**ANNA UNIVERSITY, CHENNAI 600 025**
**NON - AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY**
**REGULATIONS 2021**
**B. E. BIOMEDICAL ENGINEERING**
**CHOICE BASED CREDIT SYSTEM**
**I AND II SEMESTERS CURRICULA AND SYLLABI**

## I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. To enable the graduates to demonstrate their skills in design and develop medical devices for health care system through the core foundation and knowledge acquired in engineering and biology.
2. To enable the graduates to exhibit leadership in health care team to solve health care problems and make decisions with societal and ethical responsibilities.
3. To Carryout multidisciplinary research, addressing human healthcare problems and sustain technical competence with ethics, safety and standards.
4. To ensure that graduates will recognize the need for sustaining and expanding their technical competence and engage in learning opportunities throughout their careers.

## II. PROGRAM SPECIFIC OUTCOMES (PSOs)

1. To design and develop diagnostic and therapeutic devices that reduces physician burnout and enhance the quality of life for the end user by applying fundamentals of Biomedical Engineering.
2. To apply software skills in developing algorithms for solving healthcare related problems in various fields of Medical sector.
3. To adapt to emerging information and communication technologies (ICT) to innovate ideas and solutions for current societal and scientific issues thereby developing indigenous medical instruments that are on par with the existing technology

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**B. E. BIOMEDICAL ENGINEERING**
**I AND II SEMESTERS CURRICULA AND SYLLABI**
**SEMESTER I**

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | IP3151 | Induction Programme | - | - | - | - | - | 0 |
| **THEORY** | | | | | | | | |
| 2. | HS3151 | Professional English - I | HSMC | 3 | 1 | 0 | 4 | 4 |
| 3. | MA3151 | Matrices and Calculus | BSC | 3 | 1 | 0 | 4 | 4 |
| 4. | PH3151 | Engineering Physics | BSC | 3 | 0 | 0 | 3 | 3 |
| 5. | CY3151 | Engineering Chemistry | BSC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3151 | Problem Solving and Python Programming | ESC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 7. | GE3171 | Problem Solving and Python Programming Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 8. | BS3171 | Physics and Chemistry Laboratory | BSC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **15** | **2** | **8** | **25** | **21** |

**SEMESTER II**

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | HS3251 | Professional English - II | HSMC | 3 | 1 | 0 | 4 | 4 |
| 2. | MA3251 | Statistics and Numerical Methods | BSC | 3 | 1 | 0 | 4 | 4 |
| 3. | BM3251 | Biosciences for Medical Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | BE3251 | Basic Electrical and Electronics Engineering | ESC | 3 | 0 | 0 | 3 | 3 |
| 5. | BM3252 | Medical Physics | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3251 | Engineering Graphics | ESC | 2 | 0 | 4 | 6 | 4 |
| 7. | | NCC Credit Course Level 1* | - | 2 | 0 | 0 | 2 | 2* |
| **PRACTICALS** | | | | | | | | |
| 8. | GE3271 | Engineering Practices Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 9. | BM3271 | Biosciences Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **17** | **2** | **12** | **31** | **25** |

*NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

**IP3151** **INDUCTION PROGRAMME**

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have a broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and
also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, make decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and don'ts, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.
Discussions would be conducted in small groups of about 20 students with a faculty

mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the underprivileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering / Technology / Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

**Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.**

References:
Guide to Induction program from AICTE

**HS3151** **PROFESSIONAL ENGLISH - I** **L T P C**
**3 1 0 4**

**COURSE OBJECTIVES:**

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.
- To use language efficiently in expressing their opinions via various media.

**INTRODUCTION TO EFFECTIVE COMMUNICATION** **1**

- What is effective communication? (There are many interesting activities for this.)
- Why is communication critical for excellence during study, research and work?
- What are the seven C's of effective communication?
- What are key language skills?
- What is effective listening? What does it involve?
- What is effective speaking?
- What does it mean to be an excellent reader? What should you be able to do?
- What is effective writing?
- How does one develop language and communication skills?
- What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

**UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION** **11**

Listening –for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form

Speaking - Self Introduction; Introducing a friend; Conversation - politeness strategies; Telephone conversation; Leave a voicemail; Leave a message with another person; asking for information to fill details in a form.

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails.

Writing - Writing emails / letters introducing oneself

Grammar - Present Tense (simple and progressive); Question types: Wh / Yes or No/ and Tags

Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

**UNIT II NARRATION AND SUMMATION** **12**

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities.

Speaking - Narrating personal experiences / events; Interviewing a celebrity; Reporting / and summarizing documentaries / podcasts/ interviews.

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs.

Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.)

Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions

Vocabulary - Word forms (prefixes & suffixes); Synonyms and Antonyms. Phrasal verbs.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 12**

Listening - Listen to a product and process descriptions; a classroom lecture; and advertisements about products.

Speaking – Picture description; giving instruction to use the product; Presenting a product; and Summarizing a lecture.

Reading – Reading advertisements, gadget reviews; user manuals.

Writing - Writing definitions; instructions; and Product /Process description.

Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses.

Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words)

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 12**

Listening – Listening to TED Talks; Scientific lectures; and educational videos.

Speaking – Small Talk; Mini presentations and making recommendations.

Reading – Newspaper articles; Journal reports –and Non Verbal Communication (tables, pie charts etc,)

Writing – Note-making / Note-taking (*Study skills to be taught, not tested; Writing recommendations; Transferring information from non verbal (chart , graph etc, to verbal mode)

Grammar – Articles; Pronouns - Possessive & Relative pronouns.

Vocabulary - Collocations; Fixed / Semi fixed expressions.

**UNIT V EXPRESSION 12**

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions.

Speaking –group discussions, Debates, and Expressing opinions through Simulations & Role play.

Reading – Reading editorials; and Opinion Blogs;

Writing – Essay Writing (Descriptive or narrative).

Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences.

Vocabulary - Cause & Effect Expressions – Content vs Function words.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, learners will be able

- To listen and comprehend complex academic texts
- To read and infer the denotative and connotative meanings of technical texts
- To write definitions, descriptions, narrations and essays on various topics
- To speak fluently and accurately in formal and informal communicative contexts
- To express their opinions effectively in both oral and written medium of communication

**TEXT BOOKS :**

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCES:**

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.

2. A Course Book on Technical English By Lakshmi Narayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, R S Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

**MA3151 MATRICES AND CALCULUS**

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

- To develop the use of matrix algebra techniques that are needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

**UNIT I MATRICES** **9 + 3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane.

**UNIT II DIFFERENTIAL CALCULUS** **9 + 3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

**UNIT III FUNCTIONS OF SEVERAL VARIABLES** **9 + 3**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

**UNIT IV INTEGRAL CALCULUS** **9 + 3**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications : Hydrostatic force and pressure, moments and centres of mass.

