication, technical writing, and the effective use of multimedia tools
CO-3	Demonstrate the ability to work independently and collaboratively as an effective team member
CO-4	Learn to act responsibly and ethically in your role as an engineer
CO-5	Compile a comprehensive report based on practical experiences and project work in a professional environment.

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-2	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-3	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-4	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
CO-5	3	2	2	3	3	3	1	3	3	3	3	3	3	-	-
Average	**3**	**2**	**2**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Note:- Final presentation evaluation would be done by the Evaluation Committee formed by the Department.

Course Title: Project
Course Code: EEPB 405
L-T-P : 0-0-4
Credits: 2
Pre-requisites: NA

Course Objectives:

- To inculcate culture of handling all aspects of solution of a practical problem
- To develop ability to work in group with peers
- To understand, formulate and analyze the problem resulting into a novel solution

Course Outcomes:

CO-1	Apply engineering principles to real-world projects
CO-2	Plan and monitor project tasks individually or as a team
CO-3	Demonstrate practical experience in project execution
CO-4	Communicate project findings clearly through reports and presentations

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	3	-	-	-	2	1	1	3	2	2	**2**
CO-2	2	2	2	2	2	-	-	-	3	2	3	3	3	3	**3**
CO-3	2	2	2	2	2	-	-	-	3	2	3	3	3	3	**2**
CO-4	1	1	1	1	1	-	-	-	3	3	3	3	3	3	**2**
Average	**2**	**2**	**2**	**2**	**2**	**0**	**0**	**0**	**2.75**	**2**	**2.5**	**3**	**2.75**	**2.75**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Course Contents:

1. Initiate the work on the topic in areas of electrical and electronics engineering as propose by Project supervisor in terms of following
2. Literature Survey
3. Problem Definition
4. Preliminary investigation
5. Prepare plan of action based on above
6. Present seminars based on the work done at end of semester.

Course Title: Project Report
Course Code: EEPB 451
L-T-P : - - -
Credits: 16
Pre-requisites: EEPB 405

Course Objective:

- To inculcate culture of handling all aspects of solution of a practical problem
- To develop ability to work in group with peers
- To understand, formulate and analyze the problem resulting into a novel solution

Course Outcomes:

CO-1	Identify a domain specific and contemporary topic
CO-2	Review literature to identify gaps and define objectives & scope of the work
CO-3	Develop a prototype/model, experimental set-up or software systems to meet the objectives
CO-4	Analyze the results to draw valid conclusions

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	2	-	-	2	1	-	1	3	1	1	2	2	2	**2**
CO-2	2	2	-	-	1	2	1	1	2	2	-	3	3	3	**3**
CO-3	2	2	3	3	3	2	2	2	2	1	3	2	3	3	**2**
CO-4	2	2	-	3	3	-	-	-	2	2	-	3	3	3	**2**
Average	**2.25**	**2**	**0.75**	**1.5**	**2.25**	**1.25**	**0.75**	**1**	**2.25**	**1.5**	**1**	**2.5**	**2.75**	**2**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Course Contents:

Find solution to the problems in areas of electrical and electronics engineering as proposed by faculty members in earlier phase and present seminars and submission of project report based on the work done

Course Title: Independent Study and Seminar
Course Code: EEPB 452
L-T-P : 0-0-8
Credits: 4
Pre-requisites: Nil

Course Objective: Articulate and analyze particular skills, areas of competency, and viewpoints relevant to the subject.

Course Outcomes:

CO-1	Acquire factual knowledge, including terminology, classifications, methods, and current trends
CO-2	Design a structured plan that demonstrates ownership and responsibility for individual educational growth
CO-3	Analyze the impact of self-efficacy, goal-setting, and motivation on enhancing academic performance and engagement
CO-4	Enhance presentation, discussion, listening, argumentative, critical thinking, and questioning skills
CO-5	Describe the attributes and learning behaviours that contribute to effective and successful learning

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
-	3	2	2	3	3	3	1	3	3	3	-	3	-	-	-
C-O-2	3	2	2	3	3	3	1	3	3	3	-	3	-	-	-
CO-3	3	2	2	3	3	3	1	3	3	3	-	3	-	-	-
CO-4	3	2	2	3	3	3	1	3	3	3	-	3	-	-	-
CO-5	3	2	2	3	3	3	1	3	3	3	-	3	-	-	-
Average	**3**	**2**	**2**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**0**	**3**	**0**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 – Substantially

Note:- The Department Seminar Selection/Evaluation Committee will display the list of approved seminar topics for the semester. Students may choose any topic from this list or by your own choice.

