Scheme of Instructions & Syllabi

of

Bachelor of Technology

(Electrical Engineering)

(With effective from session 2021-22)

[Revised after the inclusion of Skill and Entrepreneurship courses effective from the session 2022-23]

(Dr. Sweta Agarwal)
HOD EE

(Dr. R.K.Shukla)
Dean Engineering

(Dr. Y.D.S Arya)
Vice Chancellor

Invertis Institute of Engineering &Technology

INVERTIS UNIVERSITY

Invertis Village, Bareilly-Lucknow NH-24, Bareilly

243123, Uttar Pradesh

STUDY AND EVALUATION SCHEME

B.Tech in Electrical Engineering
(W.e.f. academic session 2022-2023)
YEAR II, SEMESTER III

Sl. No.	Course Code	COURSE TITLE/ SUBJECTS	HOURS PER WEEK			EVALUATION SCHEME		TOTAL	Credit
			L	T	P	CA	EE		
THEORY									
1.	BEE301	Electrical Circuit Analysis	3	1	0	30	70	100	4
2.	BEE302	Digital Electronics	3	0	0	25	50	75	3
3.	BEE303	Electrical Machines – I	3	0	0	25	50	75	3
4.	BEE304	Electromagnetic Fields	2	1	0	25	50	75	3
5.	BAS301	Mathematics – III	3	1	0	30	70	100	4
6.	BMC001	Environmental Sciences	3	0	0	-	-	-	-
PRACTICALS AND PROJECTS									
7.	IIOT3	Introduction To Data Analytics	0	0	4	30	70	100	4
8.	BEE351	Digital Electronics Laboratory	0	0	2	10	15	25	1
9.	BEE352	Electrical Machines Laboratory - I	0	0	2	10	15	25	1
		TOTAL	17	3	8	185	390	575	23

L-Lecture, **T-** Tutorial , **P-** Practical , **CA –** Continuous Assessment , **EE –** End sem exam

STUDY AND EVALUATION SCHEME

B.Tech in Electrical Engineering
(w.e.f. academic session 2022-2023)
YEAR II, SEMESTER IV

Sl. No.	Course Code	COURSE TITLE/ SUBJECTS	HOURS PER WEEK			EVALUATION SCHEME		TOTAL	Credit
			L	T	P	CA	EE		
THEORY									
1.	BEE401	Analog Electronics	3	0	0	25	50	75	3
2.	BEE402	Electrical Machines – II	3	0	0	25	50	75	3
3.	BEE403	Power Electronics	3	0	0	25	50	75	3
4.	BEC404	Signals and Systems	2	1	0	25	50	75	3
5.	BEE404	Engineering Mechanics	3	1	0	30	70	100	4
6.	BSC401	Biology-I	2	1	0	25	50	75	3
PRACTICALS AND PROJECTS									
7.	BEE451	Analog Electronics Laboratory	0	0	2	10	15	25	1
8.	BEE452	Electrical Machines Laboratory - II	0	0	2	10	15	25	1
9.	BEE453	Power Electronics Laboratory	0	0	2	10	15	25	1
10.	IIOT4	Machine Learning	0	0	4	30	70	100	4
		TOTAL	16	3	10	215	435	650	26

L-Lecture, **T-** Tutorial , **P-** Practical , **CA** – Continuous Assessment , **EE** – End sem exam

MANDATORY COURSES

Sl. No.	Course Code	Course Title	Credits	Preferred Semesters
1.	BMC001	[Environmental Sciences, Induction Program, NSS/NCC]	Nil	III, IV
		Total		0

BASIC SCIENCE COURSES

Sl. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1	BAS301	Mathematics – III	3:1:0	4	III
2	BAS401	Biology – I	2:1:0	3	IV
		Total			

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PROFESSIONAL CORE COURSES [ELECTRICAL ENGINEERING]

