Course Structure & Syllabus

of

B. Tech. Programme

in

Electrical Engineering

Academic Year – 2019-20

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, ODISHA

Burla, Sambalpur-768018, Odisha

www.vssut.ac.in

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA, ODISHA

DEPARTMENT OF ELECTRICAL ENGINEERING

VISION

To be recognized as a centre of excellence in education and research in the field of Electrical Engineering by producing innovative, creative and ethical Electrical Engineering professionals for socio-economic development of society in order to meet the global challenges.

MISSION

Electrical Engineering Department of VSSUT Burla strives to impart quality education to the students with enhancement of their skills to make them globally competitive through:

M1. Maintaining state of the art research facilities to provide enabling environment to create, analyze, apply and disseminate knowledge.

M2. Fortifying collaboration with world class R&D organizations, educational institutions, industry and alumni for excellence in teaching, research and consultancy practices to fulfil 'Make in India' policy of the Government.

M3. Providing the students with academic environment of excellence, leadership, ethical guidelines and lifelong learning needed for a long productive career.

PROGRAM EDUCATIONAL OBJECTIVES

The program educational objectives of B.Tech. in Electrical Engineering program of VSSUT Burla are to prepare its graduates:

1. To have basic and advanced knowledge in Electrical Engineering with specialized knowledge in design and commissioning of electrical systems/renewable energy systems comprising of generation, transmission and distribution to become eminent, excellent and skillful engineers.
2. To succeed in getting engineering position with electrical design, manufacturing industries or in software and hardware industries, in private or government sectors, at Indian and in Multinational organizations.
3. To have a well-rounded education that includes excellent communication skills, working effectively on team-based projects, ethical and social responsibility.
4. To have the ability to pursue study in specific area of interest and be able to become successful entrepreneur.
5. To have broad knowledge serving as foundation for lifelong learning in multidisciplinary areas to enable career and professional growth in top academic, industrial and government/corporate organizations.

PEO-MISSION MATRIX

	M1	M2	M3
PEO1	**3**	**1**	**1**
PEO2	**1**	**3**	**2**
PEO3	**2**	**2**	**3**
PEO4	**1**	**3**	**3**
PEO5	**2**	**3**	**3**

PROGRAM OUTCOMES of B.Tech. (EE)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**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.
PO3	**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.
PO4	**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.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**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.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**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.
PO11	**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.
PO12	**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.

Program Specific Outcomes for B.Tech. (EE)

PSO1	Apply the knowledge of electric circuits, control systems, electrical machines, power electronics and power systems to solve complex engineering problems in the discipline of Electrical Engineering
PSO2	Develop suitable techniques and cutting-edge engineering hardware and software tools in electrical engineering to solve practical problems.
PSO3	Aware of the impact of professional electrical engineering solutions on social, economic, environmental and technological sustainability.

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA, ODISHA

PROPOSED COURSE STRUCTURE FOR BACHELOR OF TECHNOLOGY (ELECTRICAL ENGINEERING) COURSES TO BE EFFECTIVE FROM JULY/AUGUST 2020

COURSE STRUCTURE FIRST YEAR		FIRST SEMESTER (THEORY)		
Sl.No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credits**
1	BMA01001	Mathematics-I	3-1-0	4
2	BPH01001	Physics	3-0-0	3
3	BEE01001	Basic Electrical Engg.	3-0-0	3
4	BHU01001	English For Business Communication	3-0-0	3
5	BME01001	Engineering Mechanics	3-0-0	3
		SESSIONALS		
1	BPH01002	Physics Laboratory	0-0-3	1.5
2	BEE01002	Basic Electrical Engg. Lab	0-0-3	1.5
3	BHU01002	Business Communication Skills	0-0-3	1.5
4	BME01002	Workshop & Manufacturing Practices	0-0-3	1.5
		NON-CREDIT		
1	BNC01001	Induction Programme and participation in Clubs/Societies	0-0-0	0
		Total	15-1-12	22

COURSE STRUCTURE FIRST YEAR		SECOND SEMESTER (THEORY)		
Sl.No.	**CourseCode**	**Subject**	**Contact Hrs. L-T-P**	**Credits**
1	BMA02001	Mathematics - II	3-1-0	4
2	BCH02001	Chemistry	3-0-0	3
3	BEC02001	Basic Electronics	3-0-0	3
4	BIT02001	Programming for Problem Solving	3-0-0	3
5	BME02001	Basic Civil Engg.	3-0-0	3
		SESSIONALS		
1	BCH02002	Chemistry Lab	0-0-3	1.5
2	BEC02002	Basic Electronics Lab	0-0-3	1.5
3	BIT02002	Programming Lab /	0-0-3	1.5
4	BCE02002	Engineering Graphics & Design	0-0-3	1.5
		NON-CREDIT		
1	BNC02001	NSS/NCC/Yoga	0-0-0	0
		Total	15-1-12	22

COURSE STRUCTURE THIRD SEMESTER SECOND YEAR (THEORY)				
Sl.No	**CourseCode**	**Subject**	**Contact Hrs. L-T-P**	**Total Credits**
1	**BMA03001**	**Math-III**	**3-1-0**	**4**
2	**BEE03001**	**Electrical Machines-I**	**3-0-0**	**3**
3	**BEE03002**	**Network Theory**	**3-0-0**	**3**
4	**BEE03003**	**Instrumentation and Sensors**	**3-0-0**	**3**
5	**BHU03001**	**Organizational Behavior**	**3-0-0**	**3**
SESSIONAL				
1	**BEE03004**	**Electrical Machines Lab-I**	**0-0-3**	**1.5**
2	**BEE03005**	**Network Lab.**	**0-0-3**	**1.5**
3	**BEE03006**	**Electrical Computational Lab**	**0-0-3**	**1.5**
4	**BEE03007**	**Instrumentation Lab**	**0-0-3**	**1.5**
NON-CREDIT				
1	**BNC03001**	**Essence of India Traditional Knowledge/ Environmental Sciences**	**0-0-0***	**0**
TOTAL			**15-1-12**	**22**

COURSE STRUCTURE FOURTH SEMESTER SECOND YEAR (THEORY)				
SI. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	**BEE04001**	**Electrical Machines-II**	**3-0-0**	**3**
2	**BEE04002**	**Electric Power Generation Systems**	**3-0-0**	**3**
3	**BEE04003**	**Analog and Digital Electronic Circuits**	**3-0-0**	**3**
4	**BMA04001**	**Math-IV**	**3-1-0**	**4**
5	**BHU04001**	**Economics for Engineers**	**3-0-0**	**3**
SESSIONALS				
6	**BEE04004**	**Electrical Machines Lab-II**	**0-0-6**	**3**
7	**BEE04005**	**Analog and Digital Electronic Circuits Lab**	**0-0-6**	**3**
NON-CREDIT				
1	**BNC04001**	**Environmental Sciences/ Essence of India Traditional Knowledge**	**0-0-0***	**0**
2	**BNC04002**	**Summer Internship/ Training/ Project**	**0-0-0**	**0**
Total			**15-1-12**	**22**

COURSE STRUCTURE FIFTH SEMESTER THIRD YEAR (THEORY)				
SI. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	BEE05001	Electrical Power Transmission & Distribution	3-0-0	3
2	BEE05002	Control System-I	3-0-0	3
3	BEE05003	Power Electronics	3-0-0	3
4		Professional Elective -I	3-0-0	3
5		Open Elective -I	3-0-0	3
6		Professional Ethics, Professional Law & Human Values / Financial Management, Costing, Accounting, Balance Sheet & Ratio Analysis	2-0-0	2
SESSIONAL				
1	BEE05004	Control System Lab	0-0-3	1.5
2	BEE05005	Power Electronics Lab.	0-0-3	1.5
3	BEE05006	Signals & Systems lab	0-0-3	1.5
Total			17-0-9	21.5

COURSE STRUCTURE SIXTH SEMESTER THIRD YEAR (THEORY)				
SI. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	BEE06001	Switchgear & Protection	3-0-0	3
2	BEE06002	Microprocessor & Microcontroller	3-0-0	3
3		Professional Elective -II	3-0-0	3
4		Professional Elective-III	3-0-0	3
5		Open Elective-II	3-0-0	3
6		Financial Management Costing, Accounting, Balance Sheet & Ratio Analysis/ Professional Ethics, Professional Law & Human Values	2-0-0	2
SESSIONALS				
1	BEE06003	Microprocessor & Microcontroller Lab	0-0-3	1.5
2	BEE06004	Power System Lab-I	0-0-3	1.5
3	BEE06005	Electrical Machine Design	0-0-3	1.5
NON-CREDIT				
1	BNC06001	Summer Internship/ Training/ Project	0-0-0	0
Total			17-0-9	21.5

COURSE STRUCTURE SEVENTH SEMESTER FOURTH YEAR (THEORY)				
SL NO	**COURSE CODE**	**SUBJECT**	**CONTACT HRS L-T-P**	**CR**
1	BEE07001	Power System Operation and Control	3-0-0	3
2	BEE07002	High Voltage Engineering	3-0-0	3
4		Professional Elective-IV	3-0-0	3
5		Open Elective-III	3-0-0	3
		SESSIONALS		
1		Project - I	0-0-6	3
2	BEE07003	Power System Lab-II	0-0-3	1.5
3		Seminar on internship	0-0-3	1.5
		TOTAL	12-0-12	18

Steel Structures

COURSE STRUCTURE EIGHTH SEMESTER FOURTH YEAR (THEORY)				
SL NO	**COURSE CODE**	**SUBJECT**	**CONTACT HRS L-T-P**	**CR**
1		Professional Elective-V	3-0-0	3
2		Professional Elective-VI	3-0-0	3
3		Open Elective-IV	3-0-0	3
		SESSIONALS		
1		Project II	0-0-12	6
2		Seminar on Project	0-0-2	1
		TOTAL	9-0-14	16

GRAND TOTAL CREDITS: 165

Note: Each hour of practical /lab/sessional class = 0.5 credit

The students should undergo Summer Internship or Project in India or Abroad for a minimum period of 8 weeks either in 4^{th}& 6^{th} Semesters together or in one semester at a stretch.

List of Professional Elective (Third Year)			
Sl. No.	Category	Course Code	Subject Name
1	BPE-I	BEEPE501	Signals & Systems
2		BEEPE502	Electromagnetic Field Theory
3		BEEPE503	Industrial Power Electronics
4		BEEPE504	Renewable Energy Sources
1	BPE-II	BEEPE601	Control System-II
2		BEEPE602	Digital Circuit Design
3		BEEPE603	Reliability Engineering
4		BEEPE604	Computer System Architecture
1	BPE-III	BEEPE605	Electric Drives & Traction
2		BEEPE606	Engineering Optimization
3		BEEPE607	Bio-Medical Instrumentation
4		BEEPE608	Sensor Technology

List of Professional Elective (Fourth Year)

Sl. No.	Category	Course Code	Subject Name
1	BPE-IV	BEEPE701	Flexible AC Transmission System
2		BEEPE702	Power Quality
3		BEEPE703	Digital Signal Processing
4		BEEPE704	Communication Systems
5		BEEPE705	Electrical Engineering Materials
1	BPE-V	BEEPE801	Smart Power Grid
2		BEEPE802	Restructured Power System
3		BEEPE803	Electric & Hybrid Vehicles
4		BEEPE804	Electric Drives Control
5		BEEPE805	Industrial Automation & Control
1	BPE-VI	BEEPE806	Forecasting Methods in Engineering
2		BEEPE807	Soft Computing and Heuristic Optimization
3		BEEPE808	Embedded System
4		BEEPE809	Wide Area Monitoring & Control
5		BEEPE810	Energy Management and Auditing

COURSE CODE	SL. NO.	Course Code	OPEN ELECTIVE SUBJECTS
UOE-I	1	BEEOE501	Bio-Medical Instrumentation
	2	BEEOE502	Elements of Electrical Machines
	3	BEEOE503	Control System Engineering
UOE-II	1	BEEOE601	Embedded System
	2	BEEOE602	Elements of Power Electronics
	3	BEEOE603	Microprocessor & Microcontroller
UOE-III	1	BEEOE701	Renewable Energy Sources
	2	BEEOE702	Energy Management
	3	BEEOE703	Industrial Automation & Control
UOE-IV	1	BEEOE801	System Reliability
	2	BEEOE802	Time series Analysis and Forecasting
	3	BEEOE803	Electrical Power Distribution System

DETAILS SYLLABI
1st Semester

B. Tech.: Mathematics-I (Calculus and Linear Algebra) (BMA 01001) [3-1-0]

Module 1: Calculus (8 Lectures)

Rolle's theorem, Mean value theorems (statements only) and applications. Introduction to improperintegrals. Beta and Gamma functions and their properties.

Module 2: Calculus (8 Lectures)

Convergence of sequence and series, tests of convergence. Fourier series, arbitrary period, even andodd function, half range series.

Module3: Calculus (8 Lectures)

Limit, continuity and partial derivatives (two variables), maxima and minima. Vector and scalar point functions and fields, gradient of a scalar field, directional derivative, divergence of a vector field, curl of a vector field and applications

Module 4:* Linear Algebra *(8 Lectures)

Linear systems of equations, Gauss elimination, linear independence, rank of a matrix, Gauss-Jordan elimination. Vector Space; basis and dimension'

Module 5:* Linear Algebra *(8 Lectures)

Eigenvalues, eigenvectors, some applications of eigenvalue problems, symmetric, skew-symmetric and orthogonal matrices, diagonalization, quadratic forms, complex matrices and forms.

Text Book:

1) Erwin Kreyszig, Advanced Engineering Mathematics (9th Edition), Wiley India Pvt. Ltd
2) S.C. Malik and S. Arora, Mathematical Analysis, New Age International

Reference Books:

1) George B. Thomas, Jr. and Ross L. Finney, Calculus and Analytic Geometry, Addison WesleyPublishing Company
2) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
3) A. Stroud, Advanced Engineering Mathematics, Industrial Press
4) S.K. Paikray,Text book of Matrix Algebra, Kalyani Publisher

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Recognize basic knowledge of differential calculus, improper integral, Beta and Gamma functions which are useful in various fields of engineering
CO2	Analyse periodic phenomenon and describe Fourier series expansion of periodic function
CO3	Demonstrate functions of several variables that is essential in most of the branches of engineering
CO4	Apply Gauss elimination method and rank of a matrix in solving linear equations
CO5	Implement knowledge of eigenvalues and eigenvectors in a comprehensive manner

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

ENGINEERING PHYSICS (BPH01001)

Course Objectives:

- To understand the concept of Elasticity
- To gain the knowledge of Oscillations and Resonance
- To obtain knowledge and concept of wave optics through Interference, Diffraction and Polarization
- To understand the fundamentals of Electromagnetism
- To gain the basic idea on Quantum Physics and Photonics

Syllabus

Module-I PROPERTIES OF MATTEER

Ideas of Elastic Constants (Y, K, η and σ), relation between elastic constants, torsion pendulum, determination of η, cantilever at one end.

Module-II OSCILLATION AND WAVES

Review of Simple Harmonic Oscillation and application to Compound pendulum, Damped Harmonic Oscillation, Forced Oscillation, Resonance, (Amplitude Resonance, Velocity Resonance, and Sharpness of Resonance).

Module-III OPTICS

Concept of Wave and wave equation, Superposition of Many harmonic waves, Interference, Concept of coherent sources (Division of wave front and division of amplitude), Interference in thin parallel film, Newton's ring (Theory, Application, Determination of Wavelength of Light, Refractive index of liquid), Concept of Diffraction (Huygen's Principle), Types of Diffraction, Fraunhofer Diffraction due to a single slit and diffraction Grating, Determination of Wavelength, Dispersive Power and Resolving Power of a Plane Diffraction Grating, Polarization, Double Refraction, Half wave Plate, Quarter wave Plate.

Module-IV ELECTROMAGNETISM

Vector Calculus, Gradient, Divergence, Curl (Mathematical Concept), Gauss' Divergence Theorem and Stoke's Theorem (Statement Only), Derivation of Maxwell's Electromagnetic Equations in Differential form and Integral form, Electromagnetic Wave equations for $\vec{E}$ and $\vec{B}$ in vacuum and in conducting medium, Transverse nature of EM waves.

Module-V QUANTUM MECHANICS AND PHOTONICS

Wave particle duality, Matter Wave (de-Broglie Hypothesis), Wave Functions, Observables as Operators, Eigen Functions and Eigen Values, Normalization, Expectation Values, Schrodinger equation (Time Dependent and Time Independent), Particle in a box. **Lasers:** Introduction and Characteristics of Lasers, Einstein's Coefficients and Relation between them, Lasing Action (Population Inversion, Three and Four level Pumping Schemes), Different types of Lasers (Ruby lasers, He-Ne Lasers).

Text Book:

1. Principle of Engg. Physics: Md. N. Khan and S. Panigrahi
2. Engg. Physics: H.K. Malik and A.K. Singh

Reference Books:

1. Oscillations and Waves: N. Subramanyam and Brij Lal
2. Optics: A. Ghatak
3. Electrodynamics: D.J. Griffith
4. Concept of Modern Physics: A. Beiser
5. Lasers: Theory and Applications: K. Thyagarajan and A.K. Ghatak

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Explain the concepts of Stress, Strain, Elastic Modulus and Elastic Constant, Bending of Beams. Identify the importance Elastic properties in Engineering Applications
CO2	Understand simple harmonic Oscillator, Damped Harmonic and Forced Oscillators. Explain Quality factor and resonance with applications
CO3	Explain the link between Simple Harmonic Motion and Waves. Understand the principle of superposition, the need of coherent sources, analyze the difference between Interference and Diffraction and their applications. Illustrate the concept of Polarization of light and its applications.
CO4	Understand the basic mathematical concepts related to electromagnetic vector fields, Understand the concepts related to electromagnetic wave.
CO5	Understand and explain the differences between classical and quantum mechanics. Interpret the wave function, operators and Schrodinger equation to solve physical problems. Understand generation, outline and need for the laser

Course Articulation Matrix row for this Course

Table	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	POP11	PO12
CO1	3	3	2	2	1	-	-	1	-	1	-	1
CO2	3	3	3	2	1	-	-	1	-	1	-	2
CO3	3	3	3	3	1	-	-	1	-	1	-	2
CO4	3	3	3	2	1	-	-	1	-	1	-	2
CO5	3	3	2	3	2	-	-	2	-	2	-	2

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	3	2	1	1	3	3	1	1

BASIC ELECTRICAL ENGINEERING (BEE 01001)

MODULE-I (8 HOURS)

D.C circuit analysis and network theorems: Concept of network, Active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements, source transformation, Kirchoff's Law: loop and nodal methods of analysis, star delta transformation, network theorems: Thevenin's theorem, Norton's theorem, maximum power transfer theorem. Transients, in R-L, R-C and R-L-C circuits with DC Excitation.

MODULE-II (8 HOURS)

Single phase and three phase ac circuit: Sinusoidal, square and triangular waveforms-average and effective value, form the peak factors, concept of phasors, phasors representation of sinusoidally varying voltage and current, analysis of series-parallel RLC circuits. Apparent, active and reactive powers, power factor, power factor improvement, resonance in series and parallel circuits, bandwidth and quality factors, star and delta connections, balanced supply and balanced load, line and phase voltage/current relation, three phase power measurements.

MODULE-III (8 HOURS)

Magnet circuit & principle of electromechanical energy conversion: Analogy between electric and magnetic circuit, magnetic circuits with DC and AC excitation, magnetic leakage, BH curve, hysteresis and eddy current losses, magnetic circuit calculation, mutual coupling. Principles of dc motor & generator, types, emf equation of DC machine, torque equation of motor, Speed control of dc motor. characteristics and applications of DC motors.

MODULE-IV (8 HOURS)

AC MACHINES: Single Phase Transformer: Principle of operation, construction, emf equation, equivalent circuit, power losses, efficiency, Introduction to auto transformers. Three Phase Induction Motor: Type, principle of operation, slip-torque Characteristics, applications. Single Phase Induction Motor: Principle of operation and introduction to methods of starting, applications. Three Phase Synchronous Machines: Principle of operation of alternator and synchronous motor, emf equation, voltage regulation, applications.

MODULE-V (7 HOURS)

Measurement Instruments & Introduction to Power System: Types of instruments: construction and working principle of PMMC and MI type voltmeter and ammeters, single phase dynamometer type wattmeter and induction type energy meter, use of shunts and multipliers: general layout of electrical power system and function of its elements, concept of grid, Introduction to power converters.

TEXT BOOKS

[1]. Edward Hughes (revised by Ian McKenzie Smith), "Electrical & Electronics Technology", Pearson Education Limited. Indian Reprint 2002, 10th Edition.
[2]. D.Kulshreshtha, "Basic Electrical Engineering" TMH, 1st Edition.

REFERENCE BOOKS

[1]. C.L. Wadhwa, "Electrical Engineering", New Age International Publishers, 2nd Edition.
[2]. S. Parker Smith, "Problems in Electrical Engineering", Asia Publications, 10th Edition.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement principles of DC network, theorems and transients.
CO2	Analyze the concept of Single phase and three phase AC circuits.
CO3	Express the concept of magnetic circuit and DC machines.
CO4	Apply basic principles of AC machines and their working.
CO5	Demonstrate basic principles of measuring instruments and power system.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ENGLISH FOR BUSINESS COMMUNICATION (BHU01001)

Course Description

The course is designed to give students a comprehensive view of communication, its scope and importance in business, and to build the proficiency needed to succeed in today's technologically enhanced workplace. Effective communication is an integral part of life. This course focuses on improving the LSRW skills, i.e. listening, speaking, reading and writing of the students. Students will learn how to communicate effectively though the prescribed syllabus followed by an intensive practice in the language lab. This integrated approach of theory and language lab sessions will help students to communicate clearly with an impact, by improving their verbal and non-verbal communication style, as well as enhancing their competency in grammar and pronunciation. This course further tries to conversant students with the correct practices and strategies in drafting effective business correspondence.

Syllabus

Module 1: Fundamentals of Communication (6 Hours)

- Process of Communication, Types of Communication (Verbal & Non Verbal)
- Channels of Business Communication
- Barriers to Communication.
- Plain English
- Bias free language
- Cross Cultural Communication

Module 2: Communicative Grammar (6 Hours)

- Time and Tense
- Aspects (Perfective & Progressive)
- Verbs of State and Event
- Passive and Active Voice
- Conditionals

Module 3: Sounds of English (06 Hours)

- The Speech Mechanism and Organs of Speech
- Consonant Sounds of English
- Vowel Sounds of English
- Stress Pattern: Syllable, Stress and Intonation.
- Problem sounds for Indian Speakers

Module 4: Business Writing (06 Hours)

- Paragraph writing
- Sentence Linker
- Business Letters
- Report Writing
- Proposal writing

Module 5: Professional Writing (06 Hours)

- Notice, Circular and Memo writing
- Agenda & Minute writing
- Writing Cover letter
- Résumé (CV) Writing

Reference Books

1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill)
2. Business Communication by Hory Sanker Mukerjee (Oxford University Press)
3. Better English Pronunciations by J. D.O Conner (Cambridge University Press)
4. A Communicative Grammar of English by G.N. Leech and Jan Svartik (OUP)
5. Business communication by Ramachandran, Lakshmi and Krishna (Macmillan)

Course Outcomes

Upon completion of the course the students will demonstrate the ability to:

CO1	Analyse various components of human communication and to identify key elements and principles of organizational communication.
CO2	Apply correct usage of English grammar in writing and speaking.
CO3	Evaluate students' ability to articulate English key sounds as well as its basic rhythm, stress and intonation patterns correctly.
CO4	Compile, plan and structure various forms of business writing in a professional manner.
CO5	Write various business documents appropriate for different business and employment situations.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	1	-	1	-	-	1	3	-	-
CO2	-	-	-	1	-	1	-	-	1	3	-	-
CO3	-	-	-	1	-	1	-	-	1	3	-	-
CO4	-	-	-	1	-	1	-	-	1	3	-	-
CO5	-	-	-	1	-	1	-	-	1	3	-	-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	-	-	-	-	-	-	-	-	1	3	1	-

ENGINEERING MECHANICS (BME 01001)

Course Contents

Module - I (8 Hours)

Concurrent forces on a plane: Composition, resolution and equilibrium of concurrent coplanar forces, method of moment.General case of forces on a plane: Composition and equilibrium of forces in a plane, plane trusses, method of joints and method of sections, plane frame, equilibrium of ideal systems.

Module-II (8 Hours)

Friction: Problems involving dry friction, Ladder, WedgesPrinciple of virtual work.

Module - III (8 Hours)

Parallel forces on a plane: General case of parallel forces, center of parallel forces and center of gravity, centroid of composite plane figure and curves, Theorems of Pappus.

Moments of inertia: Plane figure with respect to an axis in its plane and perpendicular to the plane, Polar moment of inertia, parallel axis theorem

Module – IV (8 Hours)

Rectilinear translation: Kinematics, principle of dynamics, D Alembert's Principle,

Principle of work and energy for a particle and a rigid body in plane motion, Conservation of energy, Principle of impulse and momentum for a particle and a rigid bodies in plane motion, Conservation of momentum, System of rigid bodies, Impact, direct and central impact, coefficient of restitution.

Module – V (8 Hours)

Curvilinear translation: Kinematics, equation of motion, projectile, D Alembert's principle of curvilinear motion. Kinematics of rotation of rigid body.

Text Book:

1. Engineering Mechanics: S Timoshenko & Young; 4th Edition (International edition) McGraw Hill.

Reference Books:

1. Fundamental of Engineering mechanics (2nd Edition): S Rajesekharan& G ShankaraSubramanium; Vikas Pub. House Pvt ltd.
2. Engineering mechanics: K. L. Kumar; Tata MC Graw Hill.

Upon completion of the subject the students will be able to:

CO1	Draw free body diagrams and determine the resultant of forces and/or moments.
CO2	Solve the problems involving dry friction.
CO3	Determine the centroid and second moment of area of sections.
CO4	Apply Newton's laws and conservation laws to elastic collisions and motion of rigid bodies.
CO5	Determine the various parameters in projectile motion.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	-	3	1	-	1
CO2	3	3	2	1	2	-	-	-	3	1	-	1
CO3	3	3	2	1	2	-	-	-	3	1	-	1
CO4	3	3	2	1	2	-	-	-	3	1	-	1
CO5	3	3	2	1	2	-	-	-	3	1	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	2	-	-	-	3	1	-	1

PHYSICS LABORATORY (BPH01002)

List of Experiments

1. Determination of acceleration due to gravity by using Bar pendulum
2. Determination of surface tension of water by capillary rise method
3. To draw the characteristics of a bipolar junction transistor
4. To determine the rigidity modulus of the material of a wire by using Barton's apparatus.
5. Determination of wave length of monochromatic light with the help of Newton's ring apparatus.
6. Determination of grating element of a diffraction grating using spectrometer.