Course Title: Distributed Power Generation
Course Code: EELB 312
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Power System Analysis, Electrical Machines, Power Electronics

Course Objective: To impart knowledge about distributed generation technologies, their interconnection in grid, to understand relevance of power electronics in DG, and to understand concept of microgrid

Course Outcomes:

CO-1	To understand the concept of Distributed Generation and its importance in present scenario
CO-2	To know the different types of interfaces for Grid integration of DGs.
CO-3	To analyse the importance of power electronics in DGs.
CO-4	Develop the design of Microgrid including its Operation, Control and Modelling

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	2	-	-	-	-	-	-	-	-	3	1	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
CO-3	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
CO-4	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
Average	**3**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1.25**	**0**

1 – Slightly; 2 – Moderately; 3 – Substantially

Syllabus:

Module-1 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.

Module-II Operational Features of Grid Connected 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, 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.

Module-III 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.

Module-IV 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.

Learning Resources:

Text Books:

1. Willis HL, Scott WG. Distributed Power Generation : Planning and Evaluation / H. Lee Willis, Walter G. Scott. CRC Press; 2000. doi:10.1201/9781315215006

2. Miveh, Mohammad & Naderipour, Amirreza & Abdul-Malek, Zulkurnain. (2017). Advanced Control Methods in Microgrid, Lambert Academic.

Course Title: Switch-Mode DC-DC Converters
Course Code: EELB 361
L-T-P : 3-0-0
Credits: 3
Pre-requisites: EEBB 304 Power Electronics

Course Objective: To understand and analyze switch-mode dc-dc converters and apply knowledge to various applications.

Course Outcomes:

CO-1	To understand the concepts and operation of linear power supplies, UPS, and switched-mode power converters.
CO-2	To understand the concepts and operation of non-isolated and isolated dc-dc converters and to perform steady-state and time-domain analysis involving power stage design, filter design, magnetics design, and switch selection.
CO-3	To understand the concepts of operation and analyse isolated dc-dc converters.
CO-4	To develop and analyse the various models of dc-dc converters, design different types of controllers, and perform stability analysis.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	2	-	1	1	2	1	1	3	3	3	3
CO-2	3	3	3	3	2	-	1	1	2	1	1	3	3	3	3
CO-3	3	3	3	3	2	-	1	1	2	1	1	3	3	3	3
CO-4	3	3	3	2	3	-	-	-	-	1	-	3	3	1	2
Average	**3**	**3**	**3**	**2.75**	**2.25**	**0**	**0.75**	**0.75**	**1.5**	**1**	**0.75**	**3**	**3**	**2.5**	**2.75**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module 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. Application of linear and switch-mode power supplies.

Module II: Non-Isolated DC-DC Converters (10 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.

Module III: Isolated DC-DC Converters (10 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.

Module IV: Mathematical Modelling and Control (10 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.

Learning Resources:

Text Books:

1. Power Electronics, Controller Application and Design by Ned Mohan (Wiley)
2. Power Electronics: Circuit, Analysis, and Design by Issah Batarseh (Springer)
3. Fundamentals of Power Electronics by Robert Erickson and Dragan Maksimovic (Springer)

Reference Books:

1. Switching Power Converters: Medium and High Power by Dorin O. Neacsu (CRC Press)
2. Switching Power Supply Design BY Abraham I. Pressman and Taylor Morey (The McGraw-Hill Companies)

Other Suggested Readings:

1. NPTEL Video Course on Switch-Mode Power Conversion by Prof. L. Umanand, IISC Bangalore

Course Title: Special Electrical Machines
Course Code: EELB 362
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil
Course Objective: Understand the operation and control of reluctance Permanent Magnet, Stepper and Linear motors

Course Outcomes:

CO-1	To understand theory of operation and control of synchronous & switched reluctance motors
CO-2	To gain knowledge on the Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors & permanent magnet synchronous motors.
CO-3	To understand the performance and control of stepper motors, and their applications
CO-4	To explain the theory of travelling magnetic field and applications of linear motors

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO-2	3	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO-3	3	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO-4	3	3	3	2	-	-	-	-	-	-	-	-	3	-	-
Average	**3**	**3**	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 Synchronous and Switched Reluctance Motors

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

Switched Reluctance Motors: Construction; principle of operation; torque production, modes of operation, drive circuits.