SL. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1.	BEE301	Electrical Circuit Analysis	3:1:0	4	III
2.	BEE302	Digital Electronics	3:0:0	3	III
3.	BEE351	Digital Electronics Laboratory	0:0:2	1	III
4.	BEE303	Electrical Machines – I	3:0:0	3	III
5.	BEE352	Electrical Machines Laboratory - I	0:0:2	1	III
6.	BEE304	Electromagnetic Fields	2:1:0	3	III
7.	BEE401	Analog Electronics	3:0:0	3	IV
8.	BEE451	Analog Electronics Laboratory	0:0:2	1	IV
9.	BEE402	Electrical Machines – II	3:0:0	3	IV
10.	BEE452	Electrical Machines Laboratory - II	0:0:2	1	IV
11.	BEE403	Power Electronics	3:0:0	3	IV
12.	BEE453	Power Electronics Laboratory	0:0:2	1	IV
13.	BEE404	Signals and Systems	2:1:0	3	IV

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PROGRAMME EDUCATIONAL OBJECTIVES

PEO1	To prepare students for a professional career in Electrical Engineering.
PE02	To develop the capability in students to solve engineering problems, carry out higher studies and research in core areas.
PEO3	To induct professionalism, creativity, innovativeness and ethical attitude leading to better services of the society.
PEO4	Work in a team using technical knowledge, tools and environments to achieve project objectives.
PEO5	Engage in lifelong learning, career enhancement and adapt to changing professional and societal needs.

PROGRAMME OUTCOMES

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PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	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 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	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	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	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO7	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO8	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO9	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.

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PROGRAMME CORE COURSES

BEE301	Electrical Circuit Analysis	3L:1T:0P	4 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Apply network theorems for the analysis of electrical circuits.
- Obtain the transient and steady-state response of electrical circuits.
- Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
- Analyse two port circuit behavior.

Module 1: Network Theorems (10 Hours)

Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks.

Module 2: Solution of First and Second order networks (8 Hours)

Solution of first and second order differential equations for Series and parallel R-L, R-C, R- L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

Module 3: Sinusoidal steady state analysis (8 Hours)

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complexpower. Three-phase circuits. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

Module 4: Electrical Circuit Analysis Using Laplace Transforms (8 Hours)

Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances

Module 5: Two Port Network and Network Functions (6 Hours)

Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

Text / References:

1. M. E. Van Valkenburg, “Network Analysis”, Prentice Hall, 2006.
2. D. Roy Choudhury, “ Networks and Systems”, New Age International Publications, 1998.

3. W. H. Hayt and J. E. Kemmerly, “ Engineering Circuit Analysis” , McGraw Hill Education, 2013.
4. C. K. Alexander and M. N. O. Sadiku, “ Electric Circuits”, McGraw Hill Education, 2004.
5. K. V. V. Murthy and M. S. Kamath, “ Basic Circuit Analysis”, Jaico Publishers, 1999.

BEE302	Digital Electronics	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to
- Understand working of logic families and logic gates.
- Design and implement Combinational and Sequential logiccircuits.
- Understand the process of Analog to Digital conversion and Digital to Analog conversion.
- Be able to use PLDs to implement the given logical problem.

Module 1: Fundamentals of Digital Systems and logicfamilies (7Hours)

Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples ofICgates, number systems-binary, signed binary, octal hexadecimal number, binaryarithmetic,one’s and two’s complements arithmetic, codes, error detecting and correctingcodes,characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-statelogic.

Module 2: Combinational DigitalCircuits (7Hours)

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don’t care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial ladder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/ generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.

Module 3: Sequential circuits and systems(7Hours)

A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D types flip flops, applications of flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC’s, asynchronous sequential counters, applications of counters.

Module 4: A/D and D/A Converters (7Hours)

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs

Module 5: Semiconductor memories and Programmable logic devices. (7Hours) Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

Text/References:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

BEE351: Digital Electronics Laboratory (0:0:2 – 1 credit)

Hands-on experiments related to the course contents of BEE302.

BEE303	Electrical Machines-I	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Understand the concepts of magnetic circuits.
- Understand the operation of dc machines.
- Analyse the differences in operation of different dc machine configurations.
- Analyse single phase and three phase transformers circuits.

Module 1: Magnetic fields and magnetic circuits (6 Hours)

Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.

Module 2: Electromagnetic force and torque (9 Hours)

B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency

Module 3: DC machines (8 Hours)

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole- faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution witharmature reaction.

Module 4: DC machine - motoring and generation (7 Hours)

Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

Module 5: Transformers (12 Hours)

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three- phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Text / References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery" , New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, “Performance and design of DC machines” , CBS Publishers, 2004.
3. M. G. Say, “ Performance and design ofAC machines”, CBS Publishers, 2002.
4. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.