**UNIT V MULTIPLE INTEGRALS** **9 + 3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications : Moments and centres of mass, moment of inertia.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students will be able to

- Use the matrix algebra methods for solving practical problems.
- Apply differential calculus tools in solving various application problems.
- Able to use differential calculus ideas on several variable functions.
- Apply different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems.

**TEXT BOOKS:**

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal.B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 44th Edition , 2018.
3. James Stewart, " Calculus : Early Transcendentals ", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8 ].

**REFERENCES:**

1. Anton. H, Bivens. I and Davis. S, " Calculus", Wiley, 10th Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
3. Jain. R.K. and Iyengar. S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 5th Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, " Thomas Calculus ", 14th Edition, Pearson India, 2018.

**PH3151 ENGINEERING PHYSICS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To make the students effectively achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

**UNIT I MECHANICS** **9**

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of the system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

**UNIT II ELECTROMAGNETIC WAVES 9**

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

**UNIT III OSCILLATIONS, OPTICS AND LASERS 9**

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, $CO_2$ laser, semiconductor laser –Basic applications of lasers in industry.

**UNIT IV BASIC QUANTUM MECHANICS 9**

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes-Normalization, probabilities and the correspondence principle.

**UNIT V APPLIED QUANTUM MECHANICS 9**

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)-Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students should be able to

- Understand the importance of mechanics.
- Express their knowledge in electromagnetic waves.
- Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
- Understand the importance of quantum physics.
- Comprehend and apply quantum mechanical principles towards the formation of energy bands.

**TEXT BOOKS:**

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.

**REFERENCES:**

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.

4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

**CY3151 ENGINEERING CHEMISTRY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

**UNIT I WATER AND ITS TREATMENT 9**

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

**UNIT II NANOCHEMISTRY 9**

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

**UNIT III PHASE RULE AND COMPOSITES 9**

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

**UNIT IV FUELS AND COMBUSTION 9**

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive

range; Flue gas analysis - ORSAT Method. $CO_2$ emission and carbon footprint.

**UNIT V ENERGY SOURCES AND STORAGE DEVICES 9**

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles - working principles; Fuel cells: $H_2$-$O_2$ fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the students will be able:

- To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To apply the knowledge of phase rule and composites for material selection requirements.
- To recommend suitable fuels for engineering processes and applications.
- To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

**TEXT BOOKS:**

1. P. C. Jain and Monica Jain, “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, “A Text book of Engineering Chemistry”, S. Chand Publishing, 12th Edition, 2018

**REFERENCES:**

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, “Text book of nanoscience and nanotechnology”, Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, “Engineering Chemistry” McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

**GE3151 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.

- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

**UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9**

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

**UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9**

Python interpreter and interactive mode,debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

**UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9**

Conditionals:Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values,parameters, local and global scope, function composition, recursion; Strings: string slices,immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

**UNIT IV LISTS, TUPLES, DICTIONARIES 9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

**UNIT V FILES, MODULES, PACKAGES 9**

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

CO1: Develop algorithmic solutions to simple computational problems.
CO2: Develop and execute simple Python programs.
CO3: Write simple Python programs using conditionals and loops for solving problems.
CO4: Decompose a Python program into functions.
CO5: Represent compound data using Python lists, tuples, dictionaries etc.
CO6: Read and write data from/to files in Python programs.

**TEXT BOOKS:**

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.

2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.

**REFERENCES:**

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data‘‘, Third Edition, MIT Press , 2021
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.

**GE3171 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C**
**0 0 4 2**

**COURSE OBJECTIVES:**

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

**EXPERIMENTS:**

**Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.**

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)

8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

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

CO1: Develop algorithmic solutions to simple computational problems
CO2: Develop and execute simple Python programs.
CO3: Implement programs in Python using conditionals and loops for solving problems..
CO4: Deploy functions to decompose a Python program.
CO5: Process compound data using Python data structures.
CO6: Utilize Python packages in developing software applications.

**TEXT BOOKS:**

1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

**REFERENCES:**

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press , 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

| BS3171 | PHYSICS AND CHEMISTRY LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**PHYSICS LABORATORY : (Any Seven Experiments)**

**COURSE OBJECTIVES:**

- To learn the proper use of various kinds of physics laboratory equipment.

- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student an active participant in each part of all lab exercises.

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young's modulus
4. Uniform bending – Determination of Young's modulus
5. Laser- Determination of the wavelength of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
10. Post office box -Determination of Band gap of a semiconductor.
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde's string experiment
14. Experiment with lattice dynamics kit.

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students should be able to

- Understand the functioning of various physics laboratory equipment.
- Use graphical models to analyze laboratory data.
- Use mathematical models as a medium for quantitative reasoning and describing physical reality.
- Access, process and analyze scientific information.
- Solve problems individually and collaboratively.

**CHEMISTRY LABORATORY: (Any seven experiments to be conducted)**

**COURSE OBJECTIVES:**

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles

1. Preparation of $Na_2CO_3$ as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in a water sample.

- Split the first experiment into two

3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using a flame photometer.
13. Preparation of nanoparticles ($TiO_2$/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES :**

- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques
- To analyse and determine the composition of alloys.
- To learn simple method of synthesis of nanoparticles
- To quantitatively analyse the impurities in solution by electroanalytical techniques

**TEXT BOOKS :**

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

**HS3251 PROFESSIONAL ENGLISH - II L T P C**
**3 1 0 4**

**COURSE OBJECTIVES**

- To engage learners in meaningful language activities to improve their LSRW skills
- To enhance learners' awareness of general rules of writing for specific audiences
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

**UNIT I MAKING COMPARISONS 12**

Listening – Evaluative Listening: Advertisements, Product Descriptions, -Audio / video; Listening and filling a Graphic Organiser (Choosing a product or service by comparison)
Speaking – Marketing a product, Persuasive Speech Techniques.
Reading - Reading advertisements, user manuals, brochures;
Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases
Vocabulary – Contextual meaning of words

**UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING 12**

Listening - Listening to longer technical talks and completing– gap filling exercises. Listening technical information from podcasts – Listening to process/event descriptions to identify cause &

effects - Speaking – Describing and discussing the reasons of accidents or disasters based on news reports.
Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint,
Writing - Writing responses to complaints.
Grammar - Active Passive Voice transformations, Infinitive and Gerunds Vocabulary – Word Formation (Noun-Verb-Adj-Adv), Adverbs.