Module-II Permanent Magnet Motors:

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

Module-III Stepper Motors:

Principle of operation, variable reluctance, permanent magnet and hybrid stepper motors, characteristics, drive circuits and applications.

Module-IV Linear motors

Linear induction motor: Construction– principle of operation– applications.

Linear synchronous motor: Construction – principle of operation– applications.

Learning Resources:

Text Books:

1. Generalized Theory of Electrical Machines by P.S. Bimbhra (Khanna Publishers).

2. Principles of Electrical Machines and Power Electronics by P.C. Sen (Johnwilley&Sons).

Reference Books:

1. Theory and Problems of Electromagnetics by Joseph. A.Edminister (Tata McGraw Hill).

2. Electromagnetics with Applications by Kraus and Fleish (McGraw-Hill).

Course Title: Utilization of Electrical Energy
Course Code: EELB 373
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: Outline the concept of electric power utilization in various applications, including heating, welding, lighting, and electric traction systems.

Course Outcomes:

CO-1	Understand electric heating and implement modern methodologies for various applications
CO-2	Understand electrical applications of different types of welding
CO-3	Gain knowledge of the basic laws of illumination and design an efficient lighting system
CO-4	Gain fundamental knowledge about mechanics of train movement.
CO-5	Understand and interpret the design, working and control of electric traction systems

Course Articulation Matrix:

	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	2	2	-	-	-	1	-	-	-	-	-	2	2	-
CO-2	2	1	2	-	2	-	-	-	-	-	-	-	2	2	-
CO-3	3	2	3	3	2	-	-	-	-	-	-	-	2	2	-
CO-4	2	3	2	2	-	-	-	-	-	-	-	-	2	2	2
CO-5	2	3	2	2	-	-	1	-	-	-	-	-	2	2	2
Average	**2.4**	**2.2**	**2.2**	**2.3**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module 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

Module 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.

Module 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

Module 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.

Module V: 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.

Learning Resources:

Text Books:

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

Reference Books:

1. H.Partab, "Art And Science Of Utilisation Of Electrical Energy", Dhanpat Rai Publications

Course Title: Power Converters for Renewable Energy Sources
Course Code: EELB 411
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Power Electronics

Course Objective:

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.

Course Outcomes:

CO-1	Understand the characteristics of the renewable energy sources
CO-2	Understand the characteristics of PV, Series, parallel, MPPT and applications
CO-3	Understand the basics of wind turbine and control technique and converters.
CO-4	To understand the technique and problems to trap the wind energy system, fuel cell and energy storage solution for renewable energy source.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	2	1	-	-	-	-	-	2	-	3	2	-
CO-2	3	3	2	2	1	-	-	-	-	-	2	-	3	2	-
CO-3	3	3	2	2	1	-	-	-	-	-	1	-	3	2	-
CO-4	3	2	2	2	1	-	-	-	-	-	1	-	3	2	-
Average	**3**	**2.75**	**1.5**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**1.5**	**0**	**3**	**2**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module 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.

Module 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.

Module 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.

Module IV: Energy Storage (5 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.

Solar PV/Wind/Fuel Cell Based Cogeneration (4 Hours)

Concept of cogeneration, architectures, cogeneration issues and challenges. Introduction to AC/DC microgrids.

Learning Resources:

Text Books:

1. Power Electronics for Renewable and Distributed Energy Systems by Sudipta Chakraborty, Marcelo G. Simoes, William E Kramer, Springer.
2. Non-Conventional Energy Resources by B H Khan, Mc Graw Hill, 3rd edition.

Reference Books:

1. Wind Power Technology by Joshua Earnest, PHI, 2nd edition.
2. Renewable Energy, Power for Sustainable Future by Godfrey Boyle, Oxford, 3rd edition.

Course Title: Fundamental of Electric Vehicles
Course Code: EELB 414
L-T-P: 3-0-0
Credits: 03
Pre-requisites: Nil

Course Objective: To impart fundamental knowledge and understanding of electric vehicle dynamics, battery pack design, battery management systems, and charging infrastructure.