BEE352: Electrical Machines Laboratory– I (0:0:2 – 1 credit)

Hands-on experiments related to the course contents of BEE303.

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BEE304	Electromagnetic Fields	3L:1T:0P	4 credits

Course Outcomes:

At the end of the course, students will demonstrate the ability

- To understand the basic laws of electromagnetism.
- To obtain the electric and magnetic fields for simple configurations under static conditions.
- To analyse time varying electric and magnetic fields.
- To understand Maxwell's equation in different forms and different media.
- To understand the propagation of EM waves.

This course shall have Lectures and Tutorials. Most of the students find difficult to visualize electric and magnetic fields. Instructors may demonstrate various simulation tools to visualize electric and magnetic fields in practical devices like transformers, transmission lines and machines.

Module 1: Review of Vector Calculus (6 hours)

Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate system (rectangular, cylindrical and spherical). Vector calculus- differentiation, partial differentiation, integration, vector operator del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.

Module 2: Static Electric Field (6 Hours)

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

Module 3: Conductors, Dielectrics and Capacitance (6 Hours)

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two-wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Module 4: Static Magnetic Fields (6 Hours)

Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Module 5: Magnetic Forces, Materials and Inductance (6 Hours)

Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

Module 6: Time Varying Fields and Maxwell's Equations (6 Hours)

Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.

Module 7: Electromagnetic Waves (6 Hours)

Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

Text / References:

2. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
3. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
4. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
5. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
6. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
7. W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968.
8. E. G. Cullwick, "The Fundamentals of Electromagnetism" , Cambridge University Press, 1966.
9. B. D. Popov "Introductory Engineering Electromagnetics", Addison-Wesley Educational Publishers, International Edition, 1971.
10. W. Hayt, "Engineering Electromagnetics", McGraw Hill Education, 2012.

BEE401	Analog Electronics	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Understand the characteristics of transistors.
- Design and analyse various rectifier and amplifier circuits.
- Design sinusoidal and non-sinusoidal oscillators.
- Understand the functioning of OP-AMP and design OP-AMP based circuits.

Module 1: Diode circuits (4 Hours)

P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

Module 2: BJT circuits (8 Hours)

Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small- signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits

Module 3: MOSFET circuits (8 Hours)

MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Module 4: Differential, multi-stage and operational amplifiers (8 Hours)

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Module 5: Linear applications of op-amp (8 Hours)

Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift).

Analog to Digital Conversion.

Module 6: Nonlinear applications of op-amp (6 Hours)

Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak detector. Monoshot.

Text/References:

2. A. S. Sedra and K. C. Smith, “ Microelectronic Circuits”, New York, Oxford

University Press, 1998.
3. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.
4. J. Millman and A. Grabel, " Microelectronics", McGraw Hill Education, 1988.
5. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
P. R. Gray, R. G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

BEE451: Analog Electronic Circuits Laboratory (0:0:2 – 1 credit)

Hands-on experiments related to the course contents of BEE401.

BEE402	Electrical Machines – II	3L:0T:0P	3 credits

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Understand the concepts of rotating magnetic fields.
- Understand the operation of ac machines.
- Analyse performance characteristics of ac machines.

Module 1: Fundamentals of AC machine windings (8 Hours)

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

Module 2: Pulsating and revolving magnetic fields (4 Hours)

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current

Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Module 3: Induction Machines (12 Hours)

Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors.

Generator operation. Self-excitation. Doubly-Fed Induction Machines.

Module 4: Single-phase induction motors (6 Hours)

Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications

Module 5: Synchronous machines (10 Hours)

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

Text/References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery" , McGraw Hill Education, 2013.
2. M. G. Say, " Performance and design ofAC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, " Alternating current machines", McGraw Hill Education, 1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.

BEE452: Electrical Machines Laboratory– II (0:0:2 – 1 credit)

Hands-on experiments related to the course contents of BEE402.

BEE403	**Power Electronics**	**3L:0T:0P**	**3 credits**

Course Outcomes:

At the end of this course students will demonstrate the ability to

- Understand the differences between signal level and power level devices.
- Analyse controlled rectifier circuits.
- Analyse the operation of DC-DC choppers.
- Analyse the operation of voltage source inverters.