**UNIT III PROBLEM SOLVING 12**

Listening – Listening to / Watching movie scenes/ documentaries depicting a technical problem and suggesting solutions.
Speaking – Group Discussion(based on case studies), - techniques and Strategies,
Reading - Case Studies, excerpts from literary texts, news reports etc.,
Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay
Grammar – Error correction; If conditional sentences
Vocabulary - Compound Words, Sentence Completion.

**UNIT IV REPORTING OF EVENTS AND RESEARCH 12**

Listening – Listening Comprehension based on news reports – and documentaries – Precis writing, Summarising, Speaking –Interviewing, Presenting an oral report, Mini presentations on select topics;
Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions

**UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY 12**

Listening – Listening to TED Talks, Presentations, Formal job interviews, (analysis of the interview performance);
Speaking – Participating in a Role play, (interview/telephone interview), virtual interviews, Making presentations with visual aids;
Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses Vocabulary – Idioms.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, learners will be able

- To compare and contrast products and ideas in technical texts.
- To identify cause and effects in events, industrial processes through technical texts
- To analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.
- To report events and the processes of technical and industrial nature.
- To present their opinions in a planned and logical manner, and draft effective resumes in context of job search.

**TEXT BOOKS:**

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCES:**


1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Krishna Mohan, Meera Banerji, "Developing Communication Skills", Trinity Press, 2017.


**MA3251 STATISTICS AND NUMERICAL METHODS L T P C**
**3 1 0 4**

**COURSE OBJECTIVES:**

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

**UNIT I TESTING OF HYPOTHESIS 9 + 3**

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

**UNIT II DESIGN OF EXPERIMENTS 9 + 3**

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - $2^2$ factorial design.

**UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9 + 3**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

**UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9 +3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

**UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9 +3**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods:

Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

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

- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

**TEXT BOOKS:**

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

**REFERENCES:**

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

**BM3251 BIOSCIENCES FOR MEDICAL ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

**The student should be:**

- To study structural and functional properties of carbohydrates, proteins, lipids and amino acids
- To emphasize the role of these biomolecules by providing basic information on specific metabolic diseases and disorders of these biomolecules
- Gain knowledge on the structural and functional aspects of living organisms.

- Know the etiology and remedy in treating the pathological diseases.

**UNIT I FUNDAMENTALS TO BIOCHEMISTRY 9**

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson - Hasselbalch equation, physiological buffers in living systems, Energy in living organism. Properties of water and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes.

**UNIT II CARBOHYDRATES, LIPIDS, PROTEIN 9**

Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates - Classification of lipids- simple, compound, and derived lipids. Nomenclature of fatty acid - Structure and properties of proteins, structural organization of proteins, classification and properties of amino acids. Nucleic acid: Structural aspects – Components of DNA and RNA, Nucleosides & Nucleotides (introduction, structure & bonding), Double helical structure of DNA (Watson-Crick model), various forms of DNA.

**UNIT III CELL DEGENERATION, REPAIR AND NEOPLASIA 9**

Cell injury - Reversible cell injury and Irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification- Dystrophic and Metastatic. cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours Autopsy and biopsy.

**UNIT IV FLUID AND HEMODYNAMIC DERANGEMENTS 9**

Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, Chronic venous congestion. Hematological disorders- Bleeding disorders, Leukaemias, Lymphomas Haemorrhage.

**UNIT V FUNDAMENTALS OF MICROBIOLOGY AND IMMUNOPATHOLOGY 9**

Structure of Bacteria and Virus - Morphological features and structural organization of bacteria and virus - List of common bacterial, fungal and viral diseases of human beings.- Basics of Microscopes : Light microscope, Electron microscope (TEM & SEM). - Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury, Immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**At the end of the course, the student should be able to:**

- Explain the fundamentals of biochemistry
- Analyze structural and functional aspects of living organisms.
- Explain the function of microscope
- Describe methods involved in treating the pathological diseases.

**TEXT BOOKS:**

**1.** RAFI MD “Text book of biochemistry for Medical Student” Fourth Edition, Universities Press, Orient Blackswan Private Limited - New Delhi 2021.

- Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, “Pathologic Basis of Diseases”, 10th edition: South Asia Edition Elsevier India, 2020. (Units III & IV).

2. Ananthanarayanan & Panicker, “Microbiology” Orientblackswan, 2017 10th edition. (Units III,IV and V).

**REFERENCES:**


1. Keith Wilson & John Walker, “Practical Biochemistry - Principles & Techniques”, Oxford University Press, 2009.
2. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
3. Dubey RC and Maheswari DK. “A Text Book of Microbiology” Chand & Company Ltd, 2007
4. Prescott, Harley and Klein, “Microbiology”, 10th edition, McGraw Hill, 2017


**BE3251 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the basics of electric circuits and analysis
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To educate on the fundamental concepts of digital electronics
- To introduce the functional elements and working of measuring instruments

**UNIT I ELECTRICAL CIRCUITS 9**

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm’s Law - Kirchhoff’s Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only)

**UNIT II ELECTRICAL MACHINES 9**

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

**UNIT III ANALOG ELECTRONICS 9**

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters

**UNIT IV DIGITAL ELECTRONICS 9**

Review of number systems, binary codes, error detection and correction codes, Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps (Simple Problems only).

**UNIT V MEASUREMENTS AND INSTRUMENTATION 9**

Functional elements of an instrument, Standards and calibration, Operating Principle , types - Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT,DSO- Block diagram- Data acquisition.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES :**

After completing this course, the students will be able to

**CO1:** Compute the electric circuit parameters for simple problems
**CO2:** Explain the working principle and applications of electrical machines
**CO3:** Analyze the characteristics of analog electronic devices
**CO4:** Explain the basic concepts of digital electronics
**CO5:** Explain the operating principles of measuring instruments

**TEXT BOOKS:**


1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020
2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017.
3. Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., 2008
4. James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
5. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.


**REFERENCES:**


1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019.
2. Thomas L. Floyd, 'Digital Fundamentals', 11th Edition, Pearson Education, 2017.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010


| BM3252 | MEDICAL PHYSICS | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVE:**

- To provide understanding of the application of the radiation concepts and methods of Physics in Medical science
- To accentuate the principle, effects and clinical applications of ionizing, non-ionizing and electromagnetic radiation.
- To enunciate the fundamentals of acoustic waves and their interaction with human tissues.
- To explore the effects of radiation in matter and how isotopes are produced
- To study effects of sound and light in human body

**UNIT I LOW ENERGY ELECTROMAGNETIC SPECTRUM AND ITS MEDICAL APPLICATION** **9**

Physics of light, Intensity of light, limits of vision and color vision an overview, Non-ionizing Electromagnetic Radiation: Overview of non-ionizing radiation effects-Tissue as a leaky dielectric-Low Frequency Effects- Higher frequency effects., Thermography– Application

**UNIT II PRINCIPLES OF RADIOACTIVE NUCLIDES 9**

Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology, Decay series, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radionuclide-fission and neutron capture reaction, radionuclide Generator-Technetium generator

**UNIT III INTERACTION OF RADIATION WITH MATTER LIPIDS 9**

Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter- Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation, Interaction of neutron with matter and their clinical significance

**UNIT IV RADIATION DOSE AND ITS EFFECTS 9**

Dose and Exposure measurements – Units (SI), Inverse square law, Maximum permissible exposure, relationship between the dosimetric quantities, Radiation biology – effects of radiation, concept of LD 50, Stochastic and Non-stochastic effects, Radiation Syndrome.