Course Outcomes:

CO-1	Understand and analyze the dynamics of electric vehicles by evaluating forces, drive cycles, and powertrain design for efficient vehicle performance.
CO-2	Explain battery technologies, estimate battery health parameters, and compute the cost-effectiveness and configuration of EV battery packs.
CO-3	Illustrate the architecture, functionalities, and algorithms of Battery Management Systems (BMS) for ensuring battery safety, efficiency, and reliability.
CO-4	Classify different EV charging methods, including battery swapping and public charging infrastructure, along with their standards and applications.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	-	-	1	1	-	-	-	-	-	1	1	-
CO-2	3	3	3	3	2	1	1	-	-	-	-	-	1	1	-
CO-3	3	3	3	3	2	1	1	-	-	-	-	-	1	1	-
CO-4	3	3	3	3	2	1	1	-	-	-	-	-	1	1	-
Average	**3**	**3**	**2.75**	**2.75**	**1.5**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 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.

Module-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. Hierarchy of battery pack, modules assembling, busbar design, short circuits scenarios, efficient power delivery, cell testing & characterization

Module-III 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.

Module-IV EV Chargers:

Introduction, slow or fast chargers, battery swapping, standardization and on-board chargers, public chargers, bulk chargers/swap stations.

Learning Resources:

Text Books:

1. Electric Vehicle Engineering by Per Enge, Nick Enge, and Stephen Zoepf (McGraw Hill Education).

2. Electric and Hybrid Vehicles by Iqbal Husain (Routledge Taylor & Francis Group).

Reference Books:

1. Electric and Hybrid Vehicles by Tom Denton, Hayley Pells (Routledge Taylor & Francis Group).
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi (Routledge Taylor & Francis Group).

Course Title: Power Quality
Course Code: EELB 415
L-T-P: 3-0-0
Credits: 03
Pre-requisites: Nil
Course Objective: The objectives of the course include introduction of the power quality definitions, voltage sags, interruptions, harmonic problems and mitigation.

Course Outcomes:

CO-1	Understand the fundamental concepts of power quality issues.
CO-2	Analyze the origin, measurement, and standards of harmonic distortions in power systems.
CO-3	Evaluate the causes and effects of harmonics generated by various electrical devices and systems.
CO-4	Design appropriate filtering and compensation solutions including passive filters, active power filters, and DSTATCOMs to mitigate power quality issues.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-2	3	3	3	3	2	1	-	-	-	-	-	-	-	-	-
CO-3	3	3	3	3	2	1	-	-	-	-	-	-	-	-	-
CO-4	3	3	3	3	2	1	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**2.75**	**2.75**	**1.5**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 Concept of Power Quality:

Frequency variations, voltage variations- sag and swell, waveform distortion –dc offset, harmonics, inter-harmonics, notching and noise.

Module-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

Module-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.

Module-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.

DSTATCOMs: State of art on DSTATCOMs, Classification, principle of operations of DSTATCOMs, control technique, analysis and design of DSTATCOMs.

Learning Resources:

Text Books:

1. Electrical Power Systems Quality by Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H.Wayne Beaty (McGraw Hill Education).
2. Power Quality: Problems and Mitigation Techniques by Bhim Singh, Ambrish Chandra, and Kamal Al-Haddad (Wiley India).

Reference Books:

1. Power System Harmonic Analysis by Arrillaga J., Smith B. C., Watson N. R. and Wood A. R (Wiley India).
2. Power Quality by Sanskaran (C.R.C. Press).

Course Title: Power System Deregulation
Course Code: EELB 322
L-T-P: 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: To understand the electricity power business and technical issues in a restructured power system in both Indian and world scenario.

Course Outcomes:

CO-1	To understand the concept of Power System deregulation, its need and different entities and market models
CO-2	To know the role of Independent System Operator in different market scenarios.
CO-3	To understand Transmission Open Access and explain various pricing methods
CO-4	Analysing Ancillary Services and Reliability in Deregulated Electricity Market

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	2	-	-	-	-	-	-	-	-	3	1	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-	3	1	-
CO-3	3	3	2	2	-	-	-	-	-	-	-	-	3	1	-
CO-4	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
Average	**3**	**3**	**1.5**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1.25**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module 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.