Module 1: Power switching devices (8Hours)

Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Module 2: Thyristor rectifiers (7Hours)

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Module 3: DC-DC buck converter (5Hours)

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Module 4: DC-DC boost converter (5Hours)

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module 5: Single-phase voltage source inverter (10Hours)

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage

Module 6: Three-phase voltage source inverter (8Hours)

Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation

Text/References:

1. M. H. Rashid, "*Power electronics: circuits, devices, and applications*", Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, " Fundamentals of Power Electronics" , Springer Science & Business Media, 2007.
4. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

BEE453: Power Electronics Laboratory (0:0:2 – 1 credit)

Hands-on experiments related to the course contents of BEE403.

BEC404	**Signals and Systems**	**2L:1T:0P**	**3 credits**

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Understand the concepts of continuous time and discrete time systems.
- Analyze systems in complex frequency domain.
- Understand sampling theorem and its implications.

Module 1: Introduction to Signals and Systems (3 hours):

Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

Module 2: Behavior of continuous and discrete-time LTI systems (8 hours)

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Module 3: Fourier, Laplace and z- Transforms (10 hours)

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete- Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Module 4: Sampling and Reconstruction (4 hours)

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Text/References:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “ Signals and systems”, Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, “ Digital Signal Processing: Principles, Algorithms, and Applications” , Pearson, 2006.
3. H. P. Hsu, “ Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, “ Signals and Systems”, John Wiley and Sons, 2007.
5. A. V. Oppenheim and R. W. Schafer, “ Discrete-Time Signal Processing”, Prentice Hall, 2009.
6. M. J. Robert “ Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
7. B. P. Lathi, “ Linear Systems and Signals”, Oxford University Press, 2009.

INVERTIS UNIVERSITY BAREILLY

Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

BASIC SCIENCE COURSES

BAS301	MATHEMATICS III	3L:1T:0P	4 credits

MODULE-I

Function of Complex variable: Analytic function, C-R equations, Cauchy's integral theorem, Cauchy's integral formula for derivatives of analytic function, Taylor's and Laurent's series, singularities, Residue theorem, Evaluation of real integrals.

MODULE-II

Statistical Techniques-I: Moments, Moment generating functions, Skewness, Kurtosis, Curve fitting, Method of least squares, Fitting of straight lines, Polynomials, Exponential curves etc., Correlation, Linear, non –linear and multiple regression analysis, Probability theory.

Statistical Techniques-II: Binomial, Poisson and Normal distributions, Sampling theory (small and large), Tests of significations: Chi-square test, t-test, Analysis of variance (one way) , Application to engineering, medicine, agriculture etc.

Time series and forecasting (moving and semi-averages), Statistical quality control methods, Control charts, R, p, np, and c charts.

MODULE-III

Numerical Techniques–I: Zeroes of transcendental and polynomial equation using Bisection method, Regula-falsi method and Newton-Raphson method, Rate of convergence of above methods.

Interpolation: Finite differences, difference tables, Newton's forward and backward interpolation , Lagrange's and Newton's divided difference formula for unequal intervals.

Numerical Techniques–II: Solution of system of linear equations, Gauss- Seidal method, Crout method. Numerical differentiation, Numerical integration , Trapezoidal , Simpson'sone third and three-eight rules, Solution of ordinary differential (first order, second order and simultaneous) equations by Euler's, Picard's and forth-order Runge- Kutta methods.

Text Books:

1. Jain, Iyenger& Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, New Delhi , 2003.
2. Chandrika Prasad, Advanced Mathematics for Engineers, Prasad Mudralaya, 1996.
3. E. Kreysig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.
5. Devi Prasad, An introduction to Numerical Analysis, Narosa Publication house, New Delhi 2006.
6. R.K. Jain & S.R.K. Iyenger, Advance Engineering Mathematics, Narosa Publication House, 2002.

Reference Books:

1. J.N. Kapur, Mathematical Statistics, S. Chand & company Ltd., 2000
2. Peter V. O'Neil, Advance Engineering Mathematics Thomson (Cengage) Learning

BSC401	Biology-I	2L:1T:0P	3 credits

Module 1: Introduction (2 hours)

Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry. Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

Module 2: Classification (3 hours)

Purpose: To convey that classification *per se* is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure-prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricotelic, ureotelic (e) Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus

Module 3: Genetics (4 hours)

Purpose: To convey that " Genetics is to biology what Newton's laws are to Physical Sciences" . Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

Module 4: Biomolecules (4 hours)

Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine. Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose.Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.