**UNIT V PRINCIPLES AND APPLICATIONS OF SOUND IN MEDICINE 9**

Physics of sound, Normal sound levels, ultrasound fundamentals, Generation of ultrasound (Ultrasound Transducer), Interaction of Ultrasound with matter- Cavitations, Reflection, Transmission, Scanning methods, Artifacts, Ultrasound- Doppler effect, Clinical Applications

**TOTAL : 45 PERIODS**

**Course Outcomes:**

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

- Interpret the properties of electromagnetic radiations and its effect on human.
- Apply the principles and understand the production of radioactive nuclides.
- Explain the interaction of radiation with matter.
- Identify and Analyse the radiation quantities and its effects
- Demonstrate the knowledge on the properties of sound and its application in medicine.

**TEXT BOOKS:**

1. B.H. Brown, R.H. Smallwood, D.C. Barber, P.V. Lawford, D.R. Hose, —Medical Physics and Biomedical Engineering‖, Institute of physics publishing, Bristol and Philadelphia, 1999.
2. Gopal B. Saha —Physics and Radiobiology of Nuclear Medicine‖ Fourth edition Springer, 2006.

**REFERENCES:**

1. W.J. Meredith and J.B. Massey “Fundamental Physics of Radiology” Varghese Publishing house, Third Edition, 2013.
2. Steve Webb, The Physics of Medical Imaging, Taylor & Francis, Newyork, Second Edition, 2012.
3. R.S. Khandpur, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, 2003.

**e-RESOURCES:**

1. http://www.nptel.ac.in/courses/115102017/ , “Nuclear science and Engineering”, Dr. Santanu Gosh, Department of Physics, IIT, Delhi.
2. http://www.uthgsbsmedphys.org/GS02-0093/ ,” Introduction to Medical Physics”, Dr George Starkschall, The University of Texas at Houston.

**GE3251 ENGINEERING GRAPHICS L T P C**
**2 0 4 4**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Drawing engineering curves.
- Drawing freehand sketch of simple objects.
- Drawing orthographic projection of solids and section of solids.
- Drawing development of solids
- Drawing isometric and perspective projections of simple solids.

**CONCEPTS AND CONVENTIONS (Not for Examination)**

Importance of graphics in engineering applications — Use of drafting instruments — BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

**UNIT I PLANE CURVES AND FREEHAND SKETCHING 6+12**

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

**UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12**

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

**UNIT III PROJECTION OF SOLIDS 6+12**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

**UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6 +12**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

**UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12**

Principles of isometric projection — isometric scale —Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software(Not for examination)

**TOTAL: (L=30+P=60) 90 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- Use BIS conventions and specifications for engineering drawing.
- Construct the conic curves, involutes and cycloid.
- Solve practical problems involving projection of lines.
- Draw the orthographic, isometric and perspective projections of simple solids.
- Draw the development of simple solids.

**TEXT BOOKS:**


1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015


**REFERENCES:**


1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2nd Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.


**Publication of** Bureau of Indian Standards:

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

**Special points applicable to University Examinations on Engineering Graphics:**

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

**NX3251** **NCC Credit Course Level 1***
**(ARMY WING)**

NCC Credit Course Level - I

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

| | | |
|---|---|---|
| **NCC GENERAL** | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | 1 |
| NCC 2 | Incentives | 2 |
| NCC 3 | Duties of NCC Cadet | 1 |
| NCC 4 | NCC Camps: Types & Conduct | 2 |
| **NATIONAL INTEGRATION AND AWARENESS** | | **4** |
| NI 1 | National Integration: Importance & Necessity | 1 |
| NI 2 | Factors Affecting National Integration | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 |
| NI 4 | Threats to National Security | 1 |
| **PERSONALITY DEVELOPMENT** | | **7** |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |
| **LEADERSHIP** | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 |
| **SOCIAL SERVICE AND COMMUNITY DEVELOPMENT** | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |

**TOTAL: 30 PERIODS**

**NX3252** **NCC Credit Course Level 1***
**(NAVAL WING)**

NCC Credit Course Level - I

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

| | | |
|---|---|---|
| **NCC GENERAL** | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | 1 |
| NCC 2 | Incentives | 2 |
| NCC 3 | Duties of NCC Cadet | 1 |
| NCC 4 | NCC Camps: Types & Conduct | 2 |
| **NATIONAL INTEGRATION AND AWARENESS** | | **4** |
| NI 1 | National Integration: Importance & Necessity | 1 |
| NI 2 | Factors Affecting National Integration | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 |
| NI 4 | Threats to National Security | 1 |
| **PERSONALITY DEVELOPMENT** | | **7** |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |
| **LEADERSHIP** | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 |
| **SOCIAL SERVICE AND COMMUNITY DEVELOPMENT** | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |

**TOTAL : 30 PERIODS**

**NX3253** **NCC Credit Course Level 1***
**(AIR FORCE WING)**

| | NCC Credit Course Level - I | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

| | | |
|---|---|---|
| **NCC GENERAL** | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | 1 |
| NCC 2 | Incentives | 2 |
| NCC 3 | Duties of NCC Cadet | 1 |
| NCC 4 | NCC Camps: Types & Conduct | 2 |
| **NATIONAL INTEGRATION AND AWARENESS** | | **4** |
| NI 1 | National Integration: Importance & Necessity | 1 |
| NI 2 | Factors Affecting National Integration | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 |
| NI 4 | Threats to National Security | 1 |
| **PERSONALITY DEVELOPMENT** | | **7** |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |
| **LEADERSHIP** | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 |
| **SOCIAL SERVICE AND COMMUNITY DEVELOPMENT** | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |

**TOTAL : 30 PERIODS**

**GE3271 ENGINEERING PRACTICES LABORATORY**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in commonhousehold wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

**GROUP – A (CIVIL & ELECTRICAL)**

**PART I CIVIL ENGINEERING PRACTICES** **15**

**PLUMBING WORK:**

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers,elbows and other components which are commonly used in household.
b) Preparing plumbing line sketches.
c) Laying pipe connection to the suction side of a pump
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used inhousehold appliances.