Module 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.

Module 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.

Module IV: Ancillary Services Management and Reliability
General description of some ancillary services, ancillary services management in various countries, and reactive power management in some deregulated electricity markets. 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.

Learning Resources:

Text Books:

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

Reference Books:

Course Title: Renewable Energy Systems
Course Code: EELB 323
L-T-P: 3-0-0
Credits: 03
Pre-requisites: Nil

Course Objective: Comprehensive knowledge of the renewable energy system and their applications.

Course Outcomes:

CO-1	Understanding of different renewable energy resources and their impacts on the environment.
CO-2	Analysis of various characteristics of PV cells, wind turbines, hydraulic turbines, and fuel cells.
CO-3	Performance evaluation of PV cells, wind turbines, and hydraulic turbines under various loading conditions
CO-4	Design and develop PV cells, wind turbines, hydraulic turbines, and fuel cells.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	-	-	1	1	-	-	-	-	-	1	1	-
CO-2	3	3	3	3	-	1	1	-	-	-	-	-	1	1	-
CO-3	3	3	3	3	-	1	1	-	-	-	-	-	1	1	-
CO-4	3	3	3	3	-	1	1	-	-	-	-	-	1	1	-
Average	**3**	**3**	**2.75**	**2.75**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 Introduction

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.

Module-II PV Cell

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.

Module-III Wind Power Generation:

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

Module-IV Other Energy systems:

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

Basic principle and design of different types of fuel cells and their applications, future prospects.

Learning Resources:

Text Books:

1. Non-Conventional Energy Resources by B H Khan (McGraw Hill Education).

2. Non-Conventional Energy Resources by S. N. Singh (Pearson).

Reference Books:

1. Power Electronics for Renewable and Distributed Energy Systems by Sudipta Chakraborty, Marcelo G. Simoes, William E Kramer (Springer).
2. Wind Power Technology by Joshua Earnest (PHI).
3. Renewable Energy, Power for Sustainable Future by Godfrey Boyle (Oxford).

Course Title: Power System Operation and Control
Course Code: EELB 371
L-T-P: 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: To provide students the knowledge of the engineering and economic aspects of planning, operation, security, controlling power generation and transmission systems in electric utilities.

Course Outcomes:

CO-1	Understand the economic and optimal operation of generators in thermal power stations and their characteristics.
CO-2	Design the mathematical models of the speed governing systems, turbine, excitation system for load frequency control and different methods for voltage control.
CO-3	Design the mathematical models and understand hydro thermal scheduling.
CO-4	To analyse various parameter of power system security.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	-	2	-	-	-	-	-	-	-	-	3	1	-
CO-2	3	3	2	2	-	-	-	-	-	-	-	-	3	1	-
CO-3	3	3	2	2	-	-	-	-	-	-	-	-	3	1	-
CO-4	3	3	2	2	-	-	-	-	-	-	-	-	3	2	-
Average	**3**	**3**	**1.5**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1.25**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module 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

Module 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. 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

Module III: 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.

Module IV: 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.

Learning Resources:

Text Books:

1. Power System Analysis by Grainger J. J. and Stevenson W. D. (McGraw-Hill International Book Company, 2008.).
2. Power System Analysis Operation and Control by A. Chakrabarti, S. Halder (PHI).
3. Power System operation and Control by K. Uma Rao (Wiley India).

Reference Books:

Course Title: Energy Auditing and Management
Course Code: EELB 372
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: To provide an introduction to Energy Auditing and Management
Course Outcomes:

CO-1	To Comprehend the basics concepts of energy auditing, management and technologies
CO-2	To Apply the procedure of energy auditing procedure along with relevant technologies/tools
CO-3	To Analytics the energy performances assessment for equipment and utilities systems.
CO-4	To Design the energy audit report and interpretable in energy auditing in the industry.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	1	2	1	1	2	1	1	2	3	3	2
CO-2	3	3	3	3	3	2	2	2	3	1	2	2	3	3	3
CO-3	3	2	3	3	3	2	1	1	2	1	2	1	3	2	2
CO-4	3	3	3	3	3	2	1	1	2	1	1	2	3	3	2
Average	**3**	**2.75**	**3**	**3**	**2.5**	**2**	**1.25**	**1.25**	**2.25**	**1**	**1.5**	**1.75**	**3**	**2.75**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module 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.