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Express the idea of calculation of acceleration due to gravity at any place using the concept of oscillatory system and simple harmonic motion.
CO2	Demonstrate the working and operational technique to calculate the mechanical properties of fluid and other materials.
CO3	Evaluate the voltage, current, power and characteristics behaviour of the electronic devices.
CO4	Analyze the mechanical properties of any material with the idea of elasticity and its various applications.
CO5	Implement the measurement of different characteristic properties and related calculations of optical devices.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

BASIC ELECTRICAL ENGINEERING LABORATORY (BEE01002)

List of Experiments

1. Preliminary: Preparation of symbol chart for various systems & components as per ISS, to study the constructional & operational features for Voltmeter, Ammeter, Wattmeter, Frequency meter, multi-meter and Rheostat, Study of safety rules as per ISS
2. Measurement of the armature & field resistance of D.C. Machine by volt-amp method. & Starting and speed control of a D.C. shunt motor
3. Study of BH Curve
4. Determination of open circuit characteristics (O.C.C) of D.C shunt generator when separately excited at different speeds.
5. Measurement of earth resistance and insulation resistance.
6. Starting of Induction motor and measurement of three phase power & power factor by 2- wattmeter method.
7. Callibration of a single phase Energy Meter by directed loading & Phantom loading.
8. Obtaining the voltage, current, power and power factor of fluorescent lamp.
9. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
10. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Express the safety rules as per ISS and symbols of different electrical components and the use of various electrical instruments in laboratory.
CO2	Demonstrate the working and operational characteristics of dc motor and dc generator.
CO3	Evaluate the voltage, current, power and power factor of fluorescent lamp.
CO4	Implement the measurement of earth resistance and insulation resistance and demonstrate the internal structure of different machines.
CO5	Analyze the connection and calibration of single phase energy meter, three phase power and power factor by two wattmeter method and basic idea about converters.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

BUSINESS COMMUNICATION AND PRESENTATION SKILLS LAB (BHU 01002)

Course Description

Good communication skills are indispensable for the success of any professional. The English language, in particular, has become essential in the lives of young engineers who aspire to build their careers anywhere in the world. In this regard the language laboratory plays an important role in developing the students' basic proficiency in English. Since a large number of engineering students completed their education from vernacular medium schools, they lack the basic English language proficiency which is a detrimental factor during recruitment drives in engineering colleges. In this context the language laboratory is very helpful in practicing and assessing students' speech in different communication environments. It provides them facilities to learn pronunciation, accent, stress and rudimentary communicative English grammar along with various practice sessions like presentations, group discussions, debates, case studies which are the part and parcel of corporate life.

Syllabus (Assignments)

1. Functional English grammar: Practice and exercises
2. Practice of English phonemes
3. Reading comprehension
4. Drafting business correspondence
5. Understanding the importance of body language
6. Oral presentations (Self Introduction, Extempore, Formal Presentation, power point presentations etc.)
7. Group discussion
8. Preparation for appearing an interview
9. Situational conversation practice

Reference Books

1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill)
2. Business Communication by Hory Sanker Mukerjee (Oxford University Press)
3. Better English Pronunciations by J. D.O Conner (Cambridge University Press)
4. A Communicative Grammar of English by G.N. Leech and Jan Svartik (OUP)
5. Business communication by Ramachandran, Lakshmi and Krishna (Macmillan)

Course Outcomes

Upon completion of the sessional the students will demonstrate the ability to:

CO1	Analyse various components of effective human communication and to apply them during various practice sessions.
CO2	Apply correct usage of English grammar in writing and speaking.
CO3	Articulate English key sounds as well as its basic rhythm, stress and intonation patterns correctly.
CO4	Compile, plan and structure various forms of business writing in a professional manner.
CO5	Confidently face various recruitment drives and qualify them.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	1	3	-	-
CO2	-	-	-	-	-	1	-	-	1	3	-	-
CO3	-	-	-	-	-	1	-	-	1	3	-	-
CO4	-	-	-	-	-	1	-	-	1	3	-	-
CO5	-	-	-	-	-	1	-	-	1	3	-	-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	-	-	-	-	-	-	-	-	1	3	1	-

WORKSHOP & MANUFACTURING PRACTICES (BME01002)

Course content

1. **Carpentry Section**:

Study of different Hand tools, measuring instruments and equipments used in Carpentry work. Safety precautions.

Preparation of Job:

Wooden rack/bench/chair/stool (any one)

Includes the operations:

Measuring, Marking, Sawing, Planing, Chiseling, Mortesing, Tenoning, making Half-lap joint,
Mortese&Tenon joint and Nail joint.

2. **Fitting Section**:

Study of different Hand tools, measuring instruments and equipments used in Fitting work. Safety precautions. Study of Drilling Machine and Grinding Machine.

Preparation of Job:

Paper Wt. / Square or Rectangular joint (male-female joint) (any one)

Includes the operations:

Measuring, Marking, Filing, Sawing, Drilling, Tapping, Dieing and Punching.

3. **Black Smith Section**:

Study of different Hand tools, equipments, Open hearth furnace and Induction furnaces used in Blacksmith work. Different types of heat treatment processes. Safety precautions.

Preparation of Job:

Weeding hook/Hexagonal headed bolt/Chisel (any one)

Includes the operations:

Measuring, Marking, Cutting, Upsetting, Drawing down, Bending, Fullering and Quenching.

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Acquire knowledge on different types of hand tool, measuring instruments and machine tools are used in Fitting, Carpentry and Smithy work.
CO2	Know about different types of operations and joints performed in different shops i.e. in Fitting and Carpentry.
CO3	Know about the forging temperature of different types of ferrous metals and different types of operation (e.g. upsetting, edging, flattening and bending etc.) carried out on hot metals to prepare jobs.
CO4	Acquire skills for the preparation of different types of jobs Carpentry/fitting/smithy shops by using different types of hand tools and machine tools.
CO5	Understand the importance of safety precaution in different shops.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	2	2	1	1	3	1	2	1
CO2	-	-	1	-	2	2	1	1	3	1	2	1
CO3	-	-	-	-	1	2	1	2	3	1	2	1
CO4	-	-	-	-	3	2	1	1	3	1	2	1
CO5	-	-	-	-	-	-	-	1	2	1	1	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	1	-	2	2	1	1	3	1	2	1

2nd Semester

Mathematics-II (Differential Equations and Complex Variables) [3-1-0]

BMA 02001

Module 1: Differential Equations *(8 Lectures)*

Exact ODEs, integrating factors, linear ODEs, Bernoulli equation, homogeneous linear odes of second order, homogeneous linear ODEs with constant coefficients, Euler-Cauchy equations, non-homogeneous ODEs, Applications of ODEs to electric circuits

Module 2: Power Series Solution of Differential Equations *(8 Lectures)*

Series solution of differential equation (excluding Frobenius method), Legendre's equation, Legendrepolynomials. Bessel's Equation, properties of Bessel's functions, Bessel Functions of the first and Second Kind. ***Module 3:*** **Complex Variables** ***(8 Lectures)***

Complex valued function, differentiation, analytic function, Cauchy-Riemann equations, harmonic and conjugate harmonic functions, exponential function, trigonometric and hyperbolic functions, logarithm, general power

Module 4: Complex Variables *(8 Lectures)*

Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, power series, radius of convergence, Taylor and Maclaurin series, singularities and zeros, Laurent series, Cauchy residue theorem (statement only) and applications.

Module 5: Elementary Numerical Methods *(8 Lectures)*

Solution of algebraic and transcendental equations by Newton-Raphson and secant method.

Interpolation: Lagrange's method, divided difference method, Newton's forward and backward method. Numerical Integration: Trapezoidal and Simpson's Rule. Numerical solutions of differential equations: Euler's method and improved Euler's method.

Text Book:

1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9th edition.

Reference Books:

1) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press
2) Milton Abramowitz and Irene A. Stegun, *Handbook of Mathematical Functions*, National Bureau ofStandards, Applied Mathematics Series - 55
3) J. Sinha Roy and S. Padhy, Ordinary and Partial Differential Equation, Kalyani Publisher.
4) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Develop adequate knowledge of the effective mathematical tools for the solutions of differentialequations that models various physical processes
CO2	Describe power series solution of differential equations
CO3	Demonstrate analytic functions and applications of Cauchy-Riemann equations
CO4	Evaluate integration of complex valued functions, and apply Taylor and Laurent series expansionsof functions in various fields of engineering problems
CO5	Compute roots of algebraic and transcendental equations, and also evaluate the integralsby Trapezoidal and Simson's rules

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

Code: Subject: Chemistry Credits: 4 [3-1-0] (BCH 02001)

Module–I (9 Hours)

Schrodinger Wave equations (not to be derived), Application to particle in ID box.
Molecular rotational (microwave) spectroscopy: Basic principle and application to diatomic molecules, selection rules.
Molecular vibrational (IR) spectroscopy: Basic principle, types of vibrations and vibrational frequency, application to Harmonic and anharmonic oscillators, selection rules, modes of vibration.
Electronic (UV-Visible) spectroscopy: Basis principle, types of electronic transitions, The Franck - Condon principle, and Jablonski diagram.

Module – II (9 Hours)
Thermodynamics of Chemical Processes:

Concept of Entropy and free energy, Chemical Potential, Equilibrium Conditions.

Phase equilibria:

Phase, Components, Degree of Freedom, Phase Rule Equation.
Phase Diagrams: One Component Systems – Water and Sulphur, Basic idea of (a) Peritectic system, (b) Eutectoid system, (c) Binary phase diagrams of Pb-Ag & Fe-C system.

Module–III (9 Hours)
Electrochemistry:

Electrode Potentials and its Relevance to Oxidation and Reduction, Types of electrodes, Galvanic cell, Measurement of EMF and application of EMF measurements, Types of reference electrodes (Hydrogen, Glass, Quinhydrone Electrodes,) Determination of pH, Electrochemical energy systems its types (Dry Cells, lead acid cell and Fuel Cells: Construction, reaction, advantages and applications).

Corrosion: Concept, types of corrosion, dry or chemical and wet or Galvanic/electrochemical Corrosion, Factors affecting corrosion.

Module–IV (9 Hours)

Kinetics of complex Chemical Reactions: Reversible, Consecutive and Parallel Reactions, Steady State Approximation, Chain reaction.

Module-V (9 Hours)

Chemistry of engineering materials:

Nanomaterials: Applications of nanomaterials.
Organometallics: Application of organometallics
Books Recommended:
1) P. W. Atkins, Elements of Physical Chemistry, 4th Edition, Oxford University Press
2) C. N. Banwell and E. M. MacCash, Fundamentals of Molecular Spectroscopy, 5th Edition,
3) P. K. Kar, S. Dash and B. Mishra, B.Tech. Chemistry Vol. I, Kalyani Publications

Course Outcomes:

CO1: Apply the basic concept of classical mechanics and quantum chemistry to real life applications & to understand the basic concept of electromagnetic radiation, spectroscopic techniques and their applications.

CO2: Should perceive the spontaneity/feasibility of a process applying thermodynamics concepts and to keep up with the idea of phase equilibria, phase rule and its application to one and two component system.

CO3: Define the application of electrochemistry to commercial electrochemical cell and corrosion.

CO4: Able to apply the basic concept of kinetics of a reaction to complex reactions.

CO5: To demonstrate the properties and applications of organometallics and nanomaterials.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	-	1	-	-	1	1	1
CO2	3	3	1	-	-	-	1	-	-	1	1	1
CO3	3	3	1	-	-	-	1	-	-	1	1	1
CO4	3	3	1	-	-	-	1	-	-	1	1	1
CO4	3	3	1	-	-	-	1	-	-	1	1	1

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	1	-	-	-	1	-	-	1	1	1

BASIC ELECTRONICS (BEC 02001)

MODULE	CONTENT	HOURS
MODULE 1	Introduction to Electronics: - Signals, Frequency Spectrum of Signals, Analog and DigitalSignals, Linear Wave Shaping Circuits: - RC LPF, Integrator, RC HPF, Differentiator. Properties of Semiconductors: - Intrinsic, Extrinsic Semiconductors, Current Flow in Semiconductors, Diodes: - p-n junction theory, Current-Voltage characteristics, Analysis of Diode circuits, Rectifiers, Clippers, Clampers, Special diodes- LED, Photo diode, Zener Diode.	**12**
MODULE 2	Bipolar junction Transistor (BJTs):- Device Structure and Operation, Current-Voltage Characteristics, BJT as an Amplifier and as a Switch. Introduction to Power Amplifiers: - A,B and Ctypes. JFET:- Physical Structure, Operation and Characteristics	**10**
MODULE 3	Feedback Amplifiers: - General Feedback Structure, Properties of Negative Feedback, Four Basic Feedback Topologies (block diagram only), Practical feedback circuit. Operational Amplifiers (OP-AMPs): - The Ideal OP-AMP, Inverting Configuration, Non-Inverting Configuration. OP-AMP Applications (Adder, Subtractor, Integrator, Differentiator).	**08**
MODULE 4	Digital Fundamentals:- Binary Numbers, Signed-binary numbers, Decimal-to-Binary & Binary-to-Decimal Conversion, Binary Addition, Subtraction, Multiplication and Division, Hexadecimal Number Systems, Logic Gates, Boolean Algebra, De Morgan's Theorems, Laws of Boolean Algebra, RS Flip Flop	**06**
MODULE 5	Introduction to Electronic Instruments: - CRO: CRT, Waveform Display, Applications of CRO, Electronic Multimeter, Audio Signal Generator: - Block diagram, Front Panel Controls. Principles of Communication:- Fundamentals of AM & FM, Block diagram of Transmitters	**06**
TEXT BOOK	**1.** Microelectronics Circuits, A.S Sedra, K.C. Smith, Oxford UniversityPress. Selected portions from chapters 1 to 3, 5, 8,13. **2.** Electronics Fundamentals and Applications, D Chattopadhyay and P.C. Rakshit, New Age International Publications. Selected portions fromchapters 4 to 12, 14, 16 to 18,20,21.	
REFERENCE BOOK	1. Integrated Electronics, Millman and Halkias, TMHPublications. 2. Electronic Devices & Circuit Theory, R.L Boylestad and L.Nashelsky, PearsonEducation.	

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement different types of signals and its application to semiconductor devices and circuits.
CO2	Analyze the concept of different BJTs and its operation.
CO3	Express the concept of the Feedback Amplifiers and Operational Amplifiers.
CO4	Apply fundamentals of different Digital arithmetic operations and Digital circuits.
CO5	Demonstrate basic principles of important Electronic Instruments and Communication systems.

Relationship of Course Outcomes (CO) to Program Outcomes (PO) 1 – Low 2 – Moderate 3 – High												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	2	-	-	-	-	1
CO2	3	2	2	3	2	1	1	-	-	-	-	1
CO3	3	2	3	3	2	1	2	-	-	-	-	1
CO4	3	3	3	3	3	1	1	-	-	-	-	1
CO5	3	3	3	3	2	1	3	-	-	-	-	1

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	2	3	3	2	1	2	-	-	-	-	1

PROGRAMMING FOR PROBLEM SOLVING (BIT 02001)

L-T-P: 3-0-0 **Cr.-3**

Module I: **(8 Lectures)**

Introduction to computing- Block architecture of a computer, fundamental units of storage: bit, bytes, nibbles, word size. Introduction to problem solving- Basic concepts of an algorithm, program design methods, flowcharts. Level of programming Languages, structure of C program, Compiling and Executing C program

Module II: **(8 Lectures)**

C Language Fundamentals- Character set, Identifiers, Keywords, Data Types, Constant and Variables, Statements. Input &Output - Input & Output Assignments, Formatted Outputs. Operators and Expressions-Operators, Precedence of operators. Decision Control Structure, Loop Control Structure and Case Control Structure.

Module III: **(8 Lectures)**

Functions: Monolithic vs Modular programs, User defined vs standard functions, formal vs Actual arguments, Functions category, function prototypes, parameter passing, Recursion.Arrays1D Array, 2D Array & Multi-Dimensional Array. Strings- Declaration & Initialization, String Handling Functions.

Module IV: **(8 Lectures)**

Pointer variable and its importance, Pointer Arithmetic, Passing parameters, pointer to pointer, pointer to function. Dynamic Memory Allocation. Structure, Nested Structure, Array of Structures, Pointer to Structure, Structure & Functions, Union, Array of Union Variables, Union inside Structure, Bit Fields. Storage Class.

Module V: **(8 Lectures)**

Preprocessor Directives- Types, Pragma Directives, Conditional Directives. typedef, Enumerated Data Type. Files- Reading data from Files, Reading data from Files, Writing data to Files, Error Handling during File Operations. Advanced Issues in Input & Output – using argc&argv.

Text Books:

1. Programming in ANSI C, E Balaguruswamy
2. Computer Fundamentals &Programming in C: ReemaThareja, Oxford University Press.

Reference Books:

1. Let us C- Y.Kanetkar, BPB Publications.
2. Programming with ANSI and Turbo C- Kamthane, A.N. Pearson Education
3. C How to Program- Deitel and Deitel, Pearson Education.
4. The C Programming Language- Brian W. Kernighan and Dennis M. Ritchie, PrenticeHall.

Course Outcomes:
Upon completion of the subject the students will demonstrate the ability to:

1. grasp the fundamentals of Computer and problem solving.
2. conceptualize fundamentals of C Programming along with control structures.
3. Implement different problems on functions and arrays.
4. Apply pointers structures and unions for problem solving.
5. Gain knowledge of pre-processor directives and file operations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	-	2	-	-	3
CO2	3	3	3	3	2	-	-	-	2	-	-	3
CO3	3	3	3	3	2	-	-	-	2	-	-	3
CO4	3	3	3	3	2	-	-	-	2	-	-	3
CO5	3	3	3	3	2	-	-	-	2	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	-	-	-	2	-	-	3

Basic of Civil Engineering BCE 02001

Module-II

Introduction to Civil Engineering – Various disciplines of Civil engineering, Importance of Civil engineering in infrastructure development of the country.

Introduction to types of buildings as per NBC, Selection of site for buildings, Components of a residential building and their functions, Introduction to Industrial buildings and types.

Building Planning – Basic requirements, elements, introduction to various building area terms, computation of plinth area, carpet area.

Module-II

Surveying – Principle and objectives, Instruments used, Horizontal measurements, Ranging (direct ranging only), Instruments used for ranging, Leveling – Definition, Principles, Instruments, Preparation of level book, problems on leveling, Modern surveying instruments – EDM, Total station, GPS (Brief discussion)

Building Materials – Bricks, properties and specifications, Cement – Types, properties, grades, other types of cement and uses, Cement mortar – Constituents, Preparation, Concrete – PCC and RCC, Grades, Steel – Use of steel in buildings, types.

Module-III

Building Construction – Foundations, Classification, Bearing Capacity of Soil and related terms (definition only), Masonry Works – classifications, definition of different technical terms, Brick masonry – types, bonds, general principle, Roofs – functional requirements, basic technical terms, roof covering material, Floors – function, types, flooring materials(brief discussion), Plastering and Painting – objectives, types, preparation and procedure of application.

Module-IV

Basic Infrastructure services – air conditioning & purpose, fire protection & materials, Ventilation, necessity & functional requirements, Lifts, Escalators.

Introduction to planning and design aspects of transportation engineering, Transportation modes, Highway engineering – historical development, highway planning, classification of highway, Railway Engineering – cross section of rail track, basic terminology, geometric design parameter(brief discussion only).

Module-V

Airport engineering – development, types, definition, characteristics of aircraft, basic terminology, Traffic engineering – traffic characteristics, traffic studies, traffic operations (signals, signs, markings), Urban engineering – classification of urban road.

Irrigation & Water Supply Engineering – Introduction, Types of Irrigation, different types of hydraulic structures, dam and weirs, types of dam, purpose and functions.

Text Books:

- Basic Civil engineering, Gopi, S., Pearson Publication
- Basic Civil Engineering, Bhavikatti, S. S., New Age.

Reference Books:

- Construction Technology, Chudley, R., Longman Group, England
- Basic Civil and Environmental Engineering, C.P. Kausik, New Age.
- American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application

Course Outcomes:

- Analyze the fundamental aspect of building planning.
- Summarize general aspect of building material and surveying.
- Explain about building constructions.
- Judge transportation modes and planning.
- Describe about Airport & Irrigation Structures.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**1**	**3**	**1**	**1**	**-**						
CO2	**3**	**2**	**1**	**1**	**1**							
CO3	**2**	**1**			**3**							
CO4	**3**	**2**	**1**	**2**	**1**	**3**						
CO5	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**1**	**2**	**2**	**2**	**3**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	2	2	2	1	2	3	1	2	2	2	3

B Tech Chemistry Lab: (BCH 02002)

List of Experiments to be done (Any ten Experiments)

1. Determination of amount of sodium hydroxide and sodium carbonate in a Mixture.
2. Determination of Total hardness of water by EDTA method.
3. Estimation of calcium present in the limestone.
4. Standardization of KMnO4 using sodium oxalate.
5. Determination of ferrous iron in Mohr's salt by potassium permanganate.
6. Determination of Rate constant of acid catalyzed hydrolysis of ester.
7. Determination of dissolved oxygen in a sample of water.
8. Conductometric titration of strong acid and strong base
9. Determination of Viscosity of lubricating oil by red wood Viscometer.
10. Determination of Flash point of given oil by Pensky Marten's Flash Point Apparatus.
11. Determination of available chlorine in bleaching powder.
12. Preparation of acidic and basic buffer solution and measurement of PH using PH meter

Book Recommended:

B. Tech Practical Chemistry- .

Course Outcomes:

CO1: Develop knowledge of concepts and applications of chemistry, important laboratory analytical techniques, and instrumentation.

CO2: Apply fundamental principles for environmental analytical methods.
CO3: Identify suitable analytical techniques for analysing a specific compound in a sample and ensure quality control.
CO4: Implement suitable techniques for sampling and handling of environmental and chemical samples.
CO5: Hands on training on using different laboratory apparatus and equipments including data analysis and conclusions.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	-	1	-	2	-	1	-	1	-
CO2	3	1	2	-	1	-	2	-	1	-	1	-
CO3	3	1	2	-	1	-	2	-	1	-	1	-
CO4	3	1	2	-	1	-	2	-	1	-	1	-
CO4	3	1	2	-	1	-	2	-	1	-	1	-

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1-	PO11	PO12
CO	3	1	2	-	1	-	2	-	1	-	1	-

BASIC ELECTRONICS LAB (BEC 02002)

Experiment No.	CONTENT
1	Familiarity with electronic components and devices(Testing of semiconductor diode, Transistor, IC Pins connection) Digital Multimeter should be used.
2	Study and use of CRO to view waveforms and measure its Amplitude and Frequency.
3	Frequency response of LPF and HPF.
4	V-I Characteristics of a Semiconductor Diode. Determining DC and AC resistance.
5	Clipper Circuit.
6	Clamper Circuit.
7	Half Wave and Full Wave Rectifier without Capacitor filter. Record of Waveforms, Measurement of Average and RMS value.
8	V-I (Output) Characteristics of N-P-N/P-N-P Transistor in CE Configuration.
9	OP-AMP: Inverting and Non-Inverting Configuration. Record of Waveforms.
10	Verification of Truth table of Logic gates (AND, OR,NOT, NAND, NOR, EX-OR)
SUPPLEMENTARY BOOK	1. Integrated Electronics, Millman and Halkias, TMHPublications. 2. Electronic Devices & Circuit Theory, R.L Boylestad andL. Nashelsky, PearsonEducation.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement Acquire basic knowledge on electronic devices and components
CO2	Analyze different electronics circuits using semiconductor diodes.
CO3	Analyze and develop the characteristics of BJT and FET Circuits.
CO4	Apply fundamentals Operational amplifier circuits.
CO5	Implement knowledge on basic digital logic gates

Relationship of Course Outcomes (CO) to Program Outcomes (PO)

1 – Low 2 – Moderate 3 – High

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	2	-	-	-	-	1
CO2	3	2	2	3	2	1	1	-	-	-	-	1
CO3	3	2	3	3	2	1	2	-	-	-	-	1
CO4	3	3	3	3	3	1	1	-	-	-	-	1
CO5	3	3	3	3	2	1	3	-	-	-	-	1

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	3	2	1	2	-	-	-	-	1

PROGRAMMING FOR PROBLEM SOLVING LAB (BIT 02002)

L-T-P: 0-0-3 **Cr.-1.5**

Topics to be covered:

1. Programs using Input – Output functions.
2. Programs on variable declaration, assignments, operators and typecasting.
3. Program on selection & iterative constructs.
4. Programs on functions.
5. Programs on arrays.
6. Programs on string manipulation.
7. Programs on pointers.
8. Programs on structure & union.
9. Programs on file handling.
10. A mini-project to be designed by students using features of C.

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1: Implement the basicsof C programming.

CO 2: Exercise conditional and iterative statements to develop programs.

CO 3: Exercise user defined functions to solve real time problems.

CO 4: Demonstrate the concept of pointers to access arrays, strings and functions.

CO 5: Create C programs on file manipulations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	2	3	-	-	3
CO2	3	3	3	3	2	-	-	2	3	-	-	3
CO3	3	3	3	3	2	-	-	2	3	-	-	3
CO4	3	3	3	3	2	-	-	2	3	-	-	3
CO5	3	3	3	3	2	-	-	2	3	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	-	-	2	3	-	-	3

Engineering Graphics & Design (BCE02002)

Course Content

Module-I

Introduction to Engineering Drawing: Drawing instruments, lines, lettering and dimensioning. Scales: Plain, Diagonal and Vernier Scales.

Module-II

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute.

Module-III

Orthographic Projections: Concepts, Orthographic projections of points, Lines, Planes and Solids. Sections of solids; Development of surfaces

Module-IV

Isometric Projections: Principles, Isometric Scale, Isometric Views, Isometric Views of lines, Planes, Simpleand compound Solids.

Module-V

Introduction to Auto-Cad:

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute

Reference Books:

1 Engineering drawing by N.D. Bhatt and V.M Panchal, Charotar Publishing House, Anand.
Engineering Drawing by Venugopal, New Age publisher.