**WOOD WORK:**

a) Sawing,
b) Planing and
c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

a) Studying joints in door panels and wooden furniture
b) Studying common industrial trusses using models.

**PART II ELECTRICAL ENGINEERING PRACTICES** **15**

a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
b) Staircase wiring
c) Fluorescent Lamp wiring with introduction to CFL and LED types.
d) Energy meter wiring and related calculations/ calibration
e) Study of Iron Box wiring and assembly
f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
g) Study of emergency lamp wiring/Water heater

**GROUP – B (MECHANICAL AND ELECTRONICS)**

**PART III MECHANICAL ENGINEERING PRACTICES 15**

**WELDING WORK:**

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

**BASIC MACHINING WORK:**

a) (simple)Turning.
b) (simple)Drilling.
c) (simple)Tapping.

**ASSEMBLY WORK:**

a) Assembling a centrifugal pump.
b) Assembling a household mixer.
c) Assembling an airconditioner.

**SHEET METAL WORK:**

a) Making of a square tray

**FOUNDRY WORK:**

a) Demonstrating basic foundry operations.

**PART IV ELECTRONIC ENGINEERING PRACTICES 15**

**SOLDERING WORK:**

a) Soldering simple electronic circuits and checking continuity.

**ELECTRONIC ASSEMBLY AND TESTING WORK:**

a) Assembling and testing electronic components on a small PCB.

**ELECTRONIC EQUIPMENT STUDY:**

a) Study an elements of smart phone..
b) Assembly and dismantle of LED TV.
c) Assembly and dismantle of computer/ laptop

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES**:

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

- Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
- Wire various electrical joints in common household electrical wire work.
- Weld various joints in steel plates using arc welding work; Machine various simple processeslike turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
- Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

**BM3271** **BIOSCIENCES LABORATORY** **L T P C**
**0 0 4 2**

**COURSE OBJECTIVES:**

**To provide practice on:**

- Estimation and quantification of biomolecules.
- Separation of macromolecules.
- Use Compound microscope
- Practice on chemical examinations, Histopathological examinations etc

**LIST OF EXPERIMENTS:**

1. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions
2. Standardization of pH meter, preparation of buffers, emulsions.
3. Spectroscopy: Determination of absorption maxima (λmax) of a given solution
4. General tests for carbohydrates, proteins and lipids.
5. Identification of Blood Collection Tubes and Phlebotomy equipment
6. Preparation of serum and plasma from blood
7. Estimation of Haemoglobin and blood glucose
8. Estimation of creatinine, urea and Uric acid
9. Separation of proteins by SDS electrophoresis(Demo) and amino acids by thin layer chromatography (Demo).
10. Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood)
11. Basic staining – Hematoxylin and eosin staining.
12. Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS
13. Types of Staining : Simple stain, Gram stain
14. Study of parts of compound microscope
15. Study of Histopathological slides of benign and malignant tumours.
16. Study of Haematology slides of anemia and leukemia.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

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

- Understand the Biochemistry laboratory functional components
- Have a sound knowledge of qualitative test of different biomolecules.
- Understand the basics knowledge of Biochemical parameter and their interpretation in Blood sample.
- Have a sound knowledge of separation technology of proteins and amino acids.
- Student can perform practical experiments on staining Processes.

**TEXT BOOK**:

1. Ramnik Sood, Textbook of Medical Laboratory Technology, 6$^{th}$Edition, Jaypee Brothers Medical Publishers, 2009

**LAB REQUIREMENT FOR A BATCH OF 30 STUDENTS:**

**Requirement for a batch of 30 students**

Colorimeter 2 Nos
Spectrophotometer 1 No.
pH meter 1 No
Weighing balance 1 No

Refrigerator 1 No
SDS gel electrophoresis 1 No
TLC, ready TLC plates 1 No
Wintrobe's tube 2 Nos.
Centrifuge Normal 1 No
Microslides 2 packets
Lancet 5 boxes
Microscope 1 No
Neubaur's Chamber 2 Nos.
Heparinized Syringe 1box
Haemoglobinometer 1 No
Capillary tubes 1 box

**ANNA UNIVERSITY, CHENNAI 600 025**
**NON- AUTONOMOUS AFFILIATED COLLEGES**
**REGULATIONS 2021**
**CHOICE BASED CREDIT SYSTEM**

# B. E. BIOMEDICAL ENGINEERING

## I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. To enable the graduates to demonstrate their skills in design and develop medical devices for health care system through the core foundation and knowledge acquired in engineering and biology.

2. To enable the graduates to exhibit leadership in health care team to solve health care problems and make decisions with societal and ethical responsibilities.

3. To Carryout multidisciplinary research, addressing human healthcare problems and sustain technical competence with ethics, safety and standards.

4. To ensure that graduates will recognize the need for sustaining and expanding their technical competence and engage in learning opportunities throughout their careers.

## II. PROGRAM OUTCOMES (POs)

1 **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2 **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5 **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.

6 **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.

7 **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9 **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## III. PROGRAM SPECIFIC OUTCOMES (PSOs)

1. To design and develop diagnostic and therapeutic devices that reduces physician burnout and enhance the quality of life for the end user by applying fundamentals of Biomedical Engineering.

2. To apply software skills in developing algorithms for solving healthcare related problems in various fields of Medical sector.

3. To adapt to emerging information and communication technologies (ICT) to innovate ideas and solutions for current societal and scientific issues thereby developing indigenous medical instruments that are on par with the existing technology

**ANNA UNIVERSITY, CHENNAI 600 025**
**NON- AUTONOMOUS AFFILIATED COLLEGES**
**REGULATIONS 2021**
**B. E. BIOMEDICAL ENGINEERING**
**CHOICE BASED CREDIT SYSTEM**
**CURRICULA FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV**

**SEMESTER I**

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | IP3151 | Induction Programme | - | - | - | - | - | 0 |
| **THEORY** | | | | | | | | |
| 2. | HS3151 | Professional English - I | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | MA3151 | Matrices and Calculus | BSC | 3 | 1 | 0 | 4 | 4 |
| 4. | PH3151 | Engineering Physics | BSC | 3 | 0 | 0 | 3 | 3 |
| 5. | CY3151 | Engineering Chemistry | BSC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3151 | Problem Solving and Python Programming | ESC | 3 | 0 | 0 | 3 | 3 |
| 7. | GE3152 | அறிவியல் தமிழ் /Scientific Thoughts in Tamil | HSMC | 1 | 0 | 0 | 1 | 1 |
| **PRACTICALS** | | | | | | | | |
| 8. | GE3171 | Problem Solving and Python Programming Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 9. | BS3171 | Physics and Chemistry Laboratory | BSC | 0 | 0 | 4 | 4 | 2 |
| 10. | GE3172 | English Laboratory $ | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | 16 | 1 | 10 | 27 | 22 |