Module II: Energy Audit Basics:
Definition and objectives energy audit, types of energy audit, benchmarking, energy performances, maximizing system efficiencies, bureau of energy efficiency regulations

Module III: Energy Audit Procedure:
Energy Audit Procedure Tools/ Techniques/ Equipment Energy Audit Report Financing Activities. 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.

Module IV: 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..

Learning Resources:

Text Books:
1. Industrial Energy Management and Utilization by LC Witte, PS Schmidt and DR Brown **(**Hemisphere Publishing Corporation, Washington**).**

Reference Books:
1. Handbook on Energy Audit and Environment Management by YP Abbi and Shashank Jain (TERI Press).
2. Guide book on General Aspects of Energy Management and Energy Audit by R. Virendra, J. Nagesh Kumar et. Al, Bureau of Energy Efficiency.

Course Title: Power System Stability
Course Code: EELB 425
L-T-P : 3-0-0
Credits: 03
Pre-requisites: Nil

Course Objective: 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.

Course Outcomes:

CO-1	Understand and classify different types of power system stability including rotor angle, frequency, and voltage stability, and analyze the classical representation of synchronous machines in a single-machine infinite bus system.
CO-2	Model synchronous machines and associated systems such as excitation and prime mover systems using various dynamic models for stability analysis in power systems.
CO-3	Analyze the small-signal stability of power systems using state-space modeling, modal analysis, and participation factors, and evaluate the impact of excitation systems on system stability.
CO-4	Evaluate voltage stability in power systems using static and dynamic analysis techniques, and apply methods to prevent voltage collapse under different system operating conditions.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
CO-3	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
CO-4	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**3**	**2.25**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 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.

Module-II Smart Grid Protection

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.

Module-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.

Module-IV Voltage Stability:

Classification of voltage stability, modeling requirements, voltage stability analysis: static and dynamic, sensitivity analysis, modal analysis, voltage collapse, prevention of voltage collapse.

Learning Resources:

Text Books:

1. Power system stability and control by P. Kundur (Tata- McGraw Hill).
2. Power System Stability by Kimbark, Muhammad Marwali (Wiley India).
3. Topics on small signal stability analysis by K. R. Padiyar, M. A. Pai, K. Sen gupta (Tata-McGraw Hill)

Reference Books:

1. Power system stability by M. A. Pai and Peter W. Sauer (Pearson Education).
2. Power system dynamics by K. R. Padiyar (BSP publications).

Course Title: Advanced Applications of IOT
Course Code: EELB 331
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: Explore the architecture of IoT systems and how they interact with data processing platforms and analyzing data to derive meaningful insights.

Course Outcomes:

CO-1	Understand the basics of IoT.
CO-2	Implement the state of the Architecture of an IoT.
CO-3	Understand design methodology and hardware platforms involved in IoT.
CO-4	Understand how to analyze and organize the data
CO-5	Compare IOT Applications in Industrial & real world.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3	2	1	2	-	1	-	-	-	-	-	-	-	2	-	-
CO-4	1	2	1	3	1	-	-	-	-	-	-	-	2	-	1
CO-5	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**1**
Average	**1.6**	**1.5**	**1.5**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**1**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module I: 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.

Module 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.

Module 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

Module 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.

Module V: CASE STUDIES/INDUSTRIAL APPLICATIONS:
IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipment, Industry 4.0 concepts.

Learning Resources:

Text Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, " IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things"Cisco Press, 2017

2. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach” Universities Press, 2015

Reference Books:

1. Olivier Hersent, David Boswarthick, Omar Elloumi, “ The Internet of Things – Key applications and Protocols, Wiley, 2012
2. Jan Ho¨ ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, “ From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence” Elsevier, 2014

Course Title: Industrial Automation and Control
Course Code: EELB 332
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Control Systems (EEBB 252)

Course Objective: To provide exposure to the technology of industrial automation and control applicable to industries.

Course Outcomes:

CO-1	To learn the basics of PLC ,its operation and applications in automation
CO-2	To understand the usage of sensors and actuators in automation systems
CO-3	To understand the concepts related to signal conditioning and different control actions
CO-4	To understand the role and challenges in the use of IoT for industrial automation

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
CO-2	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
CO-3	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
CO-4	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
Average	**3**	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 Introduction

Overview and requirement of industrial automation, control devices, feedback devices, Design of systems, PLC components, Input and output modules, Programming, Ladder diagram, sequential flow chart, Communication and networking, Timer and Counter functions.