Course Outcomes:

1. Revise basics of engineering drawings and curves.
2. Use Orthographic projections of Lines, Planes, and Solids.
3. Apply Sectioning of various Solids and their representation.
4. Change Pictorial views to Orthographic Projections
5. Construct Isometric Scale, Isometric Projections and Views.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**1**	**3**	**1**	**1**							
CO2	**3**	**2**	**1**	**1**	**1**							
CO3	**2**	**1**			**2**							
CO4	**3**	**2**	**1**	**2**	**1**	**1**						
CO5	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**1**	**2**	**2**	**2**	**2**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	**3**	**2**	2	2	**1**	**1**	**3**	**1**	**2**	**2**	**2**	**2**

3RD SEMESTER

MATHEMATICS-III (BMA 03001)

(Transforms, Probability and Statistics and Multivariate Analysis) [3-1-0]

Module 1: **Laplace Transforms** ***(10 Lectures)***

Laplace transforms, inverse transforms, linearity, shifting, transforms of derivatives and integrals, solution of ODEs, unit step function, Dirac's delta function, differentiation and integration of transforms, convolution, integral equations.

Module 2: **Fourier Transforms** ***(8 Lectures)***

Basic concept of Fourier integral, Fourier sine and cosine integral, condition of convergence, Fouriertransformation, Fourier sine transform, Fourier cosine transform, properties.

Module 3: **Probability** ***(6 Lectures)***

Random variables, probability distributions, mean and variance, Binomial, Poisson and hyper-geometric distributions, Normal distribution.

Module 4: **Statistics** ***(8 Lectures)***

Random sampling, point estimation of parameters, maximum likelihood estimation, confidence intervals, testing of hypotheses for mean and variance, correlation and regression.

Module 5: **Multi-variate Analysis** ***(8 Lectures)***

Line integrals, double integrals, change of order, Green's theorem (statements only), surface integrals, triple integrals, Divergence theorem of Gauss (statements only), Stoke's theorem (statements only) and applications.

Text Book:

Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9th edition

Reference Books:

1) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
2) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Develop adequate knowledge of Laplace and Fourier transforms, and apply this idea to solve differential equations
CO2	Describe unit step function and Dirac's delta function which are useful in engineering problems
CO3	Apply Binomial, Poisson and Normal distributions in probabilistic models
CO4	Demonstrate random sampling and estimation of parameters
CO5	Evaluate multiple integrals and with various applications

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

ELECTRICAL MACHINES-I

SYLLABUS

Module-I (10 hours)

Transformers: Review of magnetic circuits. Single phase transformer: Constructional details, Core, windings, Insulation, principle of operation, emf equation, magnetizing current and core losses, no load and on load operation, Phasor diagram, equivalent circuit, losses and efficiency, condition for maximum efficiency, voltage regulation, approximate expression for voltage regulation, open circuit and short circuit tests, Sumpner'stest.Autotransformers.

Module-II (8 hours)

Electromechanical Energy conversion: Forces and torque in magnetic field systems – energy balance, energy and force in a singly excited magnetic field system, determination of magnetic force, energy; multi-excited magnetic field systems.

Basic concepts of DC Machines: Principle of operation, Action of commutator, constructional features, armature windings, lap and wave windings, simplex and multiplex windings, use of laminated armature, E.M.F. Equation,Armature reaction: Cross magnetizing and demagnetizing AT/pole, compensating winding, commutation, reactance voltage, methods of improving commutation.

Module-III (4 hours)

DC Generators –Methods of Excitation: separately excited and self excited generators, build up of E.M.F., critical field resistance and critical speed, causes for failure to self excite and remedial measures, Load characteristics of shunt, series and compound generators, parallel operation of DC generators, use of equalizer bar and cross connection of field windings, load sharing.

Module-IV (10 hours)

DC Motors: Principle of operation, Back E.M.F., Torque equation, characteristics and application of shunt, series and compound motors, Armature reaction and commutation, Starting of DC motor,

Principle of operation of 3 point and 4 point starters, drum controller, Constant & Variable losses, calculation of efficiency, condition for maximum efficiency.
Speed control of DC Motors: Armature voltage and field flux control methods, Ward Leonard method.
Methods of Testing: direct, indirect and regenerative testing, brake test, Swinburne's test, Load test, Hopkinson's test, Field's test, Retardation test, separation of stray losses in a DC motor test.

Module-V (7 hours)

Three phase Transformers: Constructional features of three phase transformers – three phase connection of transformers (Dd0, Dd6, Yy0, Yy6, Dy1, Dy11, Yd1, Yd11, zigzag), Scott connection, open delta connection, three phase to six phase connection, oscillating neutral, tertiary winding, three winding transformer, equal and unequal turns ratio, parallel operation, load sharing.Inrush of switching currents, harmonics in single phase transformers, magnetizing current wave form.

Text Books:

[1]. J. Nagrath, D. P. Kothari, "Electric Machines", TMH Publishers.
[2]. A. E. Clayton, N. Hancock, "Performance and Design of D.C Machines", BPB Publishers

Reference Books:

[1]. A. E. Fritzgerald, C. Kingsley, and S. Umans, "Electric Machinery", TMH Publisher.
[2]. P.S. Bhimra, Electrical Machinery (Part 1, Part 2), Khanna Publishers.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe and analyze the performance of single phase transformers.
CO2	Apply knowledge on the basic concepts of electromagnetic energy conversion and dc machines.
CO3	Express and analyze the performance of DC generators.
CO4	Describe and analyze the performance of DC motors.
CO5	Define and analyze the performance of three phase transformers.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

NETWORK THEORY (BEE03002)

MODULE-I (9 HOURS)

Analysis of Coupled Circuits: Self-inductance and Mutual inductance, Coefficient of coupling, Series connection of coupled circuits, Dot convention, Ideal Transformer, Analysis of multi-winding coupled circuits, Analysis of single tuned and double tuned coupled circuits.

Transient Response: Transient study in series RL, RC, and RLC networks by time domain and Laplace transform method with DC and AC excitation. Response to step, impulse and ramp inputs of series RL, RC and RLC circuit.

MODULE-II (7 HOURS)

Two Port networks: Types of port Network, short circuit admittance parameter, open circuit impedance parameters, Transmission parameters, Condition of Reciprocity and Symmetry in two port network, Inter-relationship between parameters, Input and Output Impedances in terms of two port parameters, Image impedances in terms of ABCD parameters, Ideal two port devices, ideal transformer. Tee and Pie circuit representation, Cascade and Parallel Connections.

MODULE-III (8 HOURS)

Network Functions & Responses: Concept of complex frequency, driving point and transfer functions for one port and two port network, poles & zeros of network functions, Restriction on Pole and Zero locations of network function, Time domain behavior and stability from pole-zero plot, Time domain response from pole zero plot.

Three Phase Circuits: Analysis of unbalanced loads, Neutral shift, Symmetrical components, Analysis of unbalanced system, power in terms of symmetrical components.

MODULE-IV (9 HOURS)

Network Synthesis: Realizability concept, Hurwitz property, positive realness, properties of positive real functions, Synthesis of R-L, R-C and L-C driving point functions, Foster and Cauer forms.

MODULE-V (6 HOURS)

Graph theory: Introduction, Linear graph of a network, Tie-set and cut-set schedule, incidence matrix, Analysis of resistive network using cut-set and tie-set, Dual of a network.

Filters: Classification of filters, Characteristics of ideal filters.

TEXT BOOKS

[1]. A. Chakrabarti, “Circuit Theory (Analysis and Synthesis)”, Dhanpat Rai Publications.

[2]. Mac.E Van Valkenburg, “Network Analysis”, PHI Learning publishers.

[3]. Franklin Fa-Kun. Kuo, “Network Analysis & Synthesis”, John Wiley & Sons.

REFERENCE BOOKS

[1]. M. L. Soni, J. C. Gupta, “A Course in Electrical Circuits and Analysis”, Dhanpat Rai Publications.

[2]. Mac.E Van Valkenburg, “Network Synthesis”, PHI Learning publishers.

[3]. Joseph A. Edminister, Mahmood Maqvi, “Theory and Problems of Electric Circuits”, Schaum's Outline Series, TMH publishers.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1	Analyze coupled circuits and understand the difference between the steady state and transient response of 1st and 2nd order circuit and understand the concept of time constant.
CO2	Define the different parameters of two port network.
CO3	Concept of network function and three phases circuit and know the difference of balanced and unbalanced system and importance of complex power and its components.
CO4	Synthesis the electrical network.
CO5	Analyze the network using graph theory and understand the importance of filters in electrical system.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

INSTRUMENTATION AND SENSORS (BEE03003)

Syllabus:

Module-I (8 Hours)

Measuring Instruments: Classification, Absolute and secondary instruments, indicating instruments, deflecting, control and damping torques, Ammeters and Voltmeters, PMMC, Moving Iron (MI) type, expression for the deflecting torque and control torque, extension of range using shunts and series resistance. Electrostatic Voltmeters-electrometer type and attracted disc type, extension of range of E.S. Voltmeters.

Module-II (8 Hours)

Electrodynamometer type wattmeter – Theory & its errors – Methods of correction – LPF wattmeter – Phantom loading – Induction type KWH meter – Calibration of wattmeter, energy meter. Measurement of active and reactive powers in balanced and unbalanced systems.

Galvanometers: General principle and performance equations of D'Arsonval Galvanometers, Vibration Galvanometer and Ballistic Galvanometer.

Module-III (8 Hours)

DC/AC Bridges: General equations for bridge balance, measurement of self-inductance by Maxwell's bridge (with variable inductance & variable capacitance), Hay's bridge, Owen's bridge, measurement of capacitance by Schearing bridge, errors, Wagner's earthing device.

Method of measuring low, medium and high resistance: Kelvin's double bridge for measuring low resistance, Wheat-stone's bridge, measurement of high resistance – loss of charge method.

Module-IV (8 Hours)

Instrument Transformers: Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minimizing errors.

Potentiometers: DC Potentiometer, Crompton potentiometer, construction, standardization, application. AC Potentiometer, Drysdale polar potentiometer; standardization, application.

Module-V (7 Hours)

Digital Multi-meter: Block diagram, principle of operation, Accuracy of measurement, Electronic Voltmeter: Transistor Voltmeter, Block diagram, principle of operation, various types of electronic voltmeter, Digital Frequency meter: Block diagram, principle of operation

Definition of transducers, Classification of transducers, Advantages of Electrical transducers, Characteristics and choice of transducers; Principle operation of LVDT and capacitor transducers; LVDT Applications, Strain gauge and its principle of operation, gauge factor.

TEXT Books

[1]. A K. Sawhney, "A Course in Electrical & Electronics Measurements & Instrumentation", Dhanpat Rai Publications.

[2]. Helfrick& Cooper, "Modern Electronic Instrumentation and Measurement Techniques",PHIPublshers.

REFERENCE BOOKS

[3]. Larry Jones &A Foster Chin, "Electronic Measurement & Instrumentation Systems", John Wiley & Son Publishers.

[4]. Golding &Waddis, "Electrical Measurement and Measuring Instruments",Reem Publishers.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1	Describe the principles of basic electrical measuring instruments.
CO2	Define and apply knowledge on the operation of wattmeter, energy meter and galvanometers.
CO3	Define and analyze the working of different ac and dc bridges
CO4	Describe the operation of instrument transformers and potentiometers
CO5	Describe the operation of electronic measuring instruments and transducers

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ORGANIZATIONAL BEHAVIOUR (BHU03001)

Objectives:

1. To develop an understanding of the behavior of individuals and groups inside organizations

2. To enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.

3. To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Unit Contents Class Hours

Unit 01 Fundamentals of OB: Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), behavioristic and social cognitive), Limitations of OB.

Unit 02 Attitude: Importance of attitude in an organization, Right Attitude, Components of attitude, Relationship between behavior and attitude, Developing Emotional intelligence at the workplace, Job attitude, Barriers to changing attitudes.

Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications.

Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Attribution theory, Perceptual process, Social perception (stereotyping and halo effect).

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy, Aldefer ERG theory& Herzberg's Two Factor model Theory).

Unit 03 Foundations of Group Behavior: The Meaning of Group & Group behavior & Group Dynamics, Types of Groups, The Five – Stage Model of Group Development. Managing Teams: Why Work Teams, Work Teams in Organization, Developing Work Teams, Team Effectiveness & Team Building. Leadership: Concept of Leadership, Styles of Leadership, Trait Approach Contingency Leadership Approach, Contemporary leadership, Meaning and significance of contemporary leadership, Concept of transformations leadership, Contemporary theories of leadership, Success stories of today's Global and Indian leaders.

Unit 04 Organizational Culture : Meaning & Definition of Organizational Culture, creating & Sustaining Organizational Culture, Types of Culture (Strong vs. Weak Culture, Soft Vs. Hard Culture & Formal vs. Informal Culture), Creating Positive Organizational Culture, Concept of Workplace Spirituality.

Unit 05 Organizational Change: Meaning, Definition & Nature of Organizational Change, Types of Organizational Change, Forces that acts as stimulants to change. Implementing Organizational Change : How to overcome the Resistance to Change, Approaches to managing Organizational Change, Kurt Lewin's-Three step model, Seven Stage model of Change &Kotter's Eight-Step plan for Implementing Change, Leading the Change Process, Facilitating Change, Dealing with Individual & Group Resistance, Intervention Strategies for Facilitating Organizational Change, Methods of Implementing Organizational Change, Developing a Learning Organization.

Reference Books

1. Understanding Organizational Behaviour, Parek, Oxford

2. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.

3. Organizational Behaviour, K. Awathappa,HPH.

4. Organizational Behaviour, VSP Rao, Excel

5. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.

6. Organizational Behaviour, Hitt, Miller, Colella, Wiley

Sessionals

NETWORK THEORY LABORATORY (BEE03005)

Course Objectives:-

- *To gain knowledge for solving linear circuits using network theorems.*
- *To understand resonant circuit by understanding its basic properties and find the bandwidth, Q-factor and resonance frequency of a R-L-C series circuit.*
- *To get knowledge on the Transient response of R-L, R-C and R-L-C circuits using DC excitation.*
- *To comprehend ABCD, Z, Y and h parameters of a two port network and know the property of symmetry and reciprocity of network.*
- *To analyze the spectral analysis of non-sinusoidal waveform.*

List of Experiments:

1. Verification of Superposition and Thevenin's Theorem.
2. Verification of Maximum Power Transfer Theorem.
3. Find out the band width, Q-factor and resonance frequency of a R-L-C series circuit.
4. Transient response of a D.C. R-L, R-C and R-L-C circuit.
5. Determination of ABCD, Z,Y and h parameters of a two port network.
6. Spectral Analysis of a non-sinusoidal waveform.

Course Outcomes:

Upon successful completion of this course, students should be able to

CO1	Implement the linear circuits by using network theorems.
CO2	Describe the resonant circuit by understanding its basic properties and find the bandwidth, Q-factor and resonance frequency of a R-L-C series circuit.
CO3	Describe and evaluate the Transient response of R-L, R-C and R-L-C circuits using DC excitation.
CO4	Define ABCD, Z, Y and h parameters of a two port network and know the property of symmetry and reciprocity of network.
CO5	Define and analyze the importance and reason that lead to a non-sinusoidal waveform.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

ELECTRICAL CIRCUIT COMPUTATION LABORATORY (BEE03006)

List of Experiments:

1. Power measurement of AC system using MATLAB:
2. Time response of a first/ second order system using Laplace Transform.
3. Numerical analysis: Non-linear equations and optimization, Differential equations
4. Series & parallel resonance circuit simulation.
5. Simulation of Half wave diode bridge rectifier circuit.
6. Simulation of Full wave diode bridge rectifier circuit.
7. DC analysis for R-L, R-C and R-L-C circuits using MATLAB.
8. AC analysis for R-L, R-C and R-L-C circuits using MATLAB.

Course Outcomes:

After completion of this laboratory course the students will be able to

CO1	Describe the MATLAB software and its application in DC, single phase and three phase electric circuit to analyze.
CO2	Recognize for solving other electrical problems using the software.
CO3	The students can interpret and summarize from the response the type of the system.
CO4	Discover how to apply the different numerical techniques for analysis of electrical systems and its implementation with MATLAB.
CO5	Design circuit simulation in different ways by both programming and Simulink blocks in MATLAB.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

ELECTRICAL MACHINES-I LABORATORY (BEE03004)

LIST OF EXPERIMENTS

1. Open circuit and short circuit on single phase transformer
2. Parallel operation of two single phase transformer and load sharing
3. Back –to-back test of Single phase transformer
4. Load characteristics of DC shunt/compound generator
5. Load characteristics of DC series Motor
6. Swinburne test and brake test of DC shunt machine

Course Outcomes:

Upon successful completion of this course, students should be able to:

CO1	Perform parallel connection of single phase transformers
CO2	Evaluate performance of DC series and shunt motors.
CO3	Compute the efficiency of transformer by different experimental tests.
CO4	Perform tests to evaluate performance of DC machine and transformers.
CO5	Estimate load performance of DC series motor

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

INSTRUMENTATION LABORATORY (BEE03007)

List of Experiments

1. Study the role of various sensors and actuators in measuring physical / electrical parameters or variables and able to distinguish between conventional and smart sensors.
2. Study of a linear system simulator and learn about linear approximations of a non-linear functions or a system.
3. Measurement of unknown resistance, inductance and capacitance using bridges and its realizations using breadboard or using NI cRIO platforms.
4. To plot the displacement- voltage characteristics of the LVDT.
5. Study and plot the characteristics of different temperature sensors/ transducers namely RTD, Thermistor and Thermocouples and its calibration with soft temperature sensors using LM 34/35 or AD 220.

Course Outcomes:

Upon completion of the course, students will be able to:

CO1	Express the basic principles and design requirements of smart / modern measurement schemes.
CO2	Design necessary signal conditioning circuits for the measurement of resistance, inductance and capacitance.
CO3	Define the principles of operations of displacement measurement using inductive method.
CO4	Describe the linear system simulation and linear approximation.
CO5	Describe the principles of operations of temperature sensors.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

Fourth Semester

ELECTRICAL MACHINES-II (BEE04001)

Syllabus

Module-I (8 hours)

Three phase synchronous generators: Principle and construction, relation between speed & frequency, three-phase windings, winding factors, EMF equation, Harmonic EMFs.

Cylindrical rotor theory: armature reaction, armature reaction reactance, synchronous reactance, phasor diagram, open & short circuit characteristics, short-circuit ratio, load characteristics.

Module-II (8 hours)

Voltage regulation, EMF method, MMF method, modified MMF method, ZPF method, Theory of salient pole machine: Blondel's two reaction theory, phasor diagram, direct and quadrature axis synchronous reactances, Slip Test. Power Angle characteristics. Synchronizing coefficient.

Module-III (8 hours)

Parallel operation: Synchronizing method, effect of wrong synchronization, load sharing between alternators in parallel. Sudden Short Circuit of a Synchronous Generator, Transient and Sub-transient reactances.

Synchronous Motors: Operating principle, torque-angle characteristics in non-salient pole and salient pole motors, Effect of change of excitation, V-curves & inverted V-curves, power factor correction applications. Hunting.

Module-IV (8 hours)

Three Phase Induction Motors: Types, Construction and principle of operation. Torque-slip characteristics, condition for maximum torque, effect of rotor resistance, stable & unstable region of operation. Losses and efficiency. Equivalent circuit, phasor diagram, circle diagram and performance equations. Operation with unbalanced supply voltage. Methods of starting (DOL, stator resistance starter, autotransformer starter, star-delta starter, rotor resistance starter). Methods of speed control. Double cage induction motor, Cogging and Crawling of Induction motor.

Module-V (7 hours)

Induction Generator: types, principles and applications.

Single phase induction motor: theory of operation (Double revolving field theory, equivalent circuit, Determination of parameters). Methods of starting: split phase starting, Repulsion starting, shaded pole starting, performance characteristics.

Single phase series motor, theory of operation performance and application. Universal motor.

Text Books:

[1]. J. Nagrath, D. P. Kothari, "Electric Machines", TMH Publishers.

[2]. M. G. Say, "Performance and design of AC machines", CBS Publishers.

Reference Books:

[1]. A. E. Fritzgerald, C. Kingsley, and S. Umans, "Electric Machinery", TMH Publisher.

[2]. P.S. Bhimra, Electrical Machinery (Part 1, Part 2), Khanna Publishers.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe fundamental principles and classification of synchronous machines.
CO2	Evaluate voltage regulation and analyze power angle equation.
CO3	Analyze and evaluate the performance characteristics of synchronous motors.
CO4	Describe and evaluate the performance of three phase induction motors.
CO5	Analyze and evaluate the performance of single phase motors.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ELECTRIC POWER GENERATION SYSTEMS (BEE04002)

Syllabus

Module-I (8 hours)

Introduction: Sources of energy, general discussion on their application to generation and current share in India and World, concept of sustainable energy.

Hydro Power: Hydrology: catchment area, hydrograph, flow duration curve, estimation of power potential. Classification of hydro power plants. Hydro plant components: dams, spillway, head race, surge tank, penstock, scroll casing, draft tube and tail race. Hydraulic Turbines: specific speed, operational principle of Kaplan, Francis and Pelton turbines.

Module-II (8 hours)

Thermal Power: Coal resource: relationship between MW capacity and fuel consumption. Overall plant components in block diagrams indicating air circuit, coal and ash circuit, water and steam circuit, cooling water circuit. Coal and ash handling systems; boilers, superheater, reheater, economizer, air preheater, dust collection, draught fans and chimney; condensers and cooling towers, feed water heaters, makeup water treatment. Steam turbines.

Module-III (7 hours)

Nuclear Power: Relationship between MW capacity and fuel consumption. Reactor classification. Reactor schematic and components. Boiling water reactors, pressurized water reactors, fast breeder reactors. Heavy water reactors. Fusion Power Reactors. Waste management.

Introduction to renewable power: Characteristics of wind and solar resource; Overview of components and working of wind farm and photovoltaic solar power plants.

Module-IV (8 hours)

Electrical Systems: Types of alternators (hydro, thermal, wind).Cooling and ventilation- insulation and temperature limits; fire protection. Excitation systems: DC, AC and Static. Automatic Voltage Regulators. Mechanical governors, electro hydraulic governors, digital governors, pressurized oil system. Power plant auxiliaries. Planning and layout of electrical equipment. Power station transformers. Commissioning tests. Switchyard components. Power electronic interfaces of wind and solar PV plants. Power evacuation systems. Power quality.

Module-V (8 hours)

Economics of Power Generation: Load curve, load duration curve. Maximum demand, load factor, diversity factor, plant capacity and use factor. Choice of size and number of generating units, Types of reserves. Social, economic, environmental and technological sustainability.

Life Cycle Cost, Levelized cost of generation, opportunity cost, shadow pricing. Generator Cost Curves, Energy pricing and tariff principles. Power Exchanges, Spot Pricing. National Grid. Introduction to concepts of Smart Grid.

Text Books:

Generation of Electrical Energy by B. R. Gupta, S.C. Chand Publishers

Reference Books:

Power Plant Engineering by P. K. Nag

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe the components and working of hydro power plants.
CO2	Describe the components and working of thermal power plants.
CO3	Describe the components and working of nuclear, wind and solar power plants.
CO4	Recognize electrical components in power generating stations.
CO5	Apply knowledge on power generation planning and economics.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ANALOG AND DIGITAL ELECTRONIC CIRCUITS (BEE04003)

MODULE-I (9 Hours)

Biasing of BJT: Fixed bias circuit, Self-bias circuit, Feedback bias circuit, Bias Stabilization. Transistor at Low Frequencies: Transistor Hybrid Model, h- parameters, Analysis of the transistor amplifier using h-parameter. Emitter Follower, Miller's theorem and its dual, cascading transistor amplifiers, Simplified CE and CC configurations. Transistor at high frequency: Hybrid-pi CE Transistor Model.

MODULE-II (6 Hours)

Biasing the JFET: FET in fixed bias, self-bias and feedback bias configurations. FET small signal modelling. Frequency response of an amplifier, Bode plot, Bandpass of cascaded stages, RC-Coupled amplifier and its low frequency response. Classification of amplifier, Feedback concept, Transfer gain, Negative feedback, Input-output resistance, Method of analysis of a feedback amplifier, Voltage series feedback, Current series feedback, Voltage shunt feedback, Current shunt feedback.

MODULE-III (9 Hours)

The basic operational amplifier (OPAMP), Off-set error voltages and currents, temperature drift of input offset voltage andcurrent, measurement of OPAMP parameters and its frequency response. Class –A large signal amplifier, higher order harmonic generation, Transformer-coupled audio amplifier, push-pull amplifier.

Digital circuits: Digital (Binary) operation of a system, OR gate, AND gate, NOT or inverter circuit, De Morgan's laws, NAND and NOR DTL gates, HTL gate, TTL gate, RTL and DCTL.

MODULE-IV (6 Hours)

Binary codes: BCD codes, gray codes, ASCII Character Code, Boolean Algebra & Logic gates: Axiomatic definition of Boolean algebra.Property of Boolean algebra, Boolean functions, Canonical & standard form; min terms & max terms, standard forms; Digital Logic Gates, Multipleinputs.Gate level Minimization: The Map Method, K Map up to five variables, Product of Sum simplification, Sum of Product simplification, Don't care conditions.

MODULE-V (9 Hours)

Combinational digital systems: Standard gate assembles, Binary adder, arithmetic functions, Decoder/Demultiplexer, Data selector/Multiplexer, Encoder.

Sequential digital systems: A 1-bit memory, Flip-flops, shift registers, Ripple (Asynchronous) counters, Synchronous counters, Application of counters.

TEXT BOOKS

[1]. Milliman. J, Halkias. C and Parikh. C.D., "Integrated Electronics", Tata Mc. Graw Hills 2nd Ed. 2010.

[2]. R.L Boylestad and L. Nashelsky, "Electronic Devices & Circuit Theory: Pearson Education.

[3]. M. Morris Mano, "Digital Design", PHI Publishers.

REFERENCE BOOKS

[1]. Mohammad Rashid, "Electronic Devices and Circuits", Cengage Learning Publishers.

[2]. Sergio Fransco, "Design with Operational Amplifiers& Analog Integrated Circuits", TMH Publishers.

[3]. Charles H.Roth, "Fundamentals of Logic Design", Cengage Learning Publishers.

Course Outcomes:

Upon the completion of the course, the students will able to:

CO1	Design of various types of amplifiers using BJT and FET using the concept of DC and AC analysis
CO2	Analyse the frequency response of various amplifiers. Comprehend the fundamental concepts in feedback amplifier circuits.
CO3	Acquaint with the design of logic gates using BJT.
CO4	Use the concept of Boolean algebra for the analysis and design of various combinational and sequential circuits. Design of various logic gates starting from simple ordinary gates to complex programmable logic devices.
CO5	Analyse the sequential logic circuits design both in synchronous and asynchronous modes for various complex logic and switching devices.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

MATHEMATICS-IV (Numerical Methods) (BMA04001) **4 Credits [3-1-0]**

Module I: Errors and Root Extraction *(8 Lectures)*

Definition and sources of error, Propagation of errors, finding roots of algebraic and transcendental equations by Bisection method, Newton's method, Secant method, fixed point iteration method.