**$ Skill Based Course**

**SEMESTER II**

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | HS3251 | Professional English - II | HSMC | 2 | 0 | 0 | 2 | 2 |
| 2. | MA3251 | Statistics and Numerical Methods | BSC | 3 | 1 | 0 | 4 | 4 |
| 3. | BM3251 | Biosciences for Medical Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | BE3251 | Basic Electrical and Electronics Engineering | ESC | 3 | 0 | 0 | 3 | 3 |
| 5. | BM3252 | Medical Physics | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3251 | Engineering Graphics | ESC | 2 | 0 | 4 | 6 | 4 |
| 7. | GE3252 | தமிழர் மரபு /Heritage of Tamils | HSMC | 1 | 0 | 0 | 1 | 1 |
| 8. | | NCC Credit Course Level 1# | - | 2 | 0 | 0 | 2 | 2* |
| **PRACTICALS** | | | | | | | | |
| 9. | GE3271 | Engineering Practices Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 10. | BM3271 | Biosciences Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 11. | GE3272 | Communication Laboratory / Foreign Language $ | EEC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | 17 | 1 | 16 | 34 | 26 |

**# NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.**

**$ Skill Based Course**

**SEMESTER III**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA3351 | Transforms and Partial Differential Equations | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | BM3353 | Fundamentals of Electronic Devices and Circuits | ESC | 3 | 0 | 0 | 3 | 3 |
| 3. | BM3301 | Sensors and Measurements | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | BM3352 | Electric Circuit Analysis | ESC | 3 | 0 | 0 | 3 | 3 |
| 5. | BM3351 | Anatomy and Human Physiology | PCC | 3 | 0 | 2 | 5 | 4 |
| 6. | CS3391 | Object oriented programming | ESC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 7. | BM3361 | Fundamentals of Electronic Devices and Circuits Laboratory | ESC | 0 | 0 | 3 | 3 | 1.5 |
| 8. | BM3311 | Sensors and Measurements Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 9. | CS3381 | Object oriented programming Laboratory | ESC | 0 | 0 | 3 | 3 | 1.5 |
| 10. | GE3361 | Professional Development[$] | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **18** | **1** | **13** | **32** | **25.5** |

**[$] Skill Based Course**

**SEMESTER IV**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA3355 | Random Processes and Linear Algebra | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | BM3491 | Biomedical Instrumentation | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | BM3402 | Analog and Digital Integrated Circuits | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | BM3451 | Bio Control Systems | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | BM3401 | Signal Processing | PCC | 3 | 0 | 2 | 5 | 4 |
| 6. | GE3451 | Environmental Sciences and Sustainability | BSC | 2 | 0 | 0 | 2 | 2 |
| 7. | | NCC Credit Course Level 2* | | 3 | 0 | 0 | 3 | 3 [#] |
| **PRACTICALS** | | | | | | | | |
| 8. | BM3411 | Biomedical Instrumentation Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 9. | BM3412 | Analog and Digital Integrated Circuits Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| | | | **TOTAL** | **17** | **1** | **8** | **26** | **22** |

**[#] NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.**

**SEMESTER V**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | BM3551 | Embedded Systems and IoMT | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | BM3591 | Diagnostic and Therapeutic Equipment | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Professional Elective I | PEC | - | - | - | - | 3 |
| 4. | | Professional Elective II | PEC | - | - | - | - | 3 |
| 5. | | Professional Elective III | PEC | - | - | - | - | 3 |
| 6. | | Mandatory Course-I[&] | MC | 3 | 0 | 0 | 3 | 0 |
| **PRACTICALS** | | | | | | | | |
| 7. | BM3562 | Embedded systems and IOMT Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 8. | BM3561 | Diagnostic and Therapeutic Equipment Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **-** | **-** | **-** | **-** | **18.5** |

**[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-I)**

**SEMESTER VI**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | CS3491 | Artificial Intelligence and Machine Learning | PCC | 3 | 0 | 2 | 5 | 4 |
| 2. | BM3651 | Fundamentals of Healthcare Analytics | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | BM3652 | Medical Image Processing | PCC | 3 | 0 | 2 | 5 | 4 |
| 4. | | Open Elective – I* | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective IV | PEC | - | - | - | - | 3 |
| 6. | | Professional Elective V | PEC | - | - | - | - | 3 |
| 7. | | Professional Elective VI | PEC | - | - | - | - | 3 |
| 8. | | Mandatory Course-II [&] | MC | 3 | 0 | 0 | 3 | 0 |
| 9. | | NCC Credit Course Level 3[#] | | 3 | 0 | 0 | 3 | 3[#] |
| | | | **TOTAL** | **-** | **-** | **-** | **-** | **23** |

***Open Elective – I Shall be chosen from the list of open electives offered by other Programmes**

**[&] Mandatory Course-II is a Non-credit Course (Student shall should select one course from the list given under Mandatory Course-II)**

**[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA**

**SEMESTER VII / VIII***

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | GE3791 | Human Values and Ethics | HSMC | 2 | 0 | 0 | 2 | 2 |
| 2. | | Management – Elective# | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Open Elective – II** | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Open Elective – III** | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Open Elective – IV** | OEC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 6. | BM3711 | Hospital Training | EEC | 0 | 0 | 0 | 0 | 2 |
| | | | **TOTAL** | **14** | **0** | **0** | **14** | **16** |

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.**

**** Open Elective II - IV (Shall be chosen from the list of open electives offered by other Programmes).**

**# Management – Elective shall be chosen from the Management Elective courses.**

**SEMESTER VIII /VII***

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICALS** | | | | | | | | |
| 1. | BM3811 | Project Work / Internship | EEC | 0 | 0 | 20 | 20 | 10 |
| | | | **TOTAL** | **0** | **0** | **20** | **20** | **10** |

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.**

**TOTAL CREDITS : 163**

**MANAGEMENT – ELECTIVE**

| S. NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PERWEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | GE3751 | Principles of Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 2. | GE3752 | Total Quality Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | GE3753 | Engineering Economics and Financial Accounting | HSMC | 3 | 0 | 0 | 3 | 3 |
| 4. | GE3754 | Human Resource Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 5. | GE3755 | Knowledge Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3792 | Industrial Management | HSMC | 3 | 0 | 0 | 3 | 3 |