Module-II Sensors and Actuators

Sensor types, Digital sensors, Sensor wiring, Analog sensors, Installation considerations, Types of Actuators, Pressure controllers, Flow control actuators, Power control, Motors

Module-III 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.

Module-IV 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.

Learning Resources:

Text Books:

1. Jon Stenerson, "Industrial Automation and Process Control", Pearson 2002.

Reference Books:

1. William C. Dunn, "Fundamentals of Industrial Instrumentation and Process Control", McGraw-Hill Education; 2nd edition, 2018.
2. S. Mukhopadhyay, S. Sen and A. K. Deb, “Industrial Instrumentation, Control and Automation”, Jaico Publishing House, 2013.

Course Title: Image Processing
Course Code: EELB 381
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: To learn and understand the fundamentals of digital image processing, and various image Transforms, Image Enhancement Techniques, and image compression and Segmentation used in digital image processing.

Course Outcomes:

CO-1	To become familiar with digital image fundamentals and mathematical transforms necessary for image processing
CO-2	To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
CO-3	Gain an understanding of image compression techniques to reduce storage space and transmission bandwidth requirements
CO-4	Develop skills in image segmentation techniques for partitioning images into meaningful regions or objects

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	3	2	-	-	-	-	-	-	-	3	-	-
CO-2	3	3	3	3	2	-	-	-	-	-	-	-	3	-	-
CO-3	3	3	3	3	2	-	-	-	-	-	-	-	3	-	-
CO-4	3	3	3	3	2	-	-	-	-	-	-	-	3	-	-
Average	**3**	**3**	**2.75**	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 Image Fundamentals and Transforms

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.

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.

Module-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.

Module-III 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.

Module-IV Image Segmentation Detection of discontinuities, edge linking and boundary detection, thresholding, region-oriented segmentation, use of motion in segmentation, spatial techniques, frequency domain techniques.

Learning Resources:

Text Books:

1. Digital Image Processing by R. Gonzalez and R. E. Wood (Pearson Education).
2. Introductory Computer Vision and Image Processing by Adrian Low (McGraw Hill).
3. Fundamentals of Digital Image Processing by A. K. Jain (Pearson Education).

Reference Books:

1. Pattern Recognition by William Gibson (Berkley).
2. Digital Image Processing by William K. Pratt (John Wiley)

Course Title: Intelligent Control Systems
Course Code: EELB 382
L-T-P: 3-0-0
Credits: 3
Pre-requisites: Control Systems (EEBB 252)

Course Outcomes:

CO-1	To understand the concepts of intelligent control.
CO-2	To understand the concepts of expert control systems.
CO-3	To understand and apply different tools for intelligent control e.g. ANN, fuzzy logic, neuro-control and learning control
CO-4	To acquire knowledge about hybrid intelligent control techniques.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
CO-2	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
CO-3	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
CO-4	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
Average	**3**	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Module-I: Introduction to Intelligent Control

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

Module-II: 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.

Module-III: 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.

Module-IV: Neural and Learning Control Systems

Introduction to Artificial neural networks (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, Neur-fuzzy system, Adaptive neuro-fuzzy inference system, Schemes of learning control: iterative learning control, repetitive learning control, Stability and convergence issues.

Learning Resources:

Text Books:

1. Zixing Cai, "Intelligent Control: Principles, Techniques and Applications", World Scientific Publishing Co Pte Ltd (19 December 1997)

Reference Books:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani , "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", Pearson Education India, 2015

Course Title: Biomedical Instruments and Data Interpretation
Course Code: EELB 431
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil

Course Objective: To provide an introduction to biomedical instruments and its ability to understand data interpretation.

Course Outcomes:

CO-1	To understand common forms of Physiology and transducers in biomedical instruments.
CO-2	To implement simple logical operations of Electro – Physiological measurements
CO-3	To design system for Physiological parameter measurements.
CO-4	To impart to student the concepts of medical imaging to analyse physical problems

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	1	2	1	1	2	1	1	2	3	3	2
CO-2	3	3	3	3	3	2	2	2	3	1	2	2	3	3	3
CO-3	3	2	3	3	3	2	1	1	2	1	2	1	3	2	2
CO-4	3	3	3	3	3	2	1	1	2	1	1	2	3	3	2
Average	**3**	**2.75**	**3**	**3**	**2.5**	**2**	**1.25**	**1.25**	**2.25**	**1**	**1.5**	**1.75**	**3**	**2.75**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-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.