Module I: Interpolation *(8 Lectures)*

Interpolation, Lagrange's interpolation, Newton's divided differences, Forward differences, Backward differences, Central differences, Interpolation error.

Module I: Numerical integration *(8 Lectures)*

Numerical integration: Newton-Cotes Integration formula (without derivation), Trapezoidal rule, Simpson's rule, Gaussian quadrature, Errors in Numerical Integration.

Module I: Numerical Solution of Differentianal Equations *(8 Lectures)*

Solution of ODE's: Euler's method, Improved Euler's method, Runge-Kutta Methods of order-2 & 4.

Module I: Numerical Solution of system of linear equations *(8 Lectures)*

Numerical Solution of system of linear equations, Gauss Elimination method, LU decomposition, Gauss-Jordan Elimination method, Gauss Jacobi and Gauss-seidal iteration methods

Text Books:

1. An introduction to numerical analysis, Jain, Iyengar and Jain, New Age International
2. Numerical Analysis, B. S. Grewal, Khanna Publishers

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Compile roots of algebraic and transcendental equations
CO2	Incorporate interpolating polynomial for a given set of data
CO3	Apply numerical integration methods for computing definite integrals
CO4	Describe the solution of ordinary differential equations (IVP) by using numerical methods
CO5	Demonstrate approximate solutions for system of linear equations

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Economics for Engineers (BHU04001) (3-0-0)

Course Objectives:

- To understand the basic economic principle as a consumer in an economy
- To be able to know the utility measurement in the presence of risk and uncertainty
- To prepare the Engineering students to learn about the production process and analyse the cost/revenue data.
- To provide the foundation for engineers to make good decisions in business environment and learn about the market mechanism.
- To be able to make decision on project alternatives and justify projects on an economic basis

Syllabus:

Module-1:

Theory of Demand: Demand and Utility, Demand function and the factors determining demand, Law of Demand, Reasons for downward sloping demand curve, Exceptions to the law of demand. The market forces of Supply and Demand, Elasticity of demand and its application, Utility analysis: cardinal and ordinal measurability of utility, Assumptions of cardinal utility analysis, law of diminishing marginal utility, Consumer's equilibrium: Principle of equi-marginal utility

Module-2:

Indifference curve analysis of demand: Concepts, properties, Equilibrium of the consumer, Price Consumption Curve (PCC) and Income Consumption Curve, Decomposition of price effect into income effect and substitution effect, Revealed preference hypothesis, Individual choice under Risk and Uncertainty: St. Petersburg paradox and Bernoulli's hypothesis, Neumann-Morgenstern method of constructing utility index, Friedman-Savage hypothesis, Markowitz hypothesis

Module-3

Production function: short run analysis, Total product, Average product and Marginal product, output elasticity of input, law of variable proportion, Long run production function: Isoquants and concepts of returns to scale, Optimum factor combinations, Homogeneous Production Function, Cobb–Douglas production function, CES Production function, Cost Analysis: Concepts, Accounting cost, Fixed and variable cost, opportunity cost, Short run and long run cost curves, Relationships between average cost and marginal cost

Module-4

Market and its classifications, Perfect competition: Characteristics, Short run and long run equilibrium of firm under perfect competition. Monopoly market: Price and output determination. Modern theories of firms: Baumol's theory of sales revenue maximisation, Bain's limit pricing model

Module-5

Time value of money: use of cash flow diagram, Annual economic worth, present worth, future worth, Internal Rate of Return (IRR), Net Present Value (NPV), Payback period method, Analysis of public projects: Cost-Benefit analysis, cost effectiveness

Reference Books:

1. Koutsoyiannis, A. (1979). Modern Microeconomics. The Macmillan Press Ltd., London
2. Varian, H. R. (1992). Introduction to Micro Economic Analysis, Norton and company, New York
3. Salvatore, D. (2008). Microeconomics: theory and applications. Oxford University Press
4. Pindyck, R. S., D. N. Rubinfeld and P. L. Meheta (2009). Microeconomics, Pearson India, New Delhi
5. Panneerselvam, R. (2007). Engineering Economics, Prentice-Hall of India, New Delhi
6. Henderson, J. M. and R. E. Quant (2011). Microeconomic Theory: A Mathematical Approach, Indian Higher Education, New Delhi
7. Intriligator, M. D., R. G. Bodkin and C. Hsiao(1995). Econometric Models, Techniques, and Applications, Pearson India, New Delhi

Course Outcomes:

Upon completion of the subject the student will be able to :

CO1	Utilise economics principles in consumption process
CO2	Describe the utility measurement and measure the utility associated with risk
CO3	Efficient use of resources in production and take decision regarding optimum output
CO4	Describe market mechanism and analyse product market to take proper decisions
CO5	Implement economic principles in company related decision making

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	2	-	-	-	3	3
CO2	-	-	-	-	-	3	2	2	-	-	2	1
CO3	-	-	-	-	-	3	3	-	-	-	3	-
CO4	-	-	-	-	-	2	2	1	1	1	3	-
CO5	-	-	-	-	-	1	2	1	2	-	3	1

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	-	-	-	3	2	1	1	1	3	2

Sessional

ELECTRICAL MACHINES LABORATORY-II (BEE04004)

List of Experiments

1. To determine the voltage regulation of alternator by EMF method
2. To determine the V curve and inverted V curve of a 3-Ph synchronous motor
3. Speed control of a 3 phase induction motor by rheostatic, cascading and pole changing methods
4. Synchronization of alternator with infinite bus.
5. No load and Blocked rotor test of three phase Induction motor.
6. Three phase connections of transformer
7. Determination of power angle characteristics of an Alternator
8. Load test of 3-Ph Induction Motor
9. Determination of Parameters of single phase induction motor
10. Separation of hysteresis and eddy current losses of single phase transformer.
11. Voltage regulation of 3 phase alternator by ZPF method.
12. Determination of Parameters of 3 phase three winding transformer and trace the waveform of Magnetizing Current & Induced e.m.f.

Course Outcomes:

Upon completion of this course, students will demonstrate the ability to:

CO1	Perform various tests on synchronous machines and to determine their characteristics.
CO2	Synchronize a given alternator to infinite bus.
CO3	Determine parameters of three phase and single phase induction motors.
CO4	Describe different losses of single phase transformer
CO5	Determine characteristics, parameters and connections of three phase transformers

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

ANALOG AND DIGITAL ELECTRONIC LABORATORY (BEE04005)

LISTS OF EXPERIMENTS

AE

1. Determination of the frequency response of Low pass filter.
2. Determination of the frequency response of High pass filter.
3. Study of different clipper and clamper circuits
4. Study of output characteristics of FET.
5. Study of Class A Amplifier.
6. Study of Class B Amplifier.
7. RC phase shift oscillator and to observe its output waveform

DE

1. Verification of Truth table of logic gates and verification of Demorgan's Theorems.
2. Realization of half adder, full adder, half subtractor and full subtractor.
3. Design and implementation of multiplexer using logic gates.
4. Realization of S-R and J-K flip flop using 7400.
5. Design of 3-bit asynchronous counter and mod-N counter.
6. Design of SISO, SIPO, PISO, PIPO shift registers.
7. Application of multiplexer: - design of full adder using DUAL MUX IC.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Demonstrate the operation of basic filter circuits, clipper and clamper circuits.
CO2	Demonstrate the characteristics of transistors.
CO3	Implement different power amplifier circuits.
CO4	Design combinational circuits such as adder, subtractor and multiplexers.
CO5	Design of sequential circuits such as FFs, counters and shift registers.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

Fifth Semester

ELECTRICAL POWER TRANSMISSION AND DISTRIBUTION (BEE05001)

Syllabus:

MODULE-I (8 HOURS)

General Introduction to power transmission by D.C. and A.C. overhead lines Constants: Resistance, inductance and capacitance of single and three phase lines with symmetrical and unsymmetrical spacing transposition, charging current, skin effect and proximity effect.

MODULE-II (8 HOURS)

Performance of transmission Lines: Analysis of short, medium and long lines, equivalent circuit, representation of the lines and calculation of transmission parameters, use of static or synchronous condensers for improvement of regulation. Corona: Power loss due to corona, practical importance of corona, and inductive interference with neighboring communication lines, use of bundled conductors in E.H.V. transmission lines and its advantages.

MODULE-III (8 HOURS)

Overhead line Insulators: Voltage distribution in suspension type insulators, method of equalizing, voltage distribution, economic use of insulators. Mechanical Design of Overhead Transmission Line, Sag and stress calculation, tension and sag at erection, effect of ice and wind, vibration dampers Under Ground Cable: Type and construction, grading of cables, capacitance in 3 core cables and dielectric loss.

MODULE-IV (8 HOURS)

Distribution System: types of distributors and feeders (radial & ring), voltage drop and load calculation for concentrated and distributed loads, Primary and secondary distribution network, Capacitor placement in distribution network, Distribution system planning, Service area calculation.

MODULE-V (8 HOURS)

Substation &Earthing: Types of substations, arrangement of bus-bars and control equipment, solid earthing, resistance earthing and Peterson coil Per unit system one-line diagram Power flow through transmission line, Power circle diagram, Series and shunt compensation. Introduction to Flexible AC Transmission System (FACTS), SVC, TCSC, SSSC, STATCOM and UPFC

BOOKS

1. John J Grainger, W. D. Stevenson, “Power System Analysis”, TMH Publisher.
2. J. Nagrath& D. P. Kothari, “Power System Analysis”, TMH Publisher REFERENCE BOOKS
3. S. N. Singh, “Electrical Power Generation, Transmission and Distribution”, PHI Publishers.
4. AbhijitChakrabarti, SunithaHalder, “Power System Analysis, Operation and Control, PHI Publishers

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Compute the transmission line parameters and evaluate performance.
CO2	Analyze the short, medium and long lines transmission line and the effect of corona.
CO3	Perform mechanical design and evaluate line insulators and underground cables.
CO4	Evaluate performance of primary and secondary distribution systems.
CO5	Describe types of sub-stations, earthing schemes and bus-bar schemes.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

CONTROL SYSTEM-I (BEE05002)

MODULE-I

Scope of control system Engineering, Various Classification of Control System, Closed Loop Control Versus Open Loop Control, Mathematical model of physical systems, transfer function, block diagram algebra, signal flow graph (SFG), Mason's gain formula. Feedback Characteristics: Types of feedbacks, effect of degenerative feedback on control system, regenerative feedback, Application of Control system to engineering and non-engineering problem.

MODULE-II

Time domain analysis: Standard test signals: Time response of 1st. order systems to unit step and unit ramp inputs. Time response of second order systems to unit step input. Time response specifications. Steady state errors and error constants of different types of control systems Generalized error series method, Application of MATLAB and its Tool Box for time response analysis. Effect of poles and zeros on system response.

MODULE-III

Concepts of stability: Necessary conditions of stability, Hurwitz stability criterion, Routh stability criterion, application of Routh stability criterion to linear feedback systems, Relative stability Analysis. Root locus techniques: Root locus concepts, rules for construction of root loci, determination of roots from root locus, root contours, systems with transportation lag, Root locus plots with MATLAB.

MODULE-IV

Frequency domain analysis: Introduction, Polar plots, Bode plots, determination of stability from Bode plots, Nyquist stability criterion, application of Nyquist stability criterion to linear feedback systems, Log magnitude versus phase plots, Use of MATLAB for plotting Bode &Nyquist diagram. Closed loop frequency response: Constant M circles, constant N circles, use of Nichols chart.

MODULE-V

Controllers: Proportional, derivative and integral control actions, PD, PI and PID controllers and their applications to feedback control systems, PID controller gains tuning by Zeigler- Nichols method. 2-Degree-of-freedom control.

Sensitivity transfer functions (S and T) and their significance: Measure of loop robustness in terms of the peaks of sensitivity and transfer functions for any PID compensated system.

TEXT BOOKS

1. K. Ogata, "Modem Control Engineering", PHI Publishers.
2. I.J. Nagrath, M. Gopal, "Control Systems Engineering", New Age International Publishers.
3. Norman S. Nise, "CONTROL SYSTEMS ENGINEERING", John Wiley & Sons.

REFERENCE BOOKS

1. G.F.Franklin, J.D.Powell, A. Emami, Naeini, "Feedback Control of Dynamic Systems", Schaum's Outlines, TMH Publishers.
2. B.C.Kuo, F. Golnaraghi, "Automatic Control Systems", John Willey & Sons.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Implement mathematical model of a physical system and its transfer function.
CO2	Compute steady state error for different standard test signals and estimate time domain performance indices.
CO3	Describe stability analysis using Routh-Hurwitz stability criterionandroot locus.
CO4	Evaluate frequency domain analysis using Bode plot and Nyquist criteria.
CO5	Design different controllers including PI, PD and PID controllers

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

POWER ELECTRONICS (BEE05003)

Module-I (8 hours)

Power Electronic Devices: Static and Dynamic characteristics of Power Diodes, Power BJTs, Power MOSFETs, Insulated Gate Bipolar Transistors (IGBT), Thyristor Family (SCR, DIAC, TRIAC, GTO, MCT). Thermal viewpoint. Thyristor Protection, cooling and mounting techniques. Safe Operating Area and different current and voltage ratings. Triggering and basics of driver circuits of thyristors, Different types of commutation schemes: Natural and Forced commutation.

Module-II (8 hours)

AC-DC Rectifiers: Uncontrolled rectifiers. 1-Phase Half & Full Wave Controlled Rectifier with various kinds of loads (R, R-L-E (motor)). Midpoint and Bridge type converters. Half Controlled and Fully Controlled Bridge circuits, different waveforms, Input Line Current Harmonics, Power factor, current distortion and displacement factors- Inverter Mode of Operation. Continuous and discontinuous modes, Effect of source inductance assuming constant load current. Effect of freewheeling diode. Three phase bridge converters for different types of load with constant load current, different waveforms.

Module-III (8 hours)

DC-DC converter: Classification of types of choppers, One, Two and Four quadrant operations, Step up and down choppers, concepts of duty ratio and average voltage, power circuit of buck & boost converter, analysis and waveforms at steady state, duty ratio control of output voltage.

AC-AC Converters: Single-phase mid-point and bridge types of step-up and step-down Cycloconverter. Single-phase AC Voltage regulators and its basic analysis.

Module IV (7 hours)

DC-DC Regulators: Generic Linear Regulator. Different Topologies: Shunt, series, modified shunt, negative voltage regulator, protection.

Switch Mode Power Supply: Basic scheme of SMPS and its difference & advantages over linear regulators. Different types of SMPS with single and bidirectional core excitation. Basic steady state operation and analysis of Forward and Flyback converters.

Module-V (8 hours)

DC-AC Converters: Single-phase Half and Full bridge Inverter, Pulse Width Modulated (PWM) technique for voltage control, SPWM Technique 1-phase inverters, Three-phase Voltage Source Bridge type of Inverters. (120 and 180 Degree conduction modes), Current Source Inverter (Single-phase CSI with ideal switches, Single-phase capacitor commutated CSI and Single-phase auto-sequential commutated CSI).

Applications: UPS, Induction Heating, Electronic Ballast, AC/DC drives speed control.

Text Books:

1. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.
2. P. S. Bimbhra, Power Electronics, Khanna Publishers.

Reference Books:

1. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
2. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Describe power switching devices and their drive circuits.
CO2	Analyze and evaluate the performance of thyristor rectifiers.
CO3	Express and evaluate the performance of AC-AC and DC-DC converters
CO4	Analyze and evaluate the performance of DC-DC linear regulators and SMPS.
CO5	Analyze and evaluate the performance of single phase and three phase inverters.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Professional Elective - I

SIGNALS & SYSTEMS (BEEPE501)

Module-I (7 hours)

Introduction of Signal and System: Introduction of Signals, Classification of Signals, General Signal Characteristics, Energy & Power Signal, Continuous-Time Signals, Discrete-Time Signals. Basic System Properties, Systems with and without memory, Invertibility, Casuality, Stability, Time invariance, Linearity.

Module-II (10 hours)

Convolution: Linear Time Invariant (LTI) Systems, Discrete Time LTI Systems, Convolution representation of Linear Time-Invariant Discrete-Time Systems, Convolution Representation of Linear Time-Invariant Continuous-Time Systems, Properties of convolution, Properties of LTI Systems.

Fourier Representations for Signals: Representation of Discrete Time Periodic signals, Continuous Time Periodic Signals, Discrete Time Non Periodic Signals, Continuous Time Non-Periodic Signals, Properties of Fourier Representations.

Module-III (8 hours)

Frequency Response of LTI Systems: Frequency Response of LTI Systems, Fourier Transform representation for Periodic and discrete time Signals, Sampling, reconstruction, Discrete Time Processing of Continuous Time Signals, Fourier Series representation for finite duration Non-periodic signals.

Modulation: Modulation Types and Benefits, Full Amplitude Modulation, Pulse Amplitude Modulation, Multiplexing, Phase and Group delays

MODULE-IV (7 hours)

Representation of Signals using Continuous Time Complex Exponentials: Laplace Transform, Unilateral Laplace Transform, its inversion, Bilateral Laplace Transform, Transform Analysis of Systems.

MODULE-V (7 hours)

Representation of Signals using Discrete Time Complex Exponentials: The Z-Transform, Properties of Region of convergence, Inverse Z-Transform, Transform Analysis of LTI Systems, Unilateral Z-Transform.

TEXT BOOKS

[1]. Simon Haykin and Barry Van Veen, “Signals and Systems”, John Wiley & Sons Publisher.

[2]. Alan V. Oppenheim, Alan S. Will sky, with S. Hamid, S. Hamid Nawab, “Signals and Systems”, PHI Publisher.

REFERENCE BOOKS

[1]. Hwei Hsu, “Signals and Systems”, Schaum's Outline TMH Publisher.

[2]. Edward w. Kamen and Bonnie S. Heck, “Fundamentals of Signals & systems using Web and MATLAB”, PHI Publisher

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Describe different types of signals and systems.
CO2	Perform convolution of LTI system and apply Fourier transforms
CO3	Apply modulation techniques and evaluate frequency response of LTI system.
CO4	Analyze signals using Laplace Transform techniques
CO5	Analyze signals using Z Transform techniques

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ELECTROMAGNETIC FIELD THEORY (BEEPE502)

PREREQUISITES

Coordinate Systems, Vector Algebra, Vector Calculus.

MODULE I (8 Hours)

Fields due to Different Charge Distributions, Gauss Law and Applications, Electric Potential, Relations Between E and V, Energy Density. Convection and Conduction Currents. Continuity Equation, Polarization of Dielectrics, Boundary Conditions. Poisson's and Laplace's Equations; Capacitance.

MODULEII(8 Hours)

Biot-Savart's Law, Ampere's Circuital Law and Applications, Magnetic Flux Density. Magnetic Scalar and Vector Potentials. Forces due to Magnetic Fields. Magnetic Boundary Conditions. Inductance & Mutual Inductance.Faraday's Law and Transformer EMF, Displacement Current Density, Maxwell's Equations.

MODULEIII(8 Hours)

Uniform Plane Waves, Wave Equations, Wave Propagation in Lossless and Conducting Media, Conductors & Dielectrics. Wave Polarization. Reflection and Refraction of Plane Waves – Normal and Oblique Incidences for both Perfect Conductor and Perfect Dielectrics.

MODULEIV(8 Hours)

Poynting Vector and Poynting Theorem – Applications.Types, Parameters, Transmission Line Equations, Primary &Secondary Constants, Expressions for Characteristic Impedance, Propagation Constant, Phase and Group Velocities, Infinite Line Concepts.

MODULEV(7 Hours)

Introduction to Waveguides, TE Modes, Waveguide Equation, Cut-Off Frequency. Elements Of Antenna Theory.

TEXT BOOKS:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 4 th Edition, Oxford University Press Inc. First India edition, 2009.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', Tata McGraw Hill 8th Revised edition, 2011.
3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.
4. Bhag Singh Guru and Hüseyin R. Hiziroglu "Electromagnetic field theory Fundamentals", Cambridge University Press; Second Revised Edition, 2009.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Describe the concepts of electrostatics, electrical potential, energy density and their applications.
CO2	Apply the principles of electrostatics to the solutions of problem relating to magnetic field and electric potential , boundary conditions & magnetic energy density.
CO3	Apply the concepts of Faraday's law, induced emf and Maxwell's equations.
CO4	Apply knowledge on concepts of Poynting theorem and operation of transmission lines.
CO5	Describe the basic principles of waveguides and antenna.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

INDUSTRIAL POWER ELECTRONICS (BEEPE503)

Module-I (8 Hours)

Conventional DC and AC Traction: Electric traction services, Nature of traction load, Coefficient of adhesion, Load sharing between traction motors, Main line and suburban train configurations, Calculation of traction drive rating and energy consumption. Important features of traction drives, Conventional DC and AC traction drives, Diesel electric traction.

Module-II (8 Hours)

Static converters for Traction: Semi-conductor converter controlled drive for AC traction, Semiconductor chopper controlled DC traction. Illumination: Nature of light, Basic laws of illumination, Light sources and their characteristics, Light production by excitation and ionization, Incandescence and fluorescence, Different types of lamps, Their construction, Operation. Electric Heating: Introduction to electric heating, Advantages of electric heating, Resistance heating, Temperature control of furnaces, Induction and dielectric heating.

Module-III (7 Hours)

Power Supplies: Performance parameters of power supplies, Comparison of rectifier circuits, Filters, Regulated power supplies, Switching regulators, Switch mode converter.

Module-IV (8 Hours)

Power factor Control: Static reactive power compensation, Shunt reactive power compensator, Application of static SCR controlled shunt compensators for load compensation, Power factor improvement and harmonic control of converter fed systems, Methods employing natural and forced commutation schemes, Methods of implementation of forced commutation.

Module-V (8 Hours)

Motor Control: Voltage control at constant frequency, PWM control, Synchronous tap changer, Phase control of DC motor, Servomechanism, PLL control of a DC motor.

TEXT Books

[1]. Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall inc. (1989).
[2]. Paul, B., Industrial Electronic and Control, Prentice Hall of India Private Limited (2004).
[3]. J.M.D. Murphy, F.G. Turnbull, Power Electronic Control of Ac Motors, Pergamon (1990).
[4]. Sen, P.C., Thyristor DC Drives, John Wiley and Sons (1981).

COURSE OUTCOMES

Upon completion of the course, the students will be able to:

CO1	Simulate and analyze the semiconductor controlled ac and DC drive system.
CO2	Design and develop an illumination system for domestic, industry and commercial sites.
CO3	Design an electric heating system for industrial purposes.
CO4	Equip the skill to design and develop a regulated power supply
CO5	Simulate and analyze the series and shunt compensators for power factor improvement in drive system

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

RENEWABLE ENERGY SOURCES (BEEPE504)

Module-I (10 hours)

Energy Scenario: Classification of Energy Sources, Energy resources (Conventional and nonconventional), Energy needs of India, and energy consumption patterns. Worldwide Potentials of these sources. Energy efficiency and energy security. Energy and its environmental impacts, Distributed generation.

Solar Energy: Solar thermal Systems: Types of collectors, Collection systems, efficiency calculations, applications.

Photo voltaic (PV) technology: Present status, solar cells, cell technologies, characteristics of PV systems, equivalent circuit, array design, building integrated PV system, its components, sizing and economics. Peak power operation. Standalone and grid interactive systems.

MODULE-II (8 HOURS)

Wind Energy: Wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, Types of Turbine, Turbine rating. Choice of generators, turbine rating, electrical load matching, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operation.

MODULE-III (7 HOURS)

Energy storage and hybrid system configurations: Energy storage, Battery – types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. Flywheel-energy relations, components, benefits over battery. Fuel Cell energy storage systems. Ultra Capacitors.

MODULE-IV (7 HOURS)

Grid Integration: Standalone systems, Concept of Micro-Grid and its components, Hybrid systems – hybrid with diesel, with fuel cell, solar-wind, wind –hydro systems, mode controller, load sharing, system sizing. Hybrid system economics, Interface requirements, Stable operation, Transient-safety, Operating limits of voltage, frequency, stability margin, energy storage, and load scheduling. Effect on power quality, harmonic distortion, voltage transients and sags, voltage flickers, dynamic reactive power support. Systems stiffness.

Module-V (7 Hours)

Small Hydro Systems, Bio-Mass and Bio-Fuels, Tidal power: Tidal phenomena, historical background, basic aspects of tidal power development and tide mills; Tidal power project components and types, Energy from Ocean Waves and Ocean thermal energy conversion technologies: Basic principle, System components.

Text Books

[1] Renewable Energy Resources by by John Twidell, Tony Weir, Routledge, 3rd Edition.

[2] Sustainable Energy- J.W. Tester, E.M. Drake, M. J. Driscoll, M. W. Golay , W. A. Peters, MIT Press, 2nd Edition.

Reference Books

[1] Energy Technology Nonconventional, Conventional & Renewable-Sunil S. Rao and Dr. B.B. Parulekar, Khanna Publishers.