Module 5: Enzymes (4 Hours)

Purpose: To convey that without catalysis life would not have existed on earth.
Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Module 6: Information Transfer (4 hours)

Purpose: The molecular basis of coding and decoding genetic information is universal. Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.

Module 7: Macromolecular analysis (5 hours)

Purpose: To analyse biological processes at the reductionistic level. Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Module 8: Metabolism (4 hours)

Purpose: The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Concept of K_{eq} and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.

Module 9. Microbiology (3 hours)

Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

Text / References:

1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, “ Biology: A global approach”, Pearson Education Ltd, 2014.
2. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, “Outlines of Biochemistry”, John Wiley and Sons, 2009.
3. D. L. Nelson and M. M. Cox, “ Principles of Biochemistry” , W.H. Freeman and Company, 2012.
4. G. S. Stent and R. Calendar, “ Molecular Genetics”, Freeman and company, 1978.
5. L. M. Prescott, J. P. Harley and C. A. Klein, “Microbiology”, McGraw Hill Higher Education, 2005.

Course Outcomes

After studying the course, the student will be able to:

- Describe how biological observations of 18th Century that lead to major discoveries.
- Convey that classification *per se* is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
- Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
- Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
- Classify enzymes and distinguish between different mechanisms of enzyme action.
- Identify DNA as a genetic material in the molecular basis of information transfer.
- Analyse biological processes at the reductionistic level
- Apply thermodynamic principles to biological systems.
- Identify and classify microorganisms.

ENGINEERING SCIENCE COURSES

BEE404	**Engineering Mechanics**	**3L:1T:0P**	**4 credits**

Course Outcomes: At the end of this course, students will demonstrate the ability to
Understand the concepts of co-ordinate systems.
Analyse the three-dimensional motion.
Understand the concepts of rigid bodies.
Analyse the free-body diagrams of different arrangements.
Analyse torsional motion and bending moment.

Module 1: Introduction to vectors and tensors and co-ordinate systems (5 hours)
Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indical notation; Symmetric and anti-symmetric tensors; Eigenvalues and Principal axes.

Module 2: Three-dimensional Rotation (4 hours)

Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.

Module 3: Kinematics of Rigid Body (6 hours)

Kinematics of rigid bodies: Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two- and three-dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.

Module 4: Kinetics of Rigid Bodies (5 hours)

Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws ofrigid body motion.

Module 5: Free Body Diagram (1 hour)

Free body diagrams; Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose.

Module 6: General Motion (9 hours)

Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin.

Module 7: Bending Moment (5 hours)

Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams.

Module 8: Torsional Motion (2 hours)

Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.

Module 9: Friction (3 hours)

Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.

Text / References:

1. J. L. Meriam and L. G. Kraige, "Engineering Mechanics: Dynamics", Wiley, 2011.
2. M. F. Beatty, "Principles of Engineering Mechanics", Springer Science & Business Media, 1986.

MANDATORY COURSES

BMC001	ENVIRONMENTAL SCIENCES	3L:0T:0P	0 credits

MODULE 1

Introduction to Environmental Science - Definition and scope and need for public awareness Ecosystems, Concept, structure and functions, restoration of damaged ecosystems Biodiversity – Definition, description at national and global level, threats and conservation

MODULE 2

Natural Resources - Renewable and non-renewable and their equitable use for sustainability, Material cycles – carbon, nitrogen and sulphur cycle. Conventional and Non-conventional Energy Sources – fossil fuel-based, hydroelectric, wind, -nuclear and solar energy, biomass, biodiesel, hydrogen as an alternative fuel.

MODULE 3

Transportation and industrial growth Social Issues Related to Environment–Sustainable development, reset lement and rehabilitation Environmental ethics.

MODULE 4

Environmental Changes and Human Health Environmental Pollution–Definition, causes and effects, control measures for water, air, soil, noise, thermal pollution.

Textbook:

1. Environmental Studies, J Krishna wamy, RJ Ranjit Daniels, Wiley India.

Reference Books:

2. Environmental Science, Bernard J. Nebel, Richard T. Right, 9780132854467, Prentice Hall Professional 1993.
3. Environment and Ecology, RK Khandal, 978-81-265-4277-2, Wiley India.