Modul-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.

Modul-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

Modul-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

Assisting and therapeutic equipment's

Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart Lung machine, Audio meters, Dialyzers.

Learning Resources:

Text Books:

1. Hand Book of Bio-Medical instrumentation by R.S.Khandpur (Tata McGrawHill Publishing Co.).

Reference Books:

1. Medical Instrumentation by J.Webster (John Wiley & Sons,).
2. Principles of Applied Bio-Medical Instrumentation by L.A. Geddes and L.E.Baker (John Wiley & Sons,).

Course Title: Sensor Design and System Development
Course Code: EELB 432
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Nil
Course Objective: To provide an introduction to biomedical instruments and its ability to understand data interpretation.

Course Outcomes:

CO-1	To understand Sensor Principles and Design
CO-2	To implement simple inductive & capacitive transducer
CO-3	To design and implement for actuators and micro sensors.
CO-4	To impart to student the concepts of fundamental principles underlying sensor technologies, including sensing mechanisms, transduction techniques, and sensor characteristics.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	1	2	1	1	2	1	1	2	3	3	2
CO-2	3	3	3	3	3	2	2	2	3	1	2	2	3	3	3
CO-3	3	2	3	3	3	2	1	1	2	1	2	1	3	2	2
CO-4	3	3	3	3	3	2	1	1	2	1	1	2	3	3	2
Average	**3**	**2.75**	**3**	**3**	**2.5**	**2**	**1.25**	**1.25**	**2.25**	**1**	**1.5**	**1.75**	**3**	**2.75**	**2.25**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul – 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.

Modul - 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-

Modul - III ACTUATORS MICRO SENSORS

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. 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.

Modul - IV 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.

Learning Resources:

Text Books:

1. Sensors and Transducers by Patranbis D **(**Wheeler Publishing Co.**).**

Reference Books:

1. The Mechatronics Hand Book by Robert H Bishop (CRC Press).

2. Shape Memory Actuators by Manfred Kohl (Springer).

Course Title: Embedded Control Systems Modeling and Simulation
Course Code: EELB 433
L-T-P : 3-0-0
Credits: 3
Pre-requisites: Control Systems (EEBB 252)
Course Objective: To understand the basics of embedded control systems and the use of control theory in embedded systems.

Course Outcomes:

CO-1	To understand the concept and architecture of embedded system.
CO-2	To analyze the performance and safety requirements for the control system design
CO-3	To understand the techniques for the implementation of continuous-time control using digital platform
CO-4	To understand the implementation and the issues involved in the realization of digital controllers

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
CO-2	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
CO-3	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
CO-4	3	3	2	-	2	-	-	-	-	-	-	-	3	3	-
Average	**3**	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**0**

1 - Slightly; 2 - Moderately; 3 - Substantially

Syllabus:

Modul-1 Introduction

Definition and architecture of embedded system, Communication networks in embedded systems, Multi-tasking, Planning embedded system development.

Module-II Control System Design

Requirements for control system design: safety issues, specifications, Mathematical modeling for control, Characteristics and limitations of control system, stability, Performance specifications

Module-III 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

Module-IV Implementation of Digital Controllers

Realization of digital controllers, Implementation of computer-controlled system, Analog prefiltering and computational delay, Measurement errors, nonlinear actuators, Roundoff and Quantization, Aperiodic tasks, overload management, Real-Time Scheduling, Resource sharing, Challenges

Learning Resources:

Text Books:

1. Dimitrios Hristu-Varsakelis, "Handbook of Networked and Embedded Control Systems", Birkhäuser Boston, MA, 1st ed. 2005

2. Karl Johan Astrom and Bjorn Wittenmark, "Computer Controlled Systems: Theory and Design", Dover Publications, 2011.

Reference Books:

3. Alexandru Forrai, "Embedded Control System Design: A Model Based Approach", Springer-Verlag Berlin and Heidelberg, 2013.