[2] Renewable energy sources and emerging technologies -D.P. Kothari, K.C. Singal, and R. Ranjan, PHI Learning Pvt. Ltd.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Describe the concept of energy security, energy sustainability and distributed generation and the relevance of solar power system.
CO2	Analyze the principles and components of wind energy systems.
CO3	Evaluate various energy storage devices for their suitability.
CO4	Describe the principle and components for small hydro, biomass, tidal, wave energy extraction.
CO5	Analyze grid integration issues of renewable energy systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Sessional

CONTROL SYSTEMS LABORATORY (BEE05004)

List of Experiments:

1. Study of a two-phase AC servomotor and its transfer function parameters.
2. Find the frequency response of a Lag and Lead compensator.
3. To observe the time response of a second order process with P, PI, PID control and apply PID control to a DC servomotor.
4. To study the characteristic of a relay and analyze the relay control system (Phase Plane).
5. Study of a linear system simulator
6. Study of feedback characteristic using Amplidyne
7. To study digital control of a simulated system using an 8 bit microprocessor

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Describe the operation of two-phase AC servomotor its transfer function.
CO2	Design Lag and lead compensator using frequency response.
CO3	Analyze nonlinear system using relay control system.
CO4	Construct feedback characteristic using Amplidyne.
CO5	Demonstrate the operation of digital control systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

POWER ELECTRONICS LABORATORY (BEE05005)

Syllabus:

1. Familiarization with power electronics components. (SCR, IGBT, MOSFET, GTO, BJT) & Draw the V-I Characteristics of BJT, MOSFET, SCR.
2. Study of Single phase Full and Half wave converters with R and R-L-E(Motor) loads with and without freewheeling action
3. Study of Three Phase Full and Half wave converters with R and R-L-E(Motor) loads
4. To study different triggering circuits for thyristors (Cosine Law & UJT Triggering)
5. To study single phase AC regulator using Triac (R & R-L Loads)
6. To study the single phase cycloconverter with R and R-L Loads
7. To study IGBT based PWM Inverter.
8. To study the speed control of DC motor using single-phase full wave converter.
9. DC Motor speed control by single quadrant chopper circuit.
10. To study a transistorized PWM Inverter.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Demonstrate power electronics components and their V-I Characteristics.
CO2	Produce waveforms across the loads and switches.
CO3	Implement triggering circuits for power electronic devices.
CO4	Demonstrate operation of AC-DC and AC-AC converters.
CO5	Demonstrate operation of Inverter circuits.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

SIGNALS & SYSTEMS LAB (BEE05006)

(Use MATLAB CONTROL SYSTEM and SIGNAL PROCESSING TOOL BOXES)

1. Generation of square, triangular, exponential, sinusoidal signals and step, Impulse and RAMP functions.
2. Verification of time shifting, time scaling and reflections on square, triangular, exponential, sinusoidal, ramp, impulse and step signal.
3. Evaluation of convolution of finite –duration discrete time signals and verification of convolution properties.
4. Evolution of convolution integral of given signals.
5. Compute the discrete time Fourier transform of given sequence.
6. Frequency response of LTI Systems from Impulse response.
7. Frequency response of LTI systems Describes by differential or difference Equations.
8. Generation of AM wave and analysing its frequency content.
9. Determination of frequency response from Poles and Zeros.
10. . Pole- Zero Plot in the Z-plane and determination of magnitude response.
11. Find the impulse response of a system described by Z-transform function.
12. Implementation of Decimation and Interpolation concepts

Course Outcomes:

Upon completion of the course, the students will:

CO1	Describe various elementary signal and verify its independent variable properties.
CO2	Express the concept of convolution of LTI system.
CO3	Describe the basics of modulation and frequency response of LTI system.
CO4	Apply the knowledge how to use the Laplace Transform for representing signal.
CO5	Apply the knowledge how to use the Z Transform for representing signal

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

Open Elective-I (Fifth Semester)

BIO-MEDICAL INSTRUMENTATION (BEEOE501)

Module-I (10 Hours)

Basic physiological system of the body: Problems encountered in measuring living systems, bioelectric potentials, biomaterials, Basic Transducer Principles: Active and passive transducers, Transducers for biomedical applications, Generation, propagation and distribution of bioelectric potentials (ECG, EEG and EMG)

Bio potential electrodes: Basic types (micro, skin surface and needle electrodes), biochemical transducers (PH, blood, gas and specific ions electrodes).

Module-II (5 Hours)

The cardiovascular system and measurements: Heart and cardiovascular system and circulation block diagram, blood pressure and measurement, characteristics of blood flow and heart sounds, Electrocardiography, ECG lead configurations, ECG recording and their types.

Module-III (10 Hours)

The Nervous System: The anatomy of nervous system, Neuronal communication EPSP & IPSP Organization of the brain, Measurements from the nervous system

Systemic Body & Skin Temperature Measurement: Temperature measurements, Brief idea about ultrasonic measurements.

Module-IV (10 Hours)

Patient care monitoring: Elements of intensive care: Organization of the Hospital for patient care monitoring, Pace-makers types, systems, modes and generators, Defibrillators types, Bio telemetry and applications of telemetry in patient care.

Module-V (4 Hours)

Automation of chemical tests, Instrumentation for diagnostic X Rays, Interfacing computer with medical instrumentation and other equipment, biomedical computer applications, Shock hazards from electrical equipment, methods of accident prevention.

TEXT Books

[1] R.S. Khanpur, "Handbook of Biomedical Instrumentation", TMH Publisher.

[2] Cromwell, F.J.Weibell&F.A.Pfieffer, "Biomedical Instrumentation & Measurements", PHI Publisher.

REFERENCE Books

[1] Webster J S –Medical Instrumentation-Application & Design
[2] Astor B R–Introduction to Biomedical instrumentation & measurement, McMillan.
[3] Mandeep Singh-Introduction to Biomedical Instrumentation, 2nd Edition, PHI

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Course Outcomes

Upon completion of the course students will:

CO1	Express human physiology system, electrodes & transducers used in human body
CO2	Express basic function of cardiovascular system in humans
CO3	Express nervous systems of human body
CO4	Compile health care workers' dependence on technology to administer care or treatment or to make a diagnosis.
CO5	Evaluate principles, applications, imaging and design of the medical instruments most commonly used in the hospital

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

ELEMENTS OF ELECTRICAL MACHINES (BEEOE502)

Module I: (9 hours)

D.C. Generator-Construction and principle of operation, E.M.F. Equation, types of generator, No load and load characteristics, Voltage build-up of shunt Generator, Voltage regulation, Application.

D.C. Motor -Back E.M.F, torque and speed equations, Speed control of series and shunt motors, Characteristics and performance curves, Motor starters, Losses and Efficiency of D.C machines, Application.

Module II: (6 hours)

Single phase Transformer-Construction and principle of operation, E.M.F. Equation, Phasor diagram, Actual and approximate equivalent circuits, Open and short circuit tests, voltage regulation, Losses and efficiency, Autotransformer; conventional transformer connected as Autotransformer.

Module III: (6 hours)

Three Phase Transformer- Construction and principle of operation, Connection of three single – phase units in Wye, delta, open delta configurations.

Special Transformers – Induction heating and High impedance and high frequency transformer.

Module IV: (9 hours)

Three phase Alternators-Construction and principle of operation, E.M.F. equation, distribution and pitch factors, Synchronous reactance, performance of alternators on no-load and load; Phasor diagram; voltage regulation, power calculations of turbine and hydro-generators, synchronization of an alternator.

Three Phase Synchronous Motor-Construction and principle operation, Complete phasor diagrams, V- curves, Starting methods of synchronous motor and applications.

Module V: (10 hours)

Three Phase Induction Motor: Construction of slip ring and squirrel cage type induction motors, Starting and running torque of a three phase induction motor, torque-slip characteristics; maximum torque calculations, Speed control of induction motors, Open and short-circuit tests, losses and efficiency, starting of induction motors

Single Phase Induction Motor -Construction and principle of operation, Analysis of single phase motor based on double revolving field theorem, Torque slip characteristic, capacitor- start and capacitor run motors.

REFERENCES:

[1] J. Nagrath& D.P. Kothari, “Theory and problems of Electrical Machines”, TMH Publication, New Delhi.

[2] P. S. Bhimbra, “Electrical Machinary”, Khanna Publishers, New Delhi.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe the constructional and operational features of DC machines.
CO2	Apply the knowledge & express on the principles of operation of single phase transformers.
CO3	Describe three phase transformer connections and their operating principle.
CO4	Describe the performance of synchronous generators; operation, starting and performance characteristics of synchronous motors
CO5	Describe the performance of induction motor.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

CONTROL SYSTEM ENGINEERING (BEEOE503)

Syllabus

MODULE-I

Introduction and Overview: What is control; Meaning of the terms reference input, control input, disturbance input and controlled output; Tracking and the disturbance rejection problems; Manual vs. automatic control; Feedback and feed forward control, Closed Loop Control Versus Open Loop Control, Mathematical model of physical systems, transfer function, block diagram algebra, signal flow graph (SFG), Mason's gain formula. Feedback Characteristics: Types of feedbacks, effect of degenerative feedback on control system, regenerative feedback, Example of Control system application in engineering and non-engineering problem.

MODULE-II

Time domain analysis: Standard test signals: Time response of 1st. order systems to unit step and unit ramp inputs. Time response of second order systems to unit step input. Time response specifications. Steady state errors and error constants calculation, Effect of poles and zeros on system response.

MODULE-III

Concepts of stability: Necessary conditions of stability, Hurwitz stability criterion, Routh stability criterion, application of Routh stability criterion to linear feedback systems, Root locus techniques: Root locus concepts, rules for construction of root loci, determination of roots from root locus, root contours.

Controller design: Proportional, derivative and integral control actions, PD, PI and PID controllers and their applications to feedback control systems, PID controller gains tuning by Zeigler- Nichols method.

MODULE-IV

Frequency domain analysis: Introduction, Polar plots, Bode plots, determination of stability from Bode plots, Nyquist stability criterion, application of Nyquist stability criterion to linear feedback systems, Log magnitude versus phase plots.

MODULE-V

State variable analysis: concept and analysis of state and state variable of homogeneous systems, state model for linear continuous time invariant SISO systems.

Digital control systems: Advantages and disadvantages of digital control systems, representation of sampled process, Shannon's sampling theorem, Z-transfer function: Types and properties of Z-transform, transfer function of ZOH, relation between s and Z-transfer function, Inverse Z-transfer function, pulse Z-transfer function of sampled data closed loop control system, solution of difference equation.

TEXT BOOKS

[1]. K. Ogata, "Modem Control Engineering", PHI Publishers.

[2]. I.J. Nagrath, M. Gopal, "Control Systems Engineering", New Age International Publishers.

[3]. Norman S. Nise, "CONTROL SYSTEMS ENGINEERING", John Wiley & Sons.

REFERENCE BOOKS

[1]. G.F.Franklin, J.D.Powell, A. Emami, Naeini, "Feedback Control of Dynamic Systems", Schaum's Outlines, TMH Publishers.

[2]. B.C.Kuo, F. Golnaraghi, "Automatic Control Systems", John Willey & Sons.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Design the mathematical model of a physical system and its transfer function.
CO2	Apply the knowledge on the steady state error for different standard test signal and its time domain performances.
CO3	Express the method root locus design and PID controller tuning.
CO4	Describe the method of bode and nyquist plot and be able to examine the stability of any given system.
CO5	Describe the system in discrete form and in state space form.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Sixth Semester

SWITCH GEAR AND PROTECTION (BEE06001)

Module-I (8 Hours)

Protective Devices: Philosophy of protection, Nature, Causes and consequences of faults, Zone of protection, Requirements of a protective scheme, Basic terminology components of protection scheme. Relay classification, Principle of different types of electromagnetic relay. General equation of phase and magnitude comparators, Duality of comparators.

Module-II (7 Hours)

Review of Fault Analysis, Sequence Networks. Introduction to Overcurrent Protection and overcurrent relay co-ordination, Directional Overcurrent relays, Distance relay, Differential relays.

Module-III (8 Hours)

Generator protection: Biased differential protection, restricted earth fault protection, Field suppression, Negative sequence protection, Earth fault detection in rotor circuit.

Transformer protection: Biased differential protections, restricted earth fault protection, Buchholz relay Protection of combined transformer and alternator.

Feeder Protection: Over current and earth fault protection, Distance protection, Pilot wire protection, Carrier current protection.

Bus bar Protection, Bus Bar arrangement schemes.

Module-IV (8 Hours)

Circuit Breakers: Formation of arc during circuit breaking. Characteristics of electric arc. Theories of arc Interruption. Recovery and restriking voltage, interruption of capacitive and inductive currents. Current chopping. Principle of A.C. and D.C. circuit breaking requirements of good circuit breaker circuit breaker rating. Different types of circuit breakers. Air break and Air blast circuit breaker. Plain break and controlled break all circuit breakers. Minimum oil circuit breakers. Vacuum circuit breaker, SF6 circuit breaker. D.C. Circuit breaker. H.R.C. Fuse: Construction and characteristics. Arrangement of Bus bar, Circuit breaker and isolator.

MODULE-V (8 Hours)

Elementary idea about digital & numerical protection, Protection against surge-surge absorber, Surge-diverter, Under-frequency, undervoltage and df/dt relays, Out-of-step protection, Effect of Power Swings on Distance Relaying.

Synchro-phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving protection systems.

TEXT BOOKS

1. Van C Warrington, “Protective Relays-Vol.-I & II”, John Wiley & Sons Publisher.
2. Ravindranath, M.Chander, “Power System Protection and SwitchGear”, Wiley Eastern Ltd.
3. Y. G.Paithankar and S. R. Bhide, “Fundamentals of power system protection

REFERENCE BOOKS

1. T S Madhav Rao, "Power System Protection", TMH Publication.
2. J. L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, 1987.
3. A.G. Phadke and J. S. Thorp,"Synchronized Phasor Measurements and their Applications", Springer, 2008.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Describe the different components of a protection system.
CO2	Evaluate fault current due to different types of fault in a network.
CO3	Design the protection schemes for different power system components.
CO4	Describe the principle of various types of circuit breakers.
CO5	Design digital protection systems and know the use of wide-area measurements

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

MICROPROCESSOR AND MICROCONTROLLER (BEE06002)

MODULE-I (9 HOURS)

Microprocessor Architecture: Introduction to Microprocessor and Microcomputer Architecture, Pins & Signals, Register Organization, Timing & Control Module, 8085 Instruction Timing & Execution.

Instruction Set and Assembly Language Programming of 8085: Instruction set of 8085, Memory & I/O Addressing, Assembly language programming using 8085 Instruction Set.

MODULE-II (6 HOURS)

Use of Stack & Subroutines, Data transfer techniques, 8085 interrupts.

Interfacing & support chips: Interfacing EPROM & RAM Memories, 2716, 2764, 6116 & 6264, Interfacing of I/O devices with 8085, Partial address decoding for memory and I/O devices.

MODULE-III (6 HOURS)

Microprocessor Based System Development Aids, Programmable Peripheral Interface: 8255, Programmable DMA Controller: 8257, Programmable Interrupt Controller: 8259

Application: Delay calculation, square wave generation, Interfacing of ADC & DAC, Data Acquisition System.

MODULE-IV (9 HOURS)

Advanced Microprocessor: Basic features of Advance Microprocessors, Intel 8086 (16 bit processors): 8086 Architecture, Register organization, signal descriptions, Physical Memory Organization, Addressing Modes, Instruction Formats, Instructions Sets & Simple Assembly language programs, 8086 Interrupts.

Module – V (9 Hours)

Microcontroller: Introduction for Microcontrollers, Microcontrollers & Microprocessors, 8051 Microcontrollers. MCS-51 Architecture, Registers, Stack Pointer & Program Counter. 8051 Pin Description, Connections, Parallel I/O ports, Memory Organization, 8051 Addressing Modes & Instructions, 8051 Assembly Language Programming Tools. Simple application: Delay calculation, square wave generation.

Books:

[1]. 0000 to 8085 Introduction to Microprocessor for Scientists & Engineers by Ghosh & Sridhar, PHI

[2]. Fundamentals of Microprocessor & Microcontroller by B.RAM, Dhanpat Rai Publications.

[3]. Advanced Microprocessor and Peripherals (Architecture, Programming & Interfacing) by A.K.Roy&K.M.Bhurchandi- TMH Publication.

[4]. Microcontrollers, theory and applications, TMH, Ajay V. Deshmukh.

[5]. Microprocessor and Microcontroller by N Senthil Kumar, M. Saravanan and S. Jeevananthan, Oxford University Press.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Demonstrate knowledge on microprocessor and microcontroller.
CO2	Demonstrate an ability to write assembly language programming.
CO3	Describe the basic idea about the data transfer schemes and its applications.
CO4	Apply knowledge on design of different interfacing circuits and troubleshoot interactions between software and hardware.
CO5	Express on design of microprocessor/microcontroller-based systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Professional Elective – II

CONTROL SYSTEM-II (BEEPE601)

MODULE-I (6 HOURS)

Digital Control Systems: Advantages and disadvantages of Digital Control, Representation of Sampled process, The z-transform: The Z-transform, Z-transform of Elementary functions, Important properties and Theorems of the Z-transform. The inverse Transform, Z Transform method for solving Difference Equations.

MODULE-II (8 HOURS)

Z-Plane Analysis of Discrete Time Control Systems: Impulse sampling & Data Hold, Pulse Transfer function: Starred Laplace Transform of the signal involving Both ordinary and starred Laplace Transforms; General procedures for obtaining pulse Transfer functions, Pulse Transfer function of open loop and closed loop systems. Mapping between the s-plane and the z-plane, Stability analysis of closed loop systems in the z-plane: Stability analysis by use of the Bilinear Transformation and Routh stability criterion, Jury stability Test.

MODULE-III (8 HOURS)

State Variable Analysis and Design: Introduction, Concepts of State, Sate Variables and State Model, State Models for Linear Continuous-Time Systems, State-Space Representation Using Physical Variables, State – space Representation Using Phase Variables, Phase variable formulations for transfer function with poles and zeros, State – space Representation using Canonical Variables, Derivation of Transfer Function for State Model. Diagonalization: Eigenvalues and Eigenvectors, Generalized Eigenvectors.

MODULE-IV (8 HOURS)

Solution of State Equations: Properties of the State Transition Matrix, Computation of State Transition Matrix , Computation by Techniques Based on the Cayley-Hamilton Theorem, LT method, Sylvester's Expansion theorm. Concepts of Controllability and Observability: Controllability, Observability, Pole Placement by State Feedback, Observer based state feedback control.

State Variables and Linear Discrete – Time Systems: State Models from Linear Difference Equations/z-transfer Functions, Solution of State Equations (Discrete Case), An Efficient Method of Discretization and Solution, Derivation of z-Transfer Function from Discrete-Time State Model.

MODULE-IV (8 HOURS)

Nonlinear Systems: Introduction, Behaviour of Nonlinear Systems, Common Physical Non-linarites, The Phase-plane Method: Basic Concepts, Singular Points, Stability of Nonlinear System, Construction of Phase-trajectories, The Describing Function Method: Basic Concepts, Derivation of Describing Functions: Dead-zone and Saturation, Relay with Dead-zone and Hysteresis, Backlash. Stability Analysis by Describing Function Method: Relay with Dead Zone, Relay with Hysteresis, Jump Resonance. Signal Stabilization.

Liapunov's Stability Analysis: Introduction, Liapunov's Stability Criterion, The Direct Method of Liapunov and the Linear System, Methods of Constructing Liapunov Functions for Nonlinear Systems

TEXT BOOKS

[1]. K. Ogata, "Modem Control Engineering", PHI Publisher.
[2]. I.J. Nagrath, M. Gopal, "Control Systems Engineering", New Age International Publishers.

REFERENCE BOOKS

[1]. Khalil H.K., 'Nonlinear Systems', Prentice Hall Publications, 3rd Edition, 2002.
[2]. K.Ogata, "Discrete Time Control System", Pearson Education Asia Publisher.
[3]. M. Gopal, *Digital Control and State Variable Methods*, Tata McGraw-Hill

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Perform sampling and Z transform analysis of Digital control system.
CO2	Design transfer function model of digital control system and analyze its stability.
CO3	Construct state space analysis of LTI system.
CO4	Design pole placement controller and/or observer for the given system to achieve desired specifications.
CO5	Express knowledge on Nonlinear control systems and perform stability analysis of the dynamical systems using Lyapunov method.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

DIGITAL CIRCUITS & DESIGN (BEEPE602)

Module-I (08 hours)

Number system& codes: Binary Number base conversion, Octal &hexadecimalnumbers, complements, signed binary numbers, binary codes-BCD codes, gray codes, ASCII Character Code, Codes for serial data transmission &storage.Boolean Algebra & Logic gates: Axiomatic definition of BooleanAlgebra. Property of Boolean Algebra, Boolean functions, Canonical & standard form; min terms & max terms, standard forms; Digital Logic Gates, Multiple inputs.

MODULE-II (08 HOURS)

Gate level Minimization: The Map Method, K Map up to five variables, Product of Sum simplification, Sum of Product simplification, don't care conditions. NAND and NOR Implementation, AND-OR inverter, OR-AND inverter implementation, Ex-OR Function, parity generation& checking, Hardware Description Language (HDL). Combinational Logic: Combinational Circuits, Analysis &Design procedure; Binary Adder- subs tractor, Decimal Adder, Binary Multiplier, Magnitude comparator, Multiplexers and demultiplexers, Decoders, Encoders, Multipliers, Combinational Circuits design

MODULE-III (08 HOURS)

Synchronous Sequential logic: Sequential Circuit, latches, Flip-flop, Analysis of Clocked Sequential circuits, HDL for Sequential Circuits, State Reduction &Assignment, Design procedure.
Register &Counters: Shift Register, Ripple Counters, Synchronous Counter, Asynchronous Counter, Ring Counters, Module-n Counters, HDL for Register & Counters

MODULE-IV (08 HOURS)

Memory & Programmable logic: Random Access Memory (RAM),Memory , Decoding, Error detection & correction, Read only Memory, Programmable logic array ,Sequential Programmable Devices.
Digital Integrated Logic Circuits: RTL, DTL, TTL, ECL, MOS & C-MOS Logic circuits.

MODULE-V(07 HOURS)

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/Aconverter,specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit,analog to digitalconverters: quantization and encoding, parallel comparator A/Dconverter,successive approximation A/D converter, counting A/D converter, dual slope A/Dconverter,A/Dconverterusing voltagetofrequencyandvoltagetotimeconversion,specificationsofA/Dconverters, example of A/D converters.

Books

[1] Digital Design,3rd edition by M. Morris Mano, Pearson Education
[2] R.P. Jain, "Modern Digital Electronics", TATA McGraw-Hill Publishers

References Books:

[1] D. P. Kothari | J. S. Dhillon, "Digital Circuit and Design", PEARSON
[2] Fredriac J. Hill and Gerald R. Peterson "Introduction to Switching Theory and Logic Design", John Wiley & Sons Publishers.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Describe common forms of number representation in digital electronic circuits and to be able to convert between different representations.
CO2	Describe the gate level minimization technique by K-map and Boolean algebra and design of combinational circuits with its hardware implementation.
CO3	Design of sequential circuits with its hardware implementation.
CO4	Design and implement various ICs in the form of logic families. Know various programmable logic devices.
CO5	Analyze the process of Analog to Digital conversion and Digital to Analog conversion

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

RELIABILITY ENGINEERING (BEEPE603)

SYLLABUS

Module-I (8 hours)

Types of System, Qualitative and Quantitative assessment, Use of quantitative assessment, Reliability Definition and Concept, Reliability Indices and Criteria, Reliability and Availability, Absolute and Relative Reliability, Reliability Evaluation Technique, Reliability Improvement, Reliability Activities in System Design & its Economics, Basic Probability Theory, Binomial Distribution and its engineering applications.

Module-II (8 hours)

Network modeling concepts, Series & Parallel Systems, Series-Parallel System, Partially Redundant & Standby redundant System. Modeling and Evaluation Concept, Conditional Probability Approach, Cut Set Method, Application and Comparison of Previous Technique, Tie Set Method, Connection Matrix Technique, Event Trees, Fault Tree, Multi-Failure Mode.

Module-III (8 hours)

Distribution Concept & terminologies, General Reliability Function & their evaluation techniques, Shape of Reliability Function the Poison Distribution & the Normal Concept, Exponential, Weibull, Gamma, Rayleigh, Lognormal and rectangular distributions, Data Analysis, System Reliability Evaluation of different kinds of Using Probability Distributions, Mean Time to Failure, Wear out and Component Reliability, Maintenance and Component Reliability.

Module-IV (8 hours)

Discrete Markov Chains: General Modeling Concept, Stochastic Transitional Probability Matrix, Time Dependent Probability Evaluation, Limiting State Probability Evaluation, Absorbing States, Application of Discrete Markov Technique. Continuous Markov Process: General Modeling Concept, State Space Diagrams, Stochastic Transitional Probability Matrix, Evaluating Limiting State Probabilities, Evaluating Time Dependent State Probabilities, Reliability Evaluation in Repairable System, Mean Time to Failure, Application of Technique to Complex System.

Module-V (7 hours)

Frequency and Duration Technique: Application to Multistate Problems, Frequency Balance Approach, Two Stage Repair and Installation Process. Approximate System Reliability Evaluation. System with Non-Exponential Distribution. Monte Carlo Simulation.

Text Book

Roy Billinton, Ronald N. Allan. “Reliability Evaluation of Engineering Systems” Second Edition.

Reference Books:

Gupta A.K., Reliability, Maintenance and Safety Engineering, University Science Press

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe basic reliability engineering concepts.
CO2	Perform network modelling of simple and complex systems.
CO3	Apply probability distribution for reliability evaluation.
CO4	Apply discrete and continuous Markov processes for reliability evaluation.
CO5	Evaluate approximate reliability evaluation techniques.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

COMPUTER SYSTEM ARCHITECTURE (BEEPE604)

Syllabus

Module-I (09 Hours)

Introduction: Basic Organization of Computers, Classification Micro, Mini, Mainframe and Super Computer. System Bus and Interconnection, PCI, Computer Function, I-Cycle, Interrupt and Class of Interrupts, Von-Neumann M/c: Structure of IAS.ComputerArithmetic: Data Representation: Fixed Point Representation, Floating Point Representation. Addition and Subtraction, Multiplication Algorithm, Division Algorithm, Floating Point Arithmetic Operation, Decimal ArithmeticOperation.

Module-II (05 Hours)

CPUOrganization: Fundamental Concepts: Fetching and storing a word in Memory, Register Transfer, performing an Arithmetic & Logic Operation, Execution of a Completes, Branching.

Module-III (09 Hours)

GeneralRegisterOrganization: Control word, Examples of Microsoft, Stack Organization, Register Stack, Memory Stack, RPN, Evaluation of Arithmetic Expression using RPN, Instruction Format: Three Address, Two Address, One Address and Zero Address Instruction, Addressing Modes: Types of Addressing modes, Numerical Examples, Program Relocation, Compaction, Data Transfer & Manipulation: Data transfer, Data Manipulation, Arithmetic, Logical & Bit Manipulation Instruction, Program Control: Conditional Branch Instruction, Subroutine, Program Interrupt, Types of Interrupt, RISC & CISC Characteristic. Control Unit Operation: Hardware Control & Micro Programmed Control, Introduction to Pipelining.

Module-IV (06 Hours)

Input/outputOrganization: Peripheral Devices, input – output Interface, I/O Bus, Interface Module, Asynchronous Data Transfer, Strobe Control, Handshaking, Asynchronous Serial Transfer, Asynchronous Communication Interface, Modes of Transfer: Programmed I/O, Interrupt Driven I/O, Direct Memory Access (DMA), DMA Controller, I/O Channel& Processor. Priority Interrupt: Daisy Chaining Priority, Parallel Priority Interrupt.