## MANDATORY COURSES I

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | MX3081 | Introduction to Women and Gender Studies | MC | 3 | 0 | 0 | 3 | 0 |
| 2. | MX3082 | Elements of Literature | MC | 3 | 0 | 0 | 3 | 0 |
| 3. | MX3083 | Film Appreciation | MC | 3 | 0 | 0 | 3 | 0 |
| 4. | MX3084 | Disaster Management | MC | 3 | 0 | 0 | 3 | 0 |

## MANDATORY COURSES II

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | MX3085 | Well Being with traditional practices (Yoga, Ayurveda and Siddha) | MC | 3 | 0 | 0 | 3 | 0 |
| 2. | MX3086 | History of Science and Technology in India | MC | 3 | 0 | 0 | 3 | 0 |
| 3. | MX3087 | Political and Economic Thought for a Humane Society | MC | 3 | 0 | 0 | 3 | 0 |
| 4. | MX3088 | State, Nation Building and Politics in India | MC | 3 | 0 | 0 | 3 | 0 |
| 5. | MX3089 | Industrial Safety | MC | 3 | 0 | 0 | 3 | 0 |

## PROFESSIONAL ELECTIVE COURSES: VERTICALS

| Vertical I<br>Bio Engineering | Vertical II<br>Medical Device Innovation and Development | Vertical III<br>Management (Healthcare) | Vertical IV<br>Mechanics | Vertical V<br>Signal and Image Processing | Verticals VI<br>Communication | Verticals VII<br>Advanced Healthcare Devices |
|---|---|---|---|---|---|---|
| Biomaterials | Foundation Skills in integrated product Development | Clinical Engineering | Biomechanics | Bio signal Processing | Communication Systems | Bio MEMS |
| Artificial Organs and Implants | Medical Device Design | Hospital Planning and management | Rehabilitation engineering | Computer Vision | Wearable devices | Critical Care Equipment |
| Biomedical Optics and Photonics | Patient safety, Standards and Ethics | Medical waste Management | Physiological modelling | Speech and audio signal Processing | Body Area Networks | Human Assist Devices |
| Neural Engineering | Medical Device Regulations | Economics and management for Engineers | Assistive Technology | Medical Imaging Systems | Virtual reality and Augmented Reality in Healthcare | Advancements in Healthcare Technology |
| Principles of Tissue Engineering | Medical Innovation and Entrepreneurship | Bio Statistics | Ergonomics | Brain Computer Interface and Applications | Telehealth Technology | Robotics in Medicine |
| Genetic Engineering | Rapid Prototyping | Forensic Science in healthcare | Haptics | Biometrics | Medical Informatics | Therapeutic Equipment |

**Registration of Professional Elective Courses from Verticals:**

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10.

## PROFESSIONAL ELECTIVE COURSES: VERTICALS

### VERTICAL 1: BIO ENGINEERING

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CBM337 | Biomaterials | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CBM332 | Artificial Organs and Implants | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CBM339 | Biomedical Optics and Photonics | PEC | 2 | 0 | 2 | 4 | 3 |
| 4. | CBM359 | Neural Engineering | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CBM362 | Principles of Tissue Engineering | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CBM349 | Genetic Engineering | PEC | 3 | 0 | 0 | 3 | 3 |

### VERTICAL 2: MEDICAL DEVICE INNOVATION AND DEVELOPMENT

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CBM348 | Foundation Skills in integrated product Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CBM353 | Medical Device Design | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CBM360 | Patient safety, Standards and Ethics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CBM357 | Medical Device Regulations | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CBM357 | Medical Innovation and Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CBM363 | Rapid Prototyping | PEC | 3 | 0 | 0 | 3 | 3 |

**VERTICAL 3: MANAGEMENT (HEALTHCARE)**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CBM343 | Clinical Engineering | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CBM351 | Hospital Planning and management | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CBM358 | Medical waste Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CBM345 | Economics and management for Engineers | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CBM336 | Bio Statistics | PEC | 2 | 0 | 2 | 4 | 3 |
| 6. | CBM347 | Forensic Science in Healthcare | PEC | 3 | 0 | 0 | 3 | 3 |

**VERTICAL 4: MECHANICS**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CBM338 | Biomechanics | PEC | 2 | 0 | 2 | 4 | 3 |
| 2. | CBM364 | Rehabilitation engineering | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CBM361 | Physiological modelling | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CBM333 | Assistive Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CBM346 | Ergonomics | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CBM350 | Haptics | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 5: SIGNAL AND IMAGE PROCESSING

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CBM335 | Bio signal Processing | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CBM371 | Computer Vision | PEC | 2 | 0 | 2 | 4 | 3 |
| 3. | CBM366 | Speech and audio signal Processing | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CBM355 | Medical Imaging Systems | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CBM342 | Brain Computer Interface and Applications | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CBM340 | Biometrics | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 6: COMMUNICATION

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | EC3491 | Communication Systems | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CBM370 | Wearable devices | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CBM341 | Body Area Networks | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CBM369 | Virtual reality and Augmented Reality in Healthcare | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CBM367 | Telehealth Technology | PEC | 2 | 0 | 2 | 4 | 3 |
| 6. | CBM356 | Medical Informatics | PEC | 3 | 0 | 0 | 3 | 3 |

### VERTICAL 7: ADVANCED HEALTHCARE DEVICES

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CBM334 | Bio MEMS | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CBM344 | Critical Care Equipment | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CBM352 | Human Assist Devices | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CBM331 | Advancements in Healthcare Technology | PEC | 2 | 0 | 2 | 4 | 3 |
| 5. | CBM365 | Robotics in Medicine | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CBM368 | Therapeutic Equipment | PEC | 3 | 0 | 0 | 3 | 3 |

## OPEN ELECTIVES

**(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).**

### OPEN ELECTIVES – I

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OAS351 | Space Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OIE351 | Introduction to Industrial Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OBT351 | Climate Change and its Impact | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OCE351 | Environment and Social Impact Assessment | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OEE351 | Renewable Energy System | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OEI351 | Introduction to Industrial Instrumentation and Control | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OMA351 | Graph Theory | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OCS355 | Deep Learning | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OCS356 | Digital Marketing | OEC | 3 | 0 | 0 | 3 | 3 |

## OPEN ELECTIVES – II

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OIE352 | Resource Management Techniques | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OMG351 | Fintech Regulations | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OFD351 | Holistic Nutrition | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OCE352 | ICT in Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OEI352 | Introduction to Control Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OPY351 | Pharmaceutical Nanotechnology | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OAE351 | Aviation Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OCS357 | Dev-ops | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OCS358 | Robotics Process Automation | OEC | 3 | 0 | 0 | 3 | 3 |