Module-V (10 Hours)

MemoryOrganization: Computers Memory System Overview, Characteristics of Memory System, The Memory Hierarchy, Semi-Conductor Main Memory types, Organization, Memory cell Operation. Cache Memory: Cache Principles, Elements of Cache Design, Cache Size, Mapping function, Replacement Algorithm, LRU, FIFO, LFU, Write policy. Number of Caches: Single versus two level caches, Pentium Cache Organization. Associative Memory: Hardware Organization, Match Logic. Read Operation, Write Operation, Auxiliary Memory: Magnetic Disks, Magnetic Tape. Virtual Memory: Paging, Paging h/w, Address Mapping using pages, Segmentation h/w, Demand Paging, Memory Managementh/w.

Text Books:

[1]. William Stallings, "Computer Organization & Architecture", 7th Edition,PHI.

[2]. Morris Mano, "Computer System Architecture", 3rdEdition,PHI.

Reference Books:

[1]. V.CarlHamacher, Z.G.Vranesic, and S.G.Zaky, "Computer Organization", 5th Edition, McGrawHill.
[2]. John P. Hayes, "Computer Architecture and Organization" 3rd Edition, Mc Graw Hill InternationalEditions.
[3]. D.A.Patterson&J.L.Hennessy , "Computer Organization & Design" , 3rd Edition Morgan Kaufmann Publishers(Elseviers)
[4]. Hwang and Briggs, "Computer Architecture and Parallel Processing", Mcgraw Hill 1985.

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Describe about architecture of Computer.
CO2	Recognize the CPU organization.
CO3	Apply the knowledge Register organization.
CO4	Express the I/O organization.
CO5	Compile the memory organization.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Professional Elective – III

ELECTRIC DRIVES AND TRACTION (BEEPE605)

MODULE-I (10 HOURS)

Electrical Drives, advantages, elements of drive system, drive characteristics, criteria for selection of drive components, dynamics of motor drives, steady-state stability. Speed-torque characteristics of DC motor (starting, running, braking), size and rating of industrial motors (short time, intermittent, continuous), Mechanical considerations (enclosure, bearing transmission of drive, through chain, pulley and gears noise)

MODULE-II (8 HOURS)

Phase control of DC drive systems, steady state analysis of single-phaseconverter controlled DC motor Drive, chopper control of DC drives, Principle of operation of the chopper, Duty-ratio control, current-limit control, steady state analysis, four quadrant chopper circuit and chopper for inversion.

MODULE-III (10 HOURS)

Speed-torque characteristics of AC motor (starting, running, braking), Speed control of VSI fed V/f and PWM control scheme of induction motor drive system – dynamic and regenerative braking, stator voltage control, rotor resistance control, Slip power recovery control, static Scherbius drives and modified Kramer drives, Introduction to vector control of induction motor.

MODULE-IV (7 HOURS)

Need for leading PF operation, Open loop VSI fed drive and its characteristics–True mode and Self-control of synchronous motor, Synchronous motor variable speed drive, Variable frequency control of multiple synchronous motor, Self control synchronous motor drive employing load commutated thyristor inverter, Sinusoidal PMAC motor drives, Brushless dc (or trapezoidal PMAC) motor drives.

MODULE-V (10 HOURS)

Advantages of Electric Traction, Mechanics of train movement, Speed - time curve for train movement, Requirement of tractive effort and T-N curve of a typical train load, Specific energy consumption & Factors affecting Adhesion & Coefficient of adhesion, Important Features of Traction Drives, conventional DC and AC Traction drives, Semiconductor Converter Controlled Drives- DC Traction using Chopper Controlled Drives, DC /AC Traction employing Poly-phase motors.

Recommended Books

1. G. K. Dubey &C.R.Kasaravada ,"Power Electronics & Drives", Tata McGraw Hill,1993.
2. R. Krishnan, Electric Motor Drives - Modeling, Analysis and Control Prentice- Hall of India Pvt. Ltd., New Delhi, 2003.
3. Partab," Modern Electric Traction", Dhanpat Rai & Sons.

References

1. Ned Mohan," Power Electronics and drives", et. al, Wiley 2006
2. BimalK.Bose, Modern Power Electronics and AC Drives, Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.
3. Upadhayay J. & Mahindra S.N., "Electric Traction", Allied Publishers Ltd., 1st Ed.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Apply the knowledge of modern electrical drives for selection of motor drives.
CO2	Analyze the torque-speed characteristics of DC motors and the phase controlled and DC-DC chopper drives in motoring and braking modes.
CO3	Analyze the torque-speed characteristics of AC motors and speed control of induction motor using power electronics converters in motoring, braking and transient operations and vector control of induction motors.
CO4	Apply the power factor corrections in industrial loads and application of synchronous motor in product industries.
CO5	Evaluate the electric traction technologies and movement of electric trains and the control drives of electric motor in locomotive trains.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ENGINEERING OPTIMIZATION (BEEPE606)

Syllabus

Module-I (8 hours)

Statement of an optimization problem, classical optimization techniques: single variable optimization, unconstrained and constrained multivariable optimization problems, Karush-Kuhn-Tucker (KKT) conditions, convex programming problem.

Module-II (8 hours)

Linear programming problem, simplex algorithm, duality, transportation model and its variants.
Nonlinear programming algorithms: direct search method, gradient method, separable programming, quadratic programming, chance constrained programming.

Module-III (8 hours)

Overview of the geometric programming problem. Dynamic programming: multi-stage decision process, computational procedure. Integer programming: solution using cutting-plane method, branch-and-bound method. Mixed-integer programming problems.

Module-IV (8 hours)

Stochastic processes: review of basic probability, empirical distributions, Monte carlo simulation. generation of discrete and continuous random variables, joint distribution and copula.
Decision making under certainty, risk and uncertainty, game theory. Markov chains.

Module-V (7 hours)

Multiobjective optimization: pareto optimality, selection using fuzzy membership, weighting method, utility function method, global criterion method, goal programming method.
Concept of heuristic and meta-heuristic methods, Derivative free optimization, Genetic algorithms, neural networks, swarm optimization techniques.

Books

1. S.S.Rao, “Engineering Optimization”, 3rd Ed.,New Age International (P) Ltd,New Delhi, 2007
2. H.A. Taha, Operations Research, An Introduction, PHI, 2008

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe classical optimization techniques to solve optimization problems
CO2	Construct and analyze linear and nonlinear programming problems.
CO3	Construct and analyze dynamic programming and integer programming problems.
CO4	Apply stochastic processes and tools for solving decision making problems.
CO5	Apply multi-objective optimization and evolutionary programming techniques.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

BIO-MEDICAL INSTRUMENTATION (BEEPE607)

Syllabus

Module-I (10 Hours)

Basic physiological system of the body: Problems encountered in measuring living systems, bioelectric potentials, biomaterials, Basic Transducer Principles: Active and passive transducers, Transducers for biomedical applications, Generation, propagation and distribution of bioelectric potentials (ECG, EEG and EMG)
Bio potential electrodes: Basic types (micro, skin surface and needle electrodes), biochemical transducers (PH, blood, gas and specific ions electrodes).

Module-II (5 Hours)

The cardiovascular system and measurements: Heart and cardiovascular system and circulation block diagram, blood pressure and measurement, characteristics of blood flow and heart sounds, Electrocardiography, ECG lead configurations, ECG recording and their types.

Module-III (10 Hours)

The Nervous System: The anatomy of nervous system, Neuronal communication EPSP & IPSP Organization of the brain, Measurements from the nervous system
Systemic Body & Skin Temperature Measurement: Temperature measurements, Brief idea about ultrasonic measurements.

Module-IV (10 Hours)

Patient care monitoring: Elements of intensive care: Organization of the Hospital for patient care monitoring, Pace-makers types, systems, modes and generators, Defibrillators types, Bio telemetry and applications of telemetry in patient care.

Module-V (4 Hours)

Automation of chemical tests, Instrumentation for diagnostic X Rays, Interfacing computer with medical instrumentation and other equipment, biomedical computer applications, Shock hazards from electrical equipment, methods of accident prevention.

TEXT Books

[1] R.S. Khanpur, "Handbook of Biomedical Instrumentation", TMH Publisher.
[2] Cromwell, F.J.Weibell&F.A.Pfieffer, "Biomedical Instrumentation & Measurements", PHI Publisher.

REFERENCE Books

[1] Webster J S –Medical Instrumentation-Application & Design
[2] Astor B R–Introduction to Biomedical instrumentation & measurement, McMillan.
[3] Mandeep Singh-Introduction to Biomedical Instrumentation, 2nd Edition, PHI

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Course Outcomes

Upon completion of the course students will:

CO1	Express the knowledge about human physiology system and electrodes & transducers used in human body
CO2	Describe the principle and basic function of cardiovascular system in humans
CO3	Get idea on the nervous system of human body
CO4	Apply the knowledge on health care workers' dependence on technology to administer care or treatment or to make a diagnosis.
CO5	Express the knowledge on principles, applications, imaging and design of the medical instruments most commonly used in the hospital

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

SENSOR TECHNOLOGY (BEEPE608)

Syllabus:

MODULE-I (7 Hours)

Measurement and Instrumentation: General concepts of Measurement, Instruments and Instrumentation, static and dynamic characteristics, error probability density function, least squares calibration curves, calibration of measuring instruments. Loading effect and two-port networks. Introduction to Sensor, Actuator, Transducer, Inverse Transducer, Smart / Intelligent Sensors: Analog and Digital Signal Conditioners. Classification of transducers.

MODULE-II (8 Hours)

Measurement of Electrical variables: Classifications and Limitations of Electromechanical Instruments. Classifications and Benefits of Digital Measuring Instruments. Hall-effect magnetometers: voltage sensor and current sensor. Proximity sensors: Capacitive and Inductive type probes/ pickups, RF probes. Optoelectronic transducers.

MODULE-III (8 Hours)

Measurement of Physical parameters: Working principle and design of conventional sensors and smart sensors to measure physical parameters like Temperature, Pressure, Level and Flow. LVDT, Strain Gauge, Vibration Transducer, Seismic measurement: displacement, velocity & Acceleration pickups, Piezo-resistive and Piezoelectric transducers; Moisture and/or Humidity sensors, Gas Sensors. Case studies.

MODULE-IV (8 Hours)

Signal Conditioning Devices: 1-arm, 2-arm and/or 4-arm active bridges; Resistive deflection bridges, Reactive deflection bridges; OPAMP based: Instrumentation amplifier, Charge amplifier & Impedance converters, V/I converter and I/V converter, Integrator & Differentiator; Filters; A/D and D/A conversions: sampling, quantization, encoding, and converters. TDM, FDM and WDM.

MODULE-V (8 Hours)

Digital Storage Oscilloscopes, DSO applications. Digital voltmeters, multi-meters and frequency meters. Signal Generators: LF signal generators; function generators; RF signal generators; sweep frequency generators and frequency synthesizers. Inductive and Capacitive measurements: Digital RCL meters, Q-meter. True RMS meter. Harmonic distortion meter.

Locating cable faults and methods of rectifying it. Introduction to EMC, interference coupling mechanism, basics of circuit layout and grounding, concept of interfaces, filtering and shielding.

Books:

1. John P. Bentley, “Principles of Measurement Systems”, Third edition, Pearson India, 2017.
2. David A. Bell, “Electronic Instrumentation and Measurements”, Third edition, Oxford University Press, 2013.
3. Ernest O. Doebelin and Dhanesh N. Manik, “Doebelin’s Measurement Systems”, Sixth edition, McGraw-Hill India, 2013.

References books:

1. James W. Dally, William F. Riley, and Kenneth G. McConnell, "Instrumentation for Engineering Measurements", Wiley student edition, Second edition, 2013.
2. Kim R. Fowler, "Electronic Instrument Design – Architecture for the Life cycle", Oxford University Press, 11th India edition, 2012.
3. ManabendraBhuyan, "Intelligent Instrumentation – Principles and Applications", CRC Press, 2012.

Course Outcome:

Upon completion of the course, students will be able to:

CO1	Describe the principles of measurement and instrumentation in commercial and industry environments;
CO2	Recognize mechanical or smart sensor/actuator as per specifications, and to measure the specific electrical variables in real-time;
CO3	Apply knowledge on a mechanical or smart sensor/actuator as per specifications, and to measure the physical parameters;
CO4	Express the need of the most appropriate signal conditioning (SC) devices and design of analog or digital SC circuits;
CO5	Produce idea on the need of recording and display devices along with need of communication links and safety measures as per industry standards and practices.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Sessional

ELECTRICAL MACHINE DESIGN (BEE06005)

Syllabus

1. To study the magnetic circuit design of electrical machines.

2. To study thermal design aspects of electrical machines.
3. To study the armature winding design of D.C machine.

4. To study the design of DC machine and preparation of design chart.

4. To study the design of transformer.

5. To study the design of induction motor.

6. To study the choice of specific magnetic & electric loadings of a synchronous motor.
(all the above-mentioned design to be computed using MATLAB software)

Essential Reading

1. A.K. Sawhney and A. Chakrabarti, *A Course in Electrical Machine Design*, Dhanpat Rai Publishers, New Delhi , 2006
2. P.S.Bimbhra, *Electrical machinery*, Khanna Publishers, New Delhi, 1975.
3. Say, Maurice George, and Eric Openshaw Taylor. *Direct current machines*. Pitman, 1986.

Course Outcomes

Upon completion of the course, the students will

CO1	Describe magnetic circuit design and thermal design aspects of electrical machine.
CO2	Design a D.C machine of any rating
CO3	Apply the knowledge on the design transformer
CO4	Express idea on design induction motor and will understand about the choice of magnetic& electric loading of a synchronous motor.
CO5	Describe application of MATLAB software to the above design problems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

MICROPROCESSOR AND MICROCONTROLLER LAB (BEE06003)

Syllabus:

1. Verification of basic instruction set of 8085 microprocessors.
2. Verification of additional instruction set of 8085 microprocessors.
3. Addition and subtraction of two 8-bit numbers resulting in 8/16-bit number using 8085.
4. Multiplication and division of two 8-bit numbers resulting in 8/16-bit number using 8085.
5. (a) Find smallest and largest number among 'n' numbers in a given data array using 8085.
   (b) Write an assembly language program of binary to gray code conversion in 8085.
6. Write a program to generate square waves of different frequencies on all lines of 8255 by the help of delay program.
7. Study of stepper motor and its operations (clockwise, anti-clockwise, angular movement and rotation in various speeds).
8. Study of different addressing modes of 8051 microcontrollers.
9. Addition and subtraction of two 16-bit numbers using 8051.
10. Multiplication and division of two 16-bit numbers using 8051.

Course Outcomes

Upon completion of the course, the students will be able to:

CO1	Perform different mathematical operations using microprocessor.
CO2	Demonstrate an ability to write assembly language programming.
CO3	Perform different tasks using programmable devices and work with different interfacing circuits.
CO4	Demonstrate stepper motor using microprocessor.
CO5	Produce different types of waveforms.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

POWER SYSTEM LABORATORY-I (BEE06004)

Syllabus:

1. Determination of operating characteristics of biased differential relay.
2. Determination of operating characteristics of an induction type overcurrent relay.
3. Operation and performance of Numeric Relays.
4. Operation and performance of Microprocessor based relays.
5. Study of Ferro resonance phenomenon of no-load, light load & critical load conditions.
6. Determination of A, B, C, D parameters of an artificial transmission line a transmission line.
7. Performance analysis using transmission line simulator.

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Demonstrate the operation of electromagnetic relays.
CO2	Demonstrate the operation of numeric and digital relays.
CO3	Implement relay setting.
CO4	Demonstrate ferroresonance phenomenon.
CO5	Demonstrate the determination of A, B, C, D parameters experimentally.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

Open Elective-II (Sixth Semester)

EMBEDDED SYSTEM (BEEOE601)

Syllabus

MODULE – I (8 hours)

Introduction to Embedded System: What is embedded system, History of embedded systems, classification of embedded system, Major application area of embedded system ,Purpose of embedded system, Typical Embedded sys: Core of embedded system, Memory, Sensors ,Actuators , Communication Interface, Embedded Firmware Other system component, PCB and Passive components.

MODULE – II (8 hours)

Hardware Software co-design and programming model, Fundamental Issues in Hardware –Software co design, Computational model Embedded System, , Hardware software trade off, Embedded Hardware design and development : Analog design components, Digital Electronics component, Embedded Firmware design and development, Embedded Firmware design approach

MODULE –III (8 hours)

Introduction to unified modelling language (UML), VLSI and Integrated Circuit design, , , Embedded firmware development language , Programming in Embedded C.

MODULE – IV (8 hours)

Real Time operating system (RTOS) based embedded system design, Types of operating systems, Task process and threads, Multiprocessing and multi-tasking, Task scheduling, Thread and process scheduling, putting task communication, Task synchronization, Device drivers, Task synchronization, Task scheduling, Thread and process scheduling, putting task communication, Task synchronization, Device drivers, how to choose RTOS.

MODULE – V (7 hours)

Embedded system Development environment (IDE), Types of files generated on cross compilation, Dissembler / De compiler, Simulators, Emulator, Debugging, Design Case studies, Digital Clock, Battery operated smart card Reader, Automated meter reading system (AMR), Digital Camera.

TEXT Books

[1]. Shibu K.V, “Introduction to Embedded Systems”,TMH Publication.

[2]. Rajkamal, “Embedded Systems –Architecture, Programming and Design”, TMH Publication.

REFERENCE BOOKS

[3]. Frank Vahid, Tony D. Givargis, “Embedded System Design – A Unified Hardware/Software Introduction”,John Wiley Publisher.

[4]. David E. Simon, “An Embedded Software Primer”, PHI Publication.

Course Outcomes

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe embedded system. Processor , memory , sensor , actuator
CO2	Design and programming model
CO3	Design UML programming , VLSI programming , Embedded C programming
CO4	Express knowledge on Real time programming
CO5	Implement Integrated development environment and demonstrate embedded system

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

MICROPROCESSOR AND MICROCONTROLLER (BEEOE603)

Syllabus

MODULE-I (9 HOURS)

Microprocessor Architecture: Introduction to Microprocessor and Microcomputer Architecture, Pins & Signals, Register Organization, Timing & Control Module, 8085 Instruction Timing & Execution.

Instruction Set and Assembly Language Programming of 8085: Instruction set of 8085, Memory & I/O Addressing, Assembly language programming using 8085 Instruction Set.

MODULE-II (6 HOURS)

Use of Stack & Subroutines, Data transfer techniques, 8085 interrupts.

Interfacing & support chips: Interfacing EPROM & RAM Memories, 2716, 2764, 6116 & 6264, Interfacing of I/O devices with 8085, Partial address decoding for memory and I/O devices.

MODULE-III (6 HOURS)

Microprocessor Based System Development Aids, Programmable Peripheral Interface: 8255, Programmable DMA Controller: 8257, Programmable Interrupt Controller: 8259

Application: Delay calculation, square wave generation, Interfacing of ADC & DAC, Data Acquisition System.

MODULE-IV (9 HOURS)

Advanced Microprocessor: Basic features of Advance Microprocessors, Intel 8086 (16 bit processors): 8086 Architecture, Register organization, signal descriptions, Physical Memory Organization, Addressing Modes, Instruction Formats, Instructions Sets & Simple Assembly language programs, 8086 Interrupts.

Module – V (9 Hours)

Microcontroller: Introduction for Microcontrollers, Microcontrollers & Microprocessors, 8051 Microcontrollers. MCS-51 Architecture, Registers, Stack Pointer & Program Counter. 8051 Pin Description, Connections, Parallel I/O ports, Memory Organization, 8051 Addressing Modes & Instructions, 8051 Assembly Language Programming Tools. Simple application: Delay calculation, square wave generation.

Books:

[1]. 0000 to 8085 Introduction to Microprocessor for Scientists & Engineers by Ghosh & Sridhar, PHI

[2]. Fundamentals of Microprocessor & Microcontroller by B.RAM, Dhanpat Rai Publications.

[3]. Advanced Microprocessor and Peripherals (Architecture, Programming & Interfacing) by A.K.Roy&K.M.Bhurchandi- TMH Publication.

[4]. Microcontrollers, theory and applications, TMH, Ajay V. Deshmukh.

[5]. Microprocessor and Microcontroller by N Senthil Kumar, M. Saravanan and S. Jeevananthan, Oxford University Press.

Course Outcomes:

Upon completion of the course, the students will:

CO1	Apply the knowledge on microprocessor and microcontroller.
CO2	Demonstrate an ability to write assembly language programming.
CO3	Describe the basic idea about the data transfer schemes and its applications.
CO4	Design of different interfacing circuits and troubleshoot interactions between software and hardware.
CO5	Apply the knowledge on the design of microprocessor/microcontroller-based systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ELEMENTS OF POWER ELECTRONICS (BEEOE602)

MODULE-I (8 HOURS)

Thyristors, Static V-I Characteristics of SCR, TRIAC, GTO & IGBT, Turn-On &Turn-OFF Mechanism of SCR, Insulated Gate Bipolar Transistors (IGBTs) - Basic Structure and VI Characteristics. Static, dynamic and thermal characteristics. Series and Parallel operation of devices. Triggering and basics of driver circuits.

MODULE-II (8 HOURS)

1-Phase Half & Full Wave Controlled Rectifier with various kinds of loads (R, R-L-E (motor)). Midpoint and Bridge type converters. Half Controlled and Fully Controlled Bridge circuits Inverter Mode of Operation. Continuous and discontinuous modes. Effect of freewheeling diode. Three phase bridge converters for different types of load with constant load current, different waveforms. 180- and 120-degree operations.

MODULE-III (8 HOURS)

DC-DC Converters: Classification of types of choppers, One, Two and Four quadrant operations, Step up and down choppers, Analysis of Type-A chopper, Single-and two quadrant operation with DC motor load.

MODULE-IV (8 HOURS)

Single-phase Half and Full bridge Inverter, Pulse Width Modulated (PWM) technique for voltage control, SPWM Technique 1-phase inverters, Three-phase Voltage Source Bridge type of Inverters. (120 and 180 Degree conduction modes), Current Source Inverter.

MODULE -V (8 HOURS)

AC-AC Converters: Single-phase mid-point and bridge types of step-up and step-down Cyclo-converters. Single phase AC Voltage regulators and its basic analysis, Applications: UPS, SMPS, Induction Heating, Electronic Ballast, AC/DC drives speed control.

Text Books:

1. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.
2. P. S. Bimbhra, Power Electronics, Khanna Publishers.

Reference Books:

1. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
2. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India,2009.

Course Outcomes

Upon completion of the course, the students will:

CO1	Apply the knowledge on the basic of power electronic devices.
CO2	Describe the principle of AC-DC rectifiers.
CO3	Express knowledge on the principle of DC-DC chopper.
CO4	Describe the principle of DC-AC inverter.
CO5	Define AC-AC converter.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Seventh Semester

HIGH VOLTAGE ENGINEERING (BEE07002)

MODULE-I (9 HOURS)

Conduction and breakdown in gases: Ionisation processes. Townsend current growth equation. Current growth in the presence of secondary processes. Townsend's criterion for breakdown. Experimental determination of ionization coefficients. Breakdown in electronegative gases, time lags for breakdown, streamer theory of breakdown in gases, Paschen's law, Breakdown in non-uniform field and corona discharges, Penning effect, Vacuum breakdown.

MODULE-II (7HOURS)

Conduction and breakdown in liquid dielectrics: Pure liquids and commercial liquids, conduction and breakdown in liquids.

Breakdown in solid dielectrics: Introduction, Intrinsic brakdown. Electromechanical breakdown, Thermal breakdown. Solid dielectrics in practice. Applications of nanofilled materials for outdoor and indoor insulation

MODULE-III (8 HOURS)

Generation of high voltages and currents: Generation of high D.C, voltages, Generation of high alternating voltages, Generation of Impulse voltages. Tripping and control of impulse generators. Generation of Impulse currents.

MODULE-IV (7 HOURS)

Measurements of high voltages and currents: Measurement of high D.C. voltages. Measurement of high D.C. and impulse voltages. Introduction.. Measurement of high D.C. A.C. and impulse currents, cathode ray oscillographs for impulse voltages and currents measurements.

MODULE-V (8 HOURS)

High voltage testing of electrical power apparatus: Testing of insulators and bushings. Testing of isolators and circuit breakers, cables. Testing of transformers, surge diverter

Non destructive testing of materials and electrical apparatus: Introduction. Measurement of D.C. resistivity. Measurement of dielectric constant and loss factor. Partial discharge measurements.

Radio Interference measurements.

BOOKS

1. M.S. Naidu and V. Kamaraju, *High Voltage Engineering,* Tata McGraw-Hill, 5th Edition, 2018.
2. E.Kuffel, W.S. Zaengl, and J.Kuffel "High Voltage Engineering Fundamentals", Second edition 2000, published by Butterworth-Heinemann
3. C.L.Wadhwa, "High Voltage Engineering", Third Edition, New Age International Publishers, 2012

References

1. Hugh M.Ryan,(ed) "High Voltage Engineering & Testing", 3rd Edition, The Institution of Engineering and Technology, IET series. 2001
2. M. Abdel-Salam, H. Anis, A. El-Morshedy, R. Radwan, High-Voltage Engineering – Theory and Practice, 2nd edition, Marcel Dekker, Inc,(Special Indian Edition) 2010.

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Describe various types of insulating materials (gaseous, liquids, solids, vacuum, composites) and their applications in high-voltage equipment.
CO2	Describe the breakdown phenomenon in air, solid and liquid insulation
CO3	Apply knowledge on applying techniques for generation of high voltage and high current.
CO4	Describe basic measurement of high voltage and current for testing purposes.
CO5	Describe testing high voltage electrical equipment with various testing devices

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

POWER SYSTEM OPERATION & CONTROL (BEE07001)

Prerequisite Subjects

Electrical Machines, Network Theory, Power Station Engineering, Electric Power Transmission and Distribution, Control System, Power Electronics

Syllabus

Module-I (8 Hours)

Concept of real and reactive powers, Complex power, Transmission capacity, The static load flow equations(SLFE), Definition of the load flow problem, Network model formulation, A load flow sample study, Computational aspect of the load flow problem. Gauss Siedel and Newton Raphson method for power flow fast decoupled load flow.

Module-II (8 Hours)

Power System Stability: Steady State Stability, Transient stability, Swing equation, Equal area criterion for stability, critical clearing angle, point by point Methods of improvement of transient stability. Voltage stability, concept, causes and counter measures, Voltage stability indices.

Module-III (6 Hours)

Economic Operation of Power System: Distribution offload between units within a plant, Transmission losses as function of plant generation, Calculation of loss coefficients, Distribution of loads between plants with special reference to steam and hydel plants, Automatic load dispatching. Optimal Power Flow.

Module-IV (10 Hours)

Symmetrical and unsymmetrical fault analysis for power system, L-G, L-L-G, three phase fault anlaysis, Z bus Algorithm, Z bus method in fault analysis.

Module-V (8 hours)

Load frequency control, PF versus QV control, Modelling of speed governing system, Division of power system into control areas, Single area control and two area control. On load tap changing transformer and block regulating transformer, effects of regulating transformers.

Books

[1]. John J Grainger, W. D. Stevenson, *"Power System Analysis",* TMH Publication

[2]. P. Kundur, "Power System Stability and Control", TMH Publication

[3]. C. L. Wadhwa, *"Electric Power System",* New Age Publishers.

Course Outcome

Upon completion of the course, the students will demonstrate the ability to:

CO1	Compute load flow solution by using different techniques
CO2	Assess the stability of a power system.
CO3	Determine the economical load distribution between the generating buses incorporating the transmission losses.
CO4	Compute the state of power system following the different types of faults.
CO5	Describe automatic generation control schemes and methods to analyze active and reactive power control on a power system using simulation tools.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Professional Elective- IV

FLEXIBLE AC TRANSMISSION SYSTEM (BEEPE701)

Syllabus

Module-I (8 hours)

FACTS concepts and general system considerations: Power flow in AC system, transient stability and dynamic stability, basic description of FACTS controllers, brief review of voltage sourced converter and current sourced converter, modelling philosophy.

Module-II (8 hours)

Static var compensator (SVC and STATCOM): objectives of shunt compensation, methods of controllable Var Generation, regulation slope, transfer function, V-I and V-Q characteristics, transient stability enhancement, var reserve control, conventional power flow models, shunt variable susceptance model, firing angle model, transient stability model, voltage magnitude control using SVC & STACOM, Application example.

Module-III (8 hours)

Static Series compensators (TCSC and SSSC): objectives of series compensation, improvements of voltage and transient stability, power oscillation damping, sub-synchronous damping, transmittable power and transmittable angle characteristics, control range, conventional power flow models, variable series impedance model, firing angle model, transient stability model, active power flow control using TCSC & SSSC, Application example.

Module-IV (8 hours)

Static voltage and phase angle regulator (TCVR and TCPAR): objectives of voltage and phase angle regulators, approaches to TCVR and TCPAR, switching converter based voltage and phase angle regulators, Unified power flow controller: Basic operating principles, transmission control, independent real and reactive power flow control, power flow models, transient stability model, control structure, basic control system for P and Q control, dynamic performance, Application example.

Module-V (7 hours)

Brief control studies such as Steady state analysis and control, EMTP studies, power oscillation stability analysis and control, transient stability control.

RECOMMENDED BOOKS

1. Y. H. Songs, A. T. Johns, “Flexible AC Transmission Systems”, IEE Press, 1999
2. N. G. Hingorani, L. Gyugyi, “Understanding FACTS”, IEEE Press, Indian Edition, 2001.
3. E. Acha, “FACTS: Modelling And Simulation In Power Networks”, John Wiley & Sons, 2004.
4. K. R. Padiyar ,”FACTS Controllers in Power Transmission & Distribution”, New Age International Publishers.
5. Vijay K. Sood , “HVDC and FACTS Controller: Applications of Static Converters in Power Systems” , Kluwer Power Electronics & Power System Series , 2006.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Apply knowledge on the basic philosophy of FACTS devices and modelling and control aspect of FACTS devices..
CO2	Describe and analyze fundamental function of SVC and STATCOM.
CO3	Describe and analyze power system operation with TCSC and SSSC.
CO4	Describe and analyze power flow control using TCVR, TCPAR and UPFC.
CO5	Apply comprehensive control of power system using FACTS devices.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

DIGITAL SIGNAL PROCESSING (BEEPE703)

Syllabus

Module-I (8 hours)

Discrete time signal and system: discrete- time signals (some elementary examples, classification of discrete-time signals), discrete- time system (block diagram representation, classification and interconnection of discrete time system), analysis of discrete time linear time-invariant system (response of LTI systems to arbitrary inputs, properties of convolution and interconnection of LTI systems, casual linear time-invariant systems, stability of linear time-invariant system), discrete-time systems described by difference equations, structure of LTI system, recursive and non-recursive realization of FIR systems, correlation of discrete time system.

Module-II (8 hours)

The Z-transform: The Z-transform, properties of Z-transform, inverse of Z-transform, the one-sided Z-transform.

The Discrete Fourier transform: frequency domain sampling, the DFT, relationship of DFT to other transforms, properties of the DFT, circular convolution, circular correlation, circular correlation by convolution, method linear convolution by overlap save method and by overlap add method.

Module-III (8 hours)

Fast Fourier transform: operation counts by direct computation of DFT, divide and conquer approach to computation of the DFT, radix-2 FFT algorithm, decimation-in-time (DIT) and decimation-in frequency (DIF) algorithm, efficient computation of the DFT of real sequences and a 2N-point real sequence.

MODULE-IV (7 hours)

Design of digital filter: causality and its implementation, design of linear phase FIR filters using different windows, design of IIR impulse response method and bilinear transformation method.

MODULE-V (8 hours)

Power spectrum estimation: Estimation of spectral from finite duration signals, Non-parametric method of power spectrum estimations. The Bartieff method and the Blackman and Tukey method. Implementation of Discrete Time System structure of FOR Systems-Direct form, cascaded form. Structure IIR Systems - Direct form 1&11 realizations.

TEXT BOOKS

[1]. J.G. Proakis and D.G.Manolakis, "Digital Signal Processing - Principles, Algorithms and Applications", PHI Publisher.

[2]. SanjitMitra "Digital Signal Processing – A Computer based approach" TMH Publisher.

REFERENCE BOOKS

[1]. S.Salivahanan, "Digital Signal Processing", TMH Publisher.

[2]. J.R.Johnson, "Introduction of Digital Signal Processing", PHI Publisher.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Analyze Discrete Time Signal, System and Discrete Time LTI system.
CO2	Apply Z transform and DFT in Discrete Time Signal.
CO3	Apply FFT in Discrete Time Signal.
CO4	Design and create Digital Filter.
CO5	Describe Power Spectral Estimation of Discrete Time Signal.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

COMMUNICATION SYSTEM (BEEPE704)

Syllabus:

Module-I (8 Hours)

Elements of Communication System-Analogue System, Digital System, Distinguishing features. Electromagnetic Spectrum. Bandwidth. Comparison between Analogue & Digital Communication Systems. Baseband Signals, Analogue Signal, Digital Signal. Converting an analogue signal to Digital Signal: Sampling, Nyquist Criteria. Information and Sampled value. Quantization and Binary Coding of sampled values. Transformation of Base band signal from Time domain to Frequency domain and Vice-versa. F.T.of few simple baseband signals.

Module-II (8 Hours)

Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM). Inter Symbol Interference and Crosstalk. Modulation Techniques: Need for Modulation, Analogue Modulation Techniques: Amplitude Modulation (AM), Depth of Modulation, Modulated Waveform, Powers in Carrier, and Sidebands, Generation of DSBC, VSB and SSB, Balanced Modulator, AM Demodulators.

Module-III (8 Hours)

Frequency Modulation (FM) - Frequency Deviation, Frequency Modulated Waveform, Spectrum. Narrow Band FM and Wideband FM. Generation of FM; Narrow Band FM Modulator, Wideband FM Modulator, FM Discriminator, Pre-emphasis and De-emphasis. Digital Modulation Techniques: Phase Shift Keying (PSK), Frequency Shift Keying (FSK) – their Basic Principle, Waveform, Generation and Detection.

Module-IV (8 Hours)

Noises in Communication Systems: Sources of Noise, White noise, Narrow Band Noise. Spectral Density Function of Noise (no derivation explaining its utility in noise performance a Communication System). Noise bandwidth, Available Power, Noise temperature Two port noise Bandwidth, Input Noise Temperature, Noise Figure, Equivalent noise temperature of a cascade. An example of a receiving system.

Module-V (7 Hours)

Modern Communication Systems:

Brief description of fiber optic communication System: Block Diagram, Range of operating Wavelength, Optical Fiber, Optical Sources and Detectors: Advantages of fiber optic system.

Brief description of Satellite Communication Systems: Block diagram. Frequency bands of operation, uplink and down link frequencies, Transponder, earth stations, Services available through satellite. Cellular Communication System: Block Schematic description, Cellular frequency bands, Cellular Concept.

Text Books

[1] S. Haykin, Communication systems, John Wiley.

[2] B. P. Lathi, Modern Digital and Analog Communication Systems, Oxford University

Reference Books

[1] Communication Systems by R. P. Singh and S. D. Sapre. TMH

[2] Principle of Communication System by H.Tanb and D. L. Shilling.

Course Outcomes

Upon completion of the course, the students will:

CO1	Describe basic of communication system
CO2	Apply the knowledge on the multiplexing technique and amplitude modulation
CO3	Demonstrate understanding of various analog and digital modulation and demodulation techniques.
CO4	Analyze the noise in communication systems.
CO5	Demonstrate knowledge of optical fibre systems, mobile communication and satellite systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ELECTRICAL ENGINEERING MATERIALS (BEEPE705)

Syllabus

MODULE-I (8HOURS)

Conductivity of Metal: Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, energy levels of a molecule, emission of electrons from metals, thermionic emission, photo electric emission, field emission, effect of temperature on electrical conductivity of metals, electrical conducting materials, thermal properties, thermal conductivity of metals, thermoelectric effects

MODUL-II (8HOURS)

Dielectric properties: Introduction, effect of a dielectric on the behavior of a capacitor, polarization, the dielectric constant of monatomic gases, frequency dependence of permittivity, dielectric losses, significance of the loss tangent, dipolar relaxation, frequency and temperature dependence of the dielectric constant, dielectric properties of polymeric system, ionic conductivity in insulators, insulation materials, ferroelectricity, piezoelectricity.

MODUL-III (8HOURS)

Magnetic properties of Materials: Introduction, Classification of magnetic materials, diamagnetism, Para magnetism, ferromagnetism, magnetization curve, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials, magnetic resonance.

MODUL-IV (8HOURS)

Semiconductors: energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semiconductor, diffusion, the Einstein relation, hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials.

MODUL-V (7HOURS)

Measurement of Electrical and Magnetic Properties: Introduction, Conductivity measurement, Dielectric measurement, Magnetic measurement, Measurement of semi-conductor parameters.

TEXT BOOK

[1]. C.S.Indulkar and S.Thiruvengadam, S, An introduction to Electrical Engineering Materials S.Chand and Company Ltd. Publisher.

[2]. Kenneth g.Budinski', Engineering Materials PHI. Publisher.

REFERENCE BOOKS

[1]. S.P.Seth, A Course in Electrical Engineering Materials Dhanpat Rai Publisher.

[2]. Technical Teachers Training institute, Madras, Electrical Engineering Materials TMH Publisher.

Course Outcomes

Upon completion of the course, the students will:

CO1	Describe various aspects of conductivity of material.
CO2	Apply knowledge about the various dielectric properties of material.
CO3	Recognize the various magnetic properties of material.
CO4	Describe factors affecting properties of material.
CO5	Recognize the properties of semiconductors.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

POWER QUALITY (BEEPE702)

Syllabus:

MODULE-I (8 HOURS)

PQ Definitions and Standards General Classification of PQ Phenomena IEEE and IEC PQ Standards, PQ Monitoring and Measuring Available monitoring techniques and their drawbacks Commercial power quality monitors, Power quality monitors sensitivity PQ Problems Identification, PQ Phenomena Classification Identification and localization of PQ problems Different PQ classification techniques and case studies

MODULE-II (8HOURS)

Harmonic Sources, Effects, Analysis, and Modeling, Harmonic Distortion Mitigation Voltage vs. Current Distortion, Harmonics vs. Transients Harmonic Sources from Commercial and Industrial Loads, Time domain versus frequency domain Different Harmonic filters (passive, active and hybrid); and case studies

MODULE-III (8 HOURS)

Voltage Sag, Swell and Interruptions, Transient Over-voltages, Sources of Sags and Interruptions, Fundamental Principles of Protection, Motor-Starting Sags, Utility System Fault-Clearing. Issues, and Case Studies, Sources of Transient Overvoltage; Principles of Overvoltage Protection and Switching Transient Problems with Loads

MODULE-IV (8HOURS) –

Voltage Flicker, Voltage Unbalance, Voltage Regulation Sources of voltage flicker; Effects and mitigation techniques Sources of voltage unbalance; Effects and mitigation techniques Devices for Voltage Regulation; Utility Voltage Regulator Application and End-User Capacitor Application

MODULE-V (7HOURS)

SVC and STATCOM , Active Harmonic Filtering, power quality problems created by drives, Power factor improvement, Passive Compensation, Single Phase APFC, Three Phase APFC and control technique.

BOOKS

[1]. R. Dugan, M. Mc Granaghan, S. Santoso and H. Beaty, Electrical Power System Quality, Second Edition, McGraw-Hill, 2002, ISBN 0-07-138622-X.

[2]. J. Arrillaga, B. Smith, N. Watson and A. Wood, Power System Harmonic Analysis, John Wiley, 1997, ISBN 0-471-97548-6.

[3]. Understanding Power Quality Problems by Math H. Bollen

[4]. J. Arrillaga, .Power System Quality Assessment., John wiley, 2000

[5]. R. SastryVedam , M. S. Sarma , " Power Quality: VAR Compensation in Power System " CRC Press , Taylor and Francis group , 2008

Course Outcomes:

Upon completion of the course, students will be able to:

CO1	Express idea on the reasons for increased concern for power quality issues in power systems.
CO2	Describe the benchmarking process in power quality sector.
CO3	Analysis and solve the issues in power quality improvement
CO4	Apply technology in solving the problems of power quality including distribution generation.
CO5	Describe the various monitoring methods used in power quality issues and control the power quality issues.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

Sessional

POWER SYSTEM LABORATORY-II (BEE07003)

List of Experiments:

1. Determination of transient and sub-transient reactance of a 3-phase alternator.
2. Parallel operation of two alternators and effect of its load sharing.
3. Characteristics and performance of induction generator.
4. Perform load flow, optimal power flow and economic dispatch in power systems.
5. Measurement of power quality.
6. Fault analysis and determination of transient stability of power systems.
7. Calibration of different surface gaps for measurement of high voltage (Sphere-sphere, Pin-pin, Disc-disc) and Dry flash over test on different types of insulators by 100 kV AC and 280 kV DC
8. Study of impulse generator and generating standard impulse wave shape.
9. Measurement of loss tangent and dissipation factor using high voltage Schering bridge. Testing of insulating oil.

Course Outcomes:

Upon completion of the course, students will demonstrate the ability to:

CO1	Evaluate dynamic performance parameters of alternators and demonstrate parallel operation and load sharing.
CO2	Evaluate the characteristics and performance of induction generators.
CO3	Compile and implement computer code for load flow, optimal power flow and economic dispatch ,
CO4	Compile and implement computer code for fault analysis and transient stability analysis of power systems and demonstrate power quality measurement.
CO5	Demonstrate calibration process of surface gaps, flash over test on insulators, measure dissipation factors.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

SEMINAR ON INTERNSHIP

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Organize resources acquired during internship.
CO2	Express exposure gained during internship.
CO3	Organize learning from internship and compile a report.
CO4	Demonstrate the learning in the form of oral presentation.
CO5	Plan future course of work based on experience during internship.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	3	3	3	3	3	3	3	3

PROJECT-I

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the tools and techniques learnt from theory and practical courses.
CO2	Define and formulate a problem.
CO3	Plan and organize the implementation of the project in a group.
CO4	Compile resources and develop a solution to the selected problem.
CO5	Write a technical report and demonstrate the findings.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	3	3	3	3	3	3	3	3	3	3

Open Elective-III (Seventh Semester)

RENEWABLE ENERGY SOURCES (BEEOE701)

Syllabus:

Module-I (10 hours)

Energy Scenario: Classification of Energy Sources, Energy resources (Conventional and nonconventional), Energy needs of India, and energy consumption patterns. Worldwide Potentials of these sources. Energy efficiency and energy security. Energy and its environmental impacts, Distributed generation.

Solar Energy: Solar thermal Systems: Types of collectors, Collection systems, efficiency calculations, applications.

Photo voltaic (PV) technology: Present status, solar cells, cell technologies, characteristics of PV systems, equivalent circuit, array design, building integrated PV system, its components, sizing and economics. Peak power operation. Standalone and grid interactive systems.

MODULE-II (8 HOURS)

Wind Energy: Wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, Types of Turbine, Turbine rating. Choice of generators, turbine rating, electrical load matching, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operation.

MODULE-III (7 HOURS)

Energy storage and hybrid system configurations: Energy storage, Battery – types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. Flywheel-energy relations, components, benefits over battery. Fuel Cell energy storage systems. Ultra Capacitors.

MODULE-IV (7 HOURS)

Grid Integration: Standalone systems, Concept of Micro-Grid and its components, Hybrid systems – hybrid with diesel, with fuel cell, solar-wind, wind –hydro systems, mode controller, load sharing, system sizing. Hybrid system economics, Interface requirements, Stable operation, Transient-safety, Operating limits of voltage, frequency, stability margin, energy storage, and load scheduling. Effect on power quality, harmonic distortion, voltage transients and sags, voltage flickers, dynamic reactive power support. Systems stiffness.

Module-V (7 Hours)

Small Hydro Systems, Bio-Mass and Bio-Fuels, Tidal power: Tidal phenomena, historical background, basic aspects of tidal power development and tide mills; Tidal power project components and types, Energy from Ocean Waves and Ocean thermal energy conversion technologies: Basic principle, System components.

Text Books

[1] Renewable Energy Resources by by John Twidell, Tony Weir, Routledge, 3rd Edition.

[2] Sustainable Energy- J.W. Tester, E.M. Drake, M. J. Driscoll, M. W. Golay , W. A. Peters, MIT Press, 2nd Edition.

Reference Books

[1] Energy Technology Nonconventional, Conventional & Renewable-Sunil S. Rao and Dr. B.B. Parulekar, Khanna Publishers.

[2] Renewable energy sources and emerging technologies -D.P. Kothari, K.C. Singal, and R. Ranjan, PHI Learning Pvt. Ltd.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1	Describe energy security and distributed generation and know about concept of solar energy systems.
CO2	Express the knowledge about the principle and components of wind energy systems.
CO3	Express different types and principle of energy storage devices.
CO4	Describe the principle and components for small hydro, biomass, tidal, wave energy extraction.
CO5	Apply the knowledge on the various grid integration issues of renewable energy systems.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

ENERGY MANAGEMENT (BEEOE702)

Syllabus

Module-I (10 Hours)

General principles of energy management and energy management planning; application of Pareto's model for energy management; obtaining management support; establishing energy data base; conducting energy audit; identifying, evaluating and implementing feasible energy conservation opportunities; energy audit report; monitoring, evaluating and following up energy saving measures.

Module-II (06 Hours)

Energy efficiency analysis; thermodynamics and energy; coefficient of performance; energy effectiveness; management of heating, ventilating and air-conditioning (HVAC) – principles, opportunities, case studies; management of process energy- principles, opportunities, case studies.

Module-III (04 Hours)

Management of electrical load and lighting - management opportunities with electric drives, lighting, heating and electrolytic systems; electrical load analysis; peak demand control; computer-aided energy management; cogeneration; forms of cogeneration; feasibility study for cogeneration.

Module-IV (10 Hours)

Energy efficiency of turbines, compressors and pumps (brief treatment only); specific energy consumption; parameters affecting specific energy consumption; flexi targeting technique. Lighting- Energy efficient light Sources-Energy conservation in Lighting Schemes- Electronic Ballast-Power Quality Issues-Luminaries, case study.

Module-V (09 Hours)

Financial evaluation of energy projects; cash flow model; time value of money; evaluation of proposals - payback method, average rate of return method, internal rate of return method, present value method, profitability index, life cycle costing approach, investment decision and uncertainty; consideration of income taxes, depreciation and inflation in investment analysis.

TEXT BOOKS

[1]. Pradeep Chaturvedi "Energy Management: Challenges for the Next Millennium", Vedams eBooks (P) Ltd. Publisher.

[2]. Paul O'Callaghan, "Energy management", TMH Publisher.

REFERENCE BOOKS

[3]. Craig B Smith, "Energy management principles", Pergamon Press.

[4]. Albert Thumann "Handbook of Energy Audits", Fairmont Publishers.

Course Outcomes:

Upon completion of the subject the students will:

CO1	Express the knowledge on energy data base, conducting energy audit, identifying, evaluating and implementing feasible energy conservation opportunities.
CO2	Describe the different lighting schemes, specific energy consumption.
CO3	Evaluate Energy efficiency of turbines.
CO4	Evaluate the power quality issues.
CO5	Evaluate the financial evaluation of energy projects and economic aspects.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

INDUSTRIAL AUTOMATION AND CONTROL (BEEOE703)

Syllabus:

MODULE-I

Introduction to process dynamics, its type and classifications. Control actions and controller tuning: Basic control actions-on/off, P, P+I, P+I+D, floating control, pneumatic and electronic controllers, control, controller tuning.

MODULE-II

Introduction to PLC, PAC, DCS and SCADA. IEDs, RTUs, HMI, Smart Sensors and Actuators. Communication Networks for PLC. The Instrument Lists of PLC and HMI. System Architecture, Programming languages of PLC, Relay logic and Ladder logic, Ladder Diagram Elements.

MODULE-III

Computer controlled processes: PLC based control of different types of processes such as liquid level system and flow control, open-and-closed chamber pressure control, temperature control, different types of heat exchangers.

MODULE-IV

Physical Ladder Diagram and Programmable Ladder Diagram. Case Studies: frost free refrigerator / freezer system; composite discrete / continuous control; conveyor system; oven system; elevator system; uniformly heated liquid control system, and hydro-phonic system.

MODULE-V

Advances in Automation: Programmable Automation Controllers. NI my-DAQ, my-RIO, c-RIO, and ELVIS. IEEE 802.11 / 15 Standards, IEEE 1451.5 Std. Role of Internet of Things and Cyber Physical System in Industry Automation, MQTT protocol.

BOOKS:

1. Peter D. Harriot, “Process Control”, Tata McGraw-Hill, New Delhi, 2009.
2. Liptak, “Process Control: Instruments Engineer’s Handbook”, Butterwirth Heinemann, 1995.
3. Curtis D. Johnson, “Process Control and Industrial Technology”, Pearson India, 8th ed., 2012.

REFERENCE BOOKS:

1. Norman A Anderson, “Instrumentation for Process Measurement and Control”, CRC Press, 2018.
2. B. Wayne Bequette, “Process Control – Modeling, Design, and Simulation”, Pearson India, 2015.
3. John W. Webbs, “Programmable Logic Controllers – Principals and Applications”, fifth Edition, Pearson India /PHI (Old edition), 2012.

Course Outcomes:

Upon completion of this course, the students will demonstrate the ability to:

CO1	Describe the basic principles and importance of process control applications using automation;
CO2	Express the required instrumentation, knowledge of the P&ID, the Instrumentation Lists, and final elements to ensure that well-tuned control is achieved;
CO3	Create computer control mechanism of various processes
CO4	Design, install, operate, control and maintain different process and automated applications using PLCs/PACs. Further, PLC / PAC algorithm using Ladder Logic Diagram or equivalent languages while handling a plant process;
CO5	Apply knowledge on advances in use of automation platform such as PACs and IoT while handling a plant process.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

Eighth Semester

Professional Elective - V

SMART POWER GRIDS (BEEPE801)

Syllabus

Module-I (6 hours)

Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self-Healing Grid, Present development & International policies in Smart Grid.

Module-II (8hours)

Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation.

Module-III (7 hours)

Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).

Module-IV (10 hours)

Concept of micro-grid, need & applications of micro-grid, Formation of micro-grid, Issues of interconnection, Integration of renewable energy sources, Protection & control of micro-grid. Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Module-V (7 hours)

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN), Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid, Broadband over Power line (BPL), IP based protocols.

Suggested reading:

1. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, "*Smart Grid: Technology and Applications*", Wiley 2012.
2. Clark W. Gellings, "*The Smart Grid: Enabling Energy Efficiency and Demand Response*", CRC Press, 2009.
3. Ali Keyhani, "*Design of smart power grid renewable energy systems*", Wiley-IEEE, 2011.
4. Stuart Borlas'e, "*Smart Grid: Infrastructure, Technology and solutions*", CRC Press.
5. A.G.Phadke, "*Synchronized Phasor Measurement and their Applications*", Springer.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe the difference between smart grid & conventional grid.
CO2	Apply smart metering concepts to industrial and commercial installations.
CO3	Develop solutions in the areas of smart substations, distributed generation and wide area measurements & PMUs.
CO4	Analyze the problems in integration of distributed generations with smart grid.
CO5	Evaluate smart grid solutions using AMI and modern communication technologies.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

RESTRUCTURED POWER SYSTEM (BEEPE802)

Module-I (8 hours)

Fundamentals of Electricity Markets and Energy Auctions, necessity for restructuring the power industry. Review of Concepts- marginal cost of generation, least-cost operation, incremental cost of generation. Components of restructured systems, independent system operators, functions and responsibilities, Market models (pool, bilateral and multilateral). Market power and imperfect competition. Supply and demand functions, equilibrium.

Module-II (8 hours)

OPF: Role in vertically integrated systems and in restructured markets. Transmission Open Access, Power wheeling transactions and marginal costing, transmission costing, Transmission pricing paradigms- embedded cost based, incremental cost-based methods. Optimal bidding. Power flow tracing. LMP based markets, auction models and price formation, price-based unit commitment. Tagging electricity transactions.

Module-III (8 hours)

Transmission Congestion Management and Transmission Rights, Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs, Firm Transmission Rights, FTRs as benefits and liability, FTR auction models. Predicting electricity costs, electricity cost derivation, electricity pricing of inter provincial power market.

Module-IV (8 hours)

Electric energy trading: Trading framework. Derivative instrument for energy trading (forward contracts, futures contracts, swaps), Portfolio management. Energy trading hubs.

Hedging Tools: Definition of risk and hedge. Source of electricity market risks, Value-at-Risk, country party risk, hedging weather risks.

Module-V (7 hours)

Ancillary Services: Classifications and definitions. Types, Frequency control ancillary service, voltage control ancillary service, reserves & AGC services. System security in deregulation.

Different models of deregulation- Indian model, UK model, California model, Australian and New Zealand models, Japan model, Thailand model. AS management in various markets- country practices. IT applications in restructured markets. Recent trends in Restructuring.

Recommended Books

[1]. K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, *"Operation Of Restructured Power System",* Kluwer Academic Publishers, 2001

[2]. Mohammad Shahidehpour, MuwaffaqAlomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker

[3]. S. Stott, "Power System Economics: Designing Markets For Electricity", Wiley-Interscience, 2002.

[4]. D. S. Kirschen and G. Strbac, *"Fundamentals Of Power System Economics",* John Wiley & Sons, 2004

Course Outcomes:

Upon completion of the course, the students will:

CO1	Describe the fundamentals of electricity markets
CO2	Express knowledge on different transmission pricing paradigms
CO3	Describe the operation of power systems under transmission congestion.
CO4	Describe electrical energy trading and hedging concepts.
CO5	Express idea about ancillary services and different country practices.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ELECTRIC AND HYBRID VEHICLES (BEEPE803)

Syllabus

Module-I (5 hours)

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Architectures of HEVs, series and parallel HEVs, complex HEVs.

Module-II (10 hours)

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module-III (10 hours)

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives. Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

Module-IV (7 hours)

Power Electronics in HEVs: Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.

Electric Machines and Drives in HEVs: Induction motor drives, Field oriented control of induction machines; Permanent magnet motor drives; Switched reluctance motors; Doubly salient permanent magnet machines. Case studies.

Module-V (7 hours)

Communications, supporting subsystems: In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

Recommended Books

[1]. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

[2]. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

[3]. Mi Chris, Masrur A., and Gao D.W., " Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives".

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe the requirements and architecture of EVs and HEVs.
CO2	Describe drive trains used in EVs and HEVs.
CO3	Design electric propulsion unit and storage systems for EVs and HEVs.
CO4	Design drives systems for EVs and HEVs.
CO5	Describe different communication systems used in EVs and HEVs.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

INDUSTRIAL AUTOMATION AND CONTROL (BEEPE805)

Syllabus:

MODULE-I

Introduction to process dynamics, its type and classifications. Control actions and controller tuning: Basic control actions-on/off, P, P+I, P+I+D, floating control, pneumatic and electronic controllers, control, controller tuning.

MODULE-II

Introduction to PLC, PAC, DCS and SCADA. IEDs, RTUs, HMI, Smart Sensors and Actuators. Communication Networks for PLC. The Instrument Lists of PLC and HMI. System Architecture, Programming languages of PLC, Relay logic and Ladder logic, Ladder Diagram Elements.

MODULE-III

Computer controlled processes: PLC based control of different types of processes such as liquid level system and flow control, open-and-closed chamber pressure control, temperature control, different types of heat exchangers.

MODULE-IV

Physical Ladder Diagram and Programmable Ladder Diagram. Case Studies: frost free refrigerator / freezer system; composite discrete / continuous control; conveyor system; oven system; elevator system; uniformly heated liquid control system, and hydro-phonic system.

MODULE-V

Advances in Automation: Programmable Automation Controllers. NI my-DAQ, my-RIO, c-RIO, and ELVIS. IEEE 802.11 / 15 Standards, IEEE 1451.5 Std. Role of Internet of Things and Cyber Physical System in Industry Automation, MQTT protocol.

BOOKS:

1. Peter D. Harriot, “Process Control”, Tata McGraw-Hill, New Delhi, 2009.
2. Liptak, “Process Control: Instruments Engineer’s Handbook”, Butterwirth Heinemann, 1995.
3. Curtis D. Johnson, “Process Control and Industrial Technology”, Pearson India, 8th ed., 2012.

REFERENCE BOOKS:

1. Norman A Anderson, “Instrumentation for Process Measurement and Control”, CRC Press, 2018.
2. B. Wayne Bequette, “Process Control – Modeling, Design, and Simulation”, Pearson India, 2015.
3. John W. Webbs, “Programmable Logic Controllers – Principals and Applications”, fifth Edition, Pearson India /PHI (Old edition), 2012.

Course Outcomes:

CO1	Describe the basic principles and importance of process control applications using automation;
CO2	Express the required instrumentation, knowledge of the P&ID, the Instrumentation Lists, and final elements to ensure that well-tuned control is achieved;
CO3	Create computer control mechanism of various processes
CO4	Design, install, operate, control and maintain different process and automated applications using PLCs/PACs. Further, PLC / PAC algorithm using Ladder Logic Diagram or equivalent languages while handling a plant process;
CO5	Apply knowledge on advances in use of automation platform such as PACs and IoT while handling a plant process.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

ELECTRIC DRIVES CONTROL (BEEPE804)

Module-I: CONTROL OF DC DRIVES (10 hours)

Necessity of Electric drives, Modern Electric drives, Energy efficient operation of Electric drives, block diagram/ open loop and closed loop transfer function of separately excited DC motors with armature and field flux methods, Steady state analysis of the single and three phase converter fed separately excited DC motor drive–continuous conduction, DC-DC chopper fed DC drive speed control.

Module-II: CONTROL OF INDUCTION MOTOR DRIVE (8 hours)

VSI and CSI fed speed control of induction motor drives-principles of V/f control-closed loop variable frequency PWM inverter with dynamic braking- static Scherbius drives- power factor considerations– modified Kramer drives.

Module-III: CONTROL OF SYNCHRONOUS MOTOR DRIVES (7 hours)

Need for leading PF operation, Open loop VSI fed drive and its characteristics–Self-control–Torque control –Torque angle control –Power factor control of Synchronous motor drive systems. – Brushless excitation systems.

Module-IV: CONTROL OF SRM AND BLDC MOTOR DRIVES (10 hours)

SRM construction - Principle of operation - SRM drive design factors-Torque controlled SRM-Block diagram of Instantaneous Torque control using current controllers and flux controllers. Construction and Principle of operation of BLDC Machine -Sensing and logic switching scheme,-Sinusoidal and trapezoidal type of Brushless dc motors – Block diagram of current controlled Brushless dc motor drive.

Module-V: VECTOR CONTROL OF INDUCTION MOTOR DRIVE (10 hours)

Review of dq0 model of 3-Ph IM, Principle of vector control of IM - Direct vector control – Indirect vector control with feedback - Indirect vector control with feed-forward - Indirect vector control in various frames of reference, Decoupling of vector control with feed forward compensation – Direct Torque Control of IM.

Recommended Books

1.Dubey, G.K, Power semiconductor controlled devices, Prentice Hall International New jersey, 1989.
2.R.Krishnan,, Electric Motor Drives - Modeling, Analysis and Control Prentice- Hall of India Pvt. Ltd., New Delhi, 2003.
3. Ned Mohan ,"Power Electronics and drives", et. al ,Wiley 2006

References

1.Bin Wu, High-Power Converters and AC Drives, Wiley-IEEE Press
2. Bimal K.Bose, Modern Power Electronics and AC Drives, Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.
3. R. Krishnan, Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications, CRC press, 2001.
4. Werner Leonhard, Control of Electrical Drives, 3rd Edition, Springer, Sept., 2001.
5. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CR
6. Vector Control of AC Drives, I. Boldea and S. A. Nasar, CRC Press LLC, 1992.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe the necessity of electric drives, transfer functions and control of DC drives using phase control and DC-DC chopper circuits.
CO2	Analyze the VSI and CSI with PWM techniques fed speed control of induction motors and control of slip recovery power for energy efficiency.
CO3	Describe the power factor correction techniques and the application of synchronous motors and brushless DC motors in product industries
CO4	Describe the operation of SRM and BLDC machines, torque control using current and flux controllers, Sensing and logic switching scheme.
CO5	Describe direct and indirect vector control on induction motors.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Professional Elective – VI

FORECASTING METHODS IN ENGINEERING (BEEPE806)

Module-I (8 hours)

Nature of time series data, time series statistical models, measures of dependence, stationary time series, estimation of correlation. Classical regression, exploratory data analysis, smoothing. Basics of R Programming.

Module-II (8 hours)

ARIMA Models: Autoregressive Moving Average Models, difference equations, autocorrelation and partial autocorrelation. Forecasting, estimation. Building ARIMA models. R programs.

Module-III (8 hours)

Spectral Analysis and Filtering: Cyclical behavior and periodicity. Spectral Density. Periodogram and Discrete Fourier Transform, Nonparametric and parametric spectral estimation, Multiple series and cross-spectra. Linear filters. Lagged regression models. Signal extraction and Optimal filtering. R programs.

Module-IV (8 hours)

Long memory ARMA and fractional differencing, Unit Root testing, GARCH models. Threshold models. Lagged regression and transfer function modelling. ARMAX models. R programs.

Module-V (8 hours)

State Space Models: Linear Gaussian model. Filtering, smoothing and forecasting. Maximum Likelihood estimation, Signal extraction and Forecasting, State space models with correlated errors. Bootstrapping. Smoothing Splines and Kalman Smoother. Hidden Markov Models. Stochastic Volatility. Bayesian analysis. R programs.

Text Books

Robert H. Shumway, David S. Stoffer. "Time Series Analysis and its Applications", Fourth Edition., Springer.

Jonathan D. Cryer, Kung-Sik Chan. "Time Series Analysis", Second Edition, Springer.

Reference Books

Larry Wasserman, "All of Statistics", Springer.

Course Outcomes:

Upon completion of the course, the students will:

CO1	Describe the characteristics of time series and exploratory data analysis.
CO2	Develop and apply ARIMA models.
CO3	Construct spectral analysis and filtering.
CO4	Develop and apply GARCH and ARMAX models
CO5	Develop and apply state space models.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

SOFT COMPUTING AND HEURISTIC OPTIMIZATION (BEEPE807)

Syllabus

Module-II (8 hours)

Introduction to Neuro, Fuzzy and Soft Computing. Fuzzy Sets : Basic Definition and Terminology, Set-theoretic Operations, Member Function Formulation and Parameterization, Fuzzy Rules and Fuzzy Reasoning, Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning , Fuzzy Inference Systems, Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Input Space Partitioning and Fuzzy Modeling.

Module-III (8 hours)

Neural Networks: Introduction. Architecture. Backpropagation. Supervised Learning: Perceptrons, Adaline, Multilayer Perceptron's, Radial basis functions. Learning from Reinforcement. Unsupervised learning. The Hopfield network. The Kohonen Model. Recurrent neural networks. Deep learning. Bayesian learning. Extreme learning machines.

Module-III (7 hours)

Neuro-Fuzzy Modelling: Adaptive neuro-fuzzy information; systems (ANFIS), Hybrid Learning Algorithm, Applications to control systems and pattern recognition. Data Clustering. Support Vector Machines.

Module-IV (8 hours)

Derivative-free Optimization. Genetic algorithms: Basic concepts, encoding, fitness function, reproduction. Differences of GA and traditional optimization methods. Basic genetic programming concepts Applications.

Module-V (7 hours)

Simulated Annealing, Random Search, Downhill Simplex Search, Evolutionary Computing. Differential Evolution. Swarm optimization. Cuckoo Search and Firefly Algorithm.

TEXT BOOKS

[1]. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI Publisher.
[2]. R.Eberhart, P.Simpson and R.Dobbins, "Computational Intelligence-PC Tools", AP Professional Publishers.

REFERENCE BOOKS

[1]. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill Publisher.
[2]. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley Publisher.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Define and design fuzzy systems.
CO2	Apply neural networks for solving optimization problems
CO3	Describe the various types of neuro-fuzzy models and their applications.
CO4	Apply genetic algorithm and derivative free optimization
CO5	Apply evolutionary computing techniques.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

EMBEDDED SYSTEM (BEEPE808)

MODULE – I (8 hours)

Introduction to Embedded System: What is embedded system, History of embedded systems, classification of embedded system, Major application area of embedded system, Purpose of embedded system, Typical Embedded sys: Core of embedded system, Memory, Sensors, Actuators, Communication Interface, Embedded Firmware Other system component, PCB and Passive components.

MODULE – II (8 hours)

Hardware Software co-design and programming model, Fundamental Issues in Hardware –Software co design, Computational model Embedded System, , Hardware software trade off, Embedded Hardware design and development : Analog design components, Digital Electronics component, Embedded Firmware design and development, Embedded Firmware design approach

MODULE –III (8 hours)

Introduction to unified modelling language (UML), VLSI and Integrated Circuit design, Embedded firmware development language , Programming in Embedded C.

MODULE – IV (8 hours)

Real Time operating system (RTOS) based embedded system design, Types of operating systems, Task process and threads, Multiprocessing and multi-tasking, Task scheduling, Thread and process scheduling, putting task communication, Task synchronization, Device drivers, Task synchronization, Task scheduling, Thread and process scheduling, putting task communication, Task synchronization, Device drivers, how to choose RTOS.

MODULE – V (7 hours)

Embedded system Development environment (IDE), Types of files generated on cross compilation, Dissembler / De compiler, Simulators, Emulator, Debugging, Design Case studies, Digital Clock, Battery operated smart card Reader, Automated meter reading system (AMR), Digital Camera.

TEXT Books

[1]. Shibu K.V, "Introduction to Embedded Systems",TMH Publication.

[2]. Rajkamal, "Embedded Systems –Architecture, Programming and Design", TMH Publication.

REFERENCE BOOKS

[3]. Frank Vahid, Tony D. Givargis, "Embedded System Design – A Unified Hardware/Software Introduction",John Wiley Publisher.

[4]. David E. Simon, "An Embedded Software Primer", PHI Publication.

Course Outcomes

Upon completion of the course, the students will be able to:

CO1	Describe embedded system. Processor, memory, sensor, actuator
CO2	Design and programming model
CO3	Implement UML programming, VLSI programming, Embedded C programming
CO4	Express knowledge on Real time programming
CO5	Apply Integrated development environment and demonstrate embedded systems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

WIDE AREA MONITORING & CONTROL (BEEPE809)

Syllabus

Module-I (5 Hours)

Introduction to wide area measurement system: Need of WAMS, Architecture, Components of WAMS, Applications: Voltage Stability Assessment, Frequency stability Assessment, Power Oscillation Assessment, Communication needs of WAMS, Wide Area Monitoring Protection & Control and Remedial Action Scheme.

Module-II (10 Hours)

Power system automation: Introduction, Evolution of Automation Systems, Supervisory Control and Data Acquisition (SCADA) Systems, Components of SCADA Systems, SCADA in Power Systems, SCADA Basic Functions, Advantages of SCADA in Power Systems, Deferred Capital Expenditure, Optimized Operation and Maintenance Costs, Equipment Condition Monitoring (ECM), Sequence of Events(SOE) Recording, Power Quality Improvement, Data Warehousing for Power Utilities, Types of Data and Signals in Power Systems, Flow of Data from the Field to the SCADA Control Center.

Module-III (10 Hours)

SCADA fundamentals: **SCADA FUNDAMENTALS**: Introduction, Open System: Need and Advantages, Building Blocks of SCADA Systems, Remote Terminal Unit (RTU), Evolution of RTUs, Components of RTU, Communication Subsystem, Logic Subsystem, Termination Subsystem, Testing and Human Machine Interface(HMI) Subsystem, Power Supplies, Advanced RTU Functionalities, Intelligent Electronic Devices (IEDs), Evolution of IEDs, IED Functional Block Diagram, Hardware and Software Architecture of the IED, IED Communication Subsystem, IED Advanced Functionalities, Toolsfor Settings, Commissioning, and Testing, Programmable LCD Display, Typical IEDs, Data Concentrators and Merging Units, RTUs, IEDs, and Data Concentrator, Merging Units and IEDs.

Module-IV (5 Hours)

Substation automation: Substation Automation: Technical Issues, System Responsibilities, System Architecture, Substation Host Processor, Substation LAN, User Interface, Communications Interfaces, Protocol Considerations. The New Digital Substation, Process Level, Protection and Control Level, Station Bus and Station Level, Substation Automation Architectures, Legacy Substation Automation System, Digital Substation Automation Design, New versus Existing Substations. Substation Automation (SA) Application Functions, Integrated Protection Functions: Traditional Approach and IED-Based Approach. Automation Functions.

Module-V (9 Hours)

Voltage stability & small signal stability: Basic concepts, Voltage collapse – general characterization, classification, Voltage stability analysis – modeling, dynamic analysis, static analysis, shortest distance to instability,continuation power flow analysis, prevention of voltage collapse – design measures, operating measures, Real time wide area controller for mitigating small

signal Instability, Advanced monitoring and control approaches for enhancing power system security.

TEXTBOOK:

[1]. A. R. Messina, '*Wide Area Monitoring of Interconnected Power Systems'* IET, Power& Energy Series, 2005.
[2] Allen J. Wood and Bruce Woolenberg, '*Power System Generation, Operation and Control*', John Wiley and Sons, 1996.

REFERENCE BOOK:

[1] P. Kundur, '*Power System Stability and Control*', McGraw Hill.

[2] A.R. Messina, '*Inter-area Oscillations in Power Systems*' Springer

[3] D. K. Mohanta& M. Jaya Bharata Reddy, '*Synchronized Phasor Measurements for Smart Grids*' IET, Power & Energy Series.

[4] Mini S. Thomas and John Douglas McDonald, '*Power System SCADA and Smart Grids*', CRC Press, 2015.

Course Outcomes

Upon completion of the course students will:

CO1	Describe about the necessity of wide area measurement system and its basic concept.
CO2	Express the knowledge of different automation systems.
CO3	Apply knowledge on the complete fundamentals of SCADA and its importance in real time power systems.
CO4	Express knowledge of Substation Automation, New Digital Substation and Traditional approach and IED-based approach of Integrated Protective Functions.
CO5	Apply knowledge Voltage stability, prevention of voltage collapse, dynamic stability, Analysis and small signal stability analysis

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ENERGY MANAGEMENT AND AUDIT (BEEPE810)

Syllabus:

MODULE-I (08 HOURS)

General principles of Energy management and Energy management planning. Peak Demand controls, Methodologies, Types of Industrial Loads, Optimal Load scheduling. Energy management opportunities in Lighting and Motors. Electrolytic Process and Electric heating.

MODULE-II (10 HOURS)

Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservationopportunities in boiler. Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energysavings. Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery.

MODULE-III (07 HOURS)

HVAC system: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Classification and Advantages of Waste Heat Recovery system, analysis of waste heat recovery for Energy saving opportunities.

MODULE-IV (07 HOURS)

Energy audit -Definition, Need, Types of energy audit, Energy audit Instruments. Cogeneration-Types and Schemes, Optimal operation of cogeneration plants. Computer aided energy management.

MODULE-V (07 HOURS)

Economic analysis methods-cash flow model, time value of money, evaluation of proposals, pay-back method, average rate of return method, internal rate of return method, present value method, life cycle costing approach, Case studies.

TEXT BOOKS

[1]. Albert Thumann, William J. Younger, "Handbook of Energy Audits", CRC Press, 2003.
[2]. Paul O'Callaghan, "Energy management", TMH Publisher

REFERENCE BOOKS

[3]. Craig B. Smith, "Energy management principles", PergamonPress.
[4]. Pradeep Chaturvedi, "Energy Management: Challenges for the Next Millennium", Vedams eBooks (P) Ltd. Publisher.
[5]. K.V. Sharma, P. Venkataseshaiah, "Energy Management and Conservation". I K Int. Pvt. Ltd.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Describe the concept of energy management and energy management opportunities
CO2	Express the knowledge on the different methods used to control peakdemand
CO3	Apply knowledge on the co-generation
CO4	Define energy auditing procedure
CO5	Describe the different methods used for the economic analysis of energyprojects.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

Sessional

PROJECT-II

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Compile tools and techniques.
CO2	Incorporate new dimensions to the problem.
CO3	Plan and organize the implementation of the project in a group.
CO4	Analyze the problem and develop solutions.
CO5	Write a technical report and demonstrate the findings.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	3	3	3	3	3	3	3	3

SEMINAR ON PROJECT

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Organize resources acquired during project implementation.
CO2	Express exposure gained during project implementation.
CO3	Organize learning from project execution and compile a report.
CO4	Demonstrate the learning in the form of oral presentation.
CO5	Plan future course of work based on experience during project work.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	3	3	3	3	3	3	3	3

Open Elective -IV (Eighth Semester)

SYSTEM RELIABILITY (BEEOE801)

SYLLABUS

Module-I (8 hours)

Types of System, Qualitative and Quantitative assessment, Use of quantitative assessment, Reliability Definition and Concept, Reliability Indices and Criteria, Reliability and Availability, Absolute and Relative Reliability, Reliability Evaluation Technique, Reliability Improvement, Reliability Activities in System Design & its Economics, Basic Probability Theory, Binomial Distribution and its engineering applications.

Module-II (8 hours)

Network modeling concepts, Series & Parallel Systems, Series-Parallel System, Partially Redundant & Standby redundant System. Modeling and Evaluation Concept, Conditional Probability Approach, Cut Set Method, Application and Comparison of Previous Technique, Tie Set Method, Connection Matrix Technique, Event Trees, Fault Tree, Multi-Failure Mode.

Module-III (8 hours)

Distribution Concept & terminologies, General Reliability Function & their evaluation techniques, Shape of Reliability Function the Poison Distribution & the Normal Concept, Exponential, Weibull, Gamma, Rayleigh, Lognormal and rectangular distributions, Data Analysis, System Reliability Evaluation of different kinds of Using Probability Distributions, Mean Time to Failure, Wear out and Component Reliability, Maintenance and Component Reliability.

Module-IV (8 hours)

Discrete Markov Chains: General Modeling Concept, Stochastic Transitional Probability Matrix, Time Dependent Probability Evaluation, Limiting State Probability Evaluation, Absorbing States, Application of Discrete Markov Technique. Continuous Markov Process: General Modeling Concept, State Space Diagrams, Stochastic Transitional Probability Matrix, Evaluating Limiting State Probabilities, Evaluating Time Dependent State Probabilities, Reliability Evaluation in Repairable System, Mean Time to Failure, Application of Technique to Complex System.

Module-V (7 hours)

Frequency and Duration Technique: Application to Multistate Problems, Frequency Balance Approach, Two Stage Repair and Installation Process. Approximate System Reliability Evaluation. System with Non-Exponential Distribution. Monte Carlo Simulation.

TEXT BOOK

1. Roy Billinton, Ronald N. Allan. "Reliability Evaluation of Engineering Systems" Second Edition.

REFERENCE BOOKS:

1. Gupta A.K., Reliability, Maintenance and Safety Engineering, University Science Press

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe basic reliability engineering concepts.
CO2	Perform network modelling of simple and complex systems.
CO3	Apply probability distribution for reliability evaluation.
CO4	Apply discrete and continuous Markov processes for reliability evaluation.
CO5	Evaluate approximate reliability evaluation techniques.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1

TIME SERIES ANALYSIS AND FORECASTING (BEEOE802)

Syllabus

Module-I (8 hours)

Nature of time series data, time series statistical models, measures of dependence, stationary time series, estimation of correlation. Classical regression, exploratory data analysis, smoothing. Basics of R Programming.

Module-II (8 hours)

ARIMA Models: Autoregressive Moving Average Models, difference equations, autocorrelation and partial autocorrelation. Forecasting, estimation. Building ARIMA models. R programs.

Module-III (8 hours)

Spectral Analysis and Filtering: Cyclical behavior and periodicity. Spectral Density. Period gram and Discrete Fourier Transform, Nonparametric and parametric spectral estimation, Multiple series and cross-spectra. Linear filters. Lagged regression models. Signal extraction and Optimal filtering. R programs.

Module-IV (8 hours)

Long memory ARMA and fractional differencing, Unit Root testing, GARCH models. Threshold models. Lagged regression and transfer function modelling. ARMAX models. R programs.

Module-V (8 hours)

State Space Models: Linear Gaussian model. Filtering, smoothing and forecasting. Maximum Likelihood estimation, Signal extraction and Forecasting, State space models with correlated errors. Bootstrapping. Smoothing Splines and Kalman Smoother. Hidden Markov Models. Stochastic Volatility. Bayesian analysis. R programs.

BOOKS

1. Robert H. Shumway, David S. Stoffer. "Time Series Analysis and its Applications", Fourth Edition., Springer.
2. Jonathan D. Cryer, Kung-Sik Chan. "Time Series Analysis", Second Edition, Springer.
3. Larry Wasserman, "All of Statistics", Springer.

Course Outcomes:

Upon completion of the course, the students will:

CO1	Describe the characteristics of time series and exploratory data analysis.
CO2	Develop and apply ARIMA models.
CO3	Express spectral analysis and filtering.
CO4	Develop and apply GARCH and ARMAX model
CO5	Develop and apply state space models.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ELECTRICAL POWER DISTRIBUTION SYSTEMS (BEEOE803)

Syllabus

Module – I (7 hours)

General Concepts: Introduction to distribution systems, Load modeling and characteristics – Coincidence factor – Contribution factor- loss factor – Relationship between the load factor and loss factor – Classification of loads (Residential, commercial, and Agricultural) and their characteristics.

Module – II (8 hours)

Substations: Location of substations: Rating of distribution substation – Service area within primary feeders – Benefits derived through optimal location of substations. Distribution Feeders Design Considerations of distribution feeders: Radial and loop types of primary feeders – Voltage levels – Feeder loading – Basic design practice of the secondary distribution system.

Module – III (8 hours)

System Analysis: Voltage drop and power–loss calculations: Derivation for voltage drop and power loss in lines – Manual methods of solution for radial networks – Three phase balanced primary lines.

Module – IV (8 hours)

Protection: Objectives of distribution system protection – Types of common faults and procedure for fault calculations – Protective devices: Principle of operation of fuses – Circuit reclosures – Line sectionalizes and circuit breakers.

Coordination: Coordination of protective devices: General coordination procedure – Residual current circuit breaker RCCB (Wikipedia).

Module – V (8 hours)

Compensation for Power Factor Improvement: Capacitive compensation for power–factor control – Different types of power capacitors – shunt and series capacitors – Effect of shunt capacitors (Fixed and switched) – Power factor correction – Capacitor allocation – Effect of series capacitors – Effect of AVB/AVR –Line drop compensation. Equipment for voltage control Economic justification – Procedure to determine the best capacitor location.

TEXT BOOK

- "Electric Power Distribution system, Engineering" – by TuranGonen, McGraw–hill Book Company.

REFERENCE BOOKS

- Electrical Distribution Systems by Dale R.Patrick and Stephen W.Fardo, CRC press
- Electric Power Distribution – by A.S. Pabla, Tata McGraw–hill Publishing company, 4th edition, 1997.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Describe the several factors of distribution system.
CO2	Express idea to design the feeders and substation and determine the voltage drop and power loss.
CO3	Describe the protection and its coordination
CO4	Describe the effect of compensation on p.f improvement.
CO5	Express the knowledge on the effect of voltage, current distribution system performance.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	1	1	2	1	-	-	-	-	1