## OPEN ELECTIVES – III

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OHS351 | English for Competitive Examinations | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OMG352 | NGOs and Sustainable Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMG353 | Democracy and Good Governance | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OME353 | Renewable Energy Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OME354 | Applied Design Thinking | OEC | 2 | 0 | 2 | 4 | 3 |
| 6. | OMF351 | Reverse Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OMF353 | Sustainable Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OAU351 | Electric and Hybrid Vehicle | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OAS352 | Space Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 10. | OIM351 | Industrial Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OIE354 | Quality Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OSF351 | Fire Safety Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | OML351 | Introduction to non-destructive testing | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OMR351 | Mechatronics | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | ORA351 | Foundation of Robotics | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OAE352 | Fundamentals of Aeronautical engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OGI351 | Remote Sensing Concepts | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OAI351 | Urban Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OEN351 | Drinking Water Supply and Treatment | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 20. | OEE352 | Electric Vehicle technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OEI353 | Introduction to PLC Programming | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OCH351 | Nano Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OCH352 | Functional Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | OBT352 | Biomedical Instrumentation | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | OFD352 | Traditional Indian Foods | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OFD353 | Introduction to food processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OPY352 | IPR for Pharma Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OTT351 | Basics of Textile Finishing | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OTT352 | Industrial Engineering for Garment Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OTT353 | Basics of Textile Manufacture | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OPE351 | Introduction to Petroleum Refining and Petrochemicals | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OPE352 | Energy Conservation and Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OPT351 | Basics of Plastics Processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OEC351 | Signals and Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OEC352 | Fundamentals of Electronic Devices and Circuits | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OMA352 | Operations Research | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OMA353 | Algebra and Number Theory | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OMA354 | Linear Algebra | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OCE353 | Lean Concepts, Tools And Practices | OEC | 3 | 0 | 0 | 3 | 3 |

**OPEN ELECTIVES – IV**

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OHS352 | Project Report Writing | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OMA355 | Advanced Numerical Methods | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMA356 | Random Processes | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OMA357 | Queuing and Reliability Modelling | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OMG354 | Production and Operations Management for Entrepreneurs | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OMG355 | Multivariate Data Analysis | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OME352 | Additive Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OME353 | New Product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OME355 | Industrial Design & Rapid Prototyping Techniques | OEC | 2 | 0 | 2 | 4 | 3 |
| 10. | OMF352 | Micro and Precision Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OMF354 | Cost Management of Engineering Projects | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OAU352 | Batteries and Management system | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 13. | OAU353 | Sensors and Actuators | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OAS353 | Space Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | OIM352 | Management Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OIM353 | Production Planning and Control | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OIE353 | Operations Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OSF352 | Industrial Hygiene | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OSF353 | Chemical Process Safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OML352 | Electrical, Electronic and Magnetic materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OML353 | Nanomaterials and applications | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OMR352 | Hydraulics and Pneumatics | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OMR353 | Sensors | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | ORA352 | Foundation of Automation | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | ORA353 | Concepts in Mobile Robotics | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OMV351 | Marine Propulsion | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OMV352 | Marine Merchant Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OMV353 | Elements of Marine Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OAE353 | Drone Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OGI352 | Geographical Information System | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OAI352 | Agriculture Entrepreneurship Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OEN352 | Biodiversity Conservation | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OEE353 | Introduction to control systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OEI354 | Introduction to Industrial Automation Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OCH353 | Energy Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OCH354 | Surface Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OBT353 | Environment and Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OFD354 | Fundamentals of Food Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OFD355 | Food safety and Quality Regulations | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | OPY353 | Nutraceuticals | OEC | 3 | 0 | 0 | 3 | 3 |
| 41. | OTT354 | Basics of Dyeing and Printing | OEC | 3 | 0 | 0 | 3 | 3 |
| 42. | OTT355 | Fibre Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 43. | OTT356 | Garment Manufacturing Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 44. | OPE353 | Industrial safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 45. | OPE354 | Unit Operations in Petro Chemical Industries | OEC | 3 | 0 | 0 | 3 | 3 |
| 46. | OPT352 | Plastic Materials for Engineers | OEC | 3 | 0 | 0 | 3 | 3 |
| 47. | OPT353 | Properties and Testing of Plastics | OEC | 3 | 0 | 0 | 3 | 3 |
| 48. | OEC353 | VLSI Design | OEC | 3 | 0 | 0 | 3 | 3 |
| 49. | OEC354 | Industrial IoT and Industry 4.0 | OEC | 2 | 0 | 2 | 4 | 3 |
| 50. | OCE354 | Basics of Integrated Water Resources Management | OEC | 3 | 0 | 0 | 3 | 3 |

## SUMMARY

| Name of the Programme: B.E. Biomedical Engineering | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S.No | Subject Area | Credits per Semester | | | | | | | | Total Credits |
| | | I | II | III | IV | V | VI | VII/VIII | VIII/VII | |
| 1 | HSMC | 4 | 3 | | | | | 5 | | 12 |
| 2 | BSC | 12 | 4 | 4 | 6 | | | | | 26 |
| 3 | ESC | 5 | 9 | 12 | | | | | | 26 |
| 4 | PCC | | 8 | 8.5 | 16 | 9.5 | 11 | | | 53 |
| 5 | PEC | | | | | 9 | 9 | | | 18 |
| 6 | OEC | | | | | | 3 | 9 | | 12 |
| 7 | EEC | 1 | 2 | 1 | | | | 2 | 10 | 16 |
| 8 | Non-Credit /(Mandatory) | | | | | √ | √ | | | |
| Total | | 22 | 26 | 25.5 | 22 | 18.5 | 23 | 16 | 10 | 163 |

## ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.
Complete details are available in clause 4.10 of Regulations 2021.

## VERTICALS FOR MINOR DEGREE
## (In addition to all the verticals of other programmes)

| Vertical I<br>Fintech and Block Chain | Vertical II<br>Entrepreneurship | Vertical III<br>Public Administration | Vertical IV<br>Business Data Analytics | Vertical V<br>Environmental and Sustainability |
|---|---|---|---|---|
| Financial Management | Foundations of Entrepreneurship | Principles of Public Administration | Statistics for Management | Sustainable infrastructure Development |
| Fundamentals of Investment | Team Building & Leadership Management for Business | Constitution of India | Datamining for Business Intelligence | Sustainable Agriculture and Environmental Management |
| Banking, Financial Services and Insurance | Creativity & Innovation in Entrepreneurship | Public Personnel Administration | Human Resource Analytics | Sustainable Bio Materials |
| Introduction to Blockchain and its Applications | Principles of Marketing Management For Business | Administrative Theories | Marketing and Social Media Web Analytics | Materials for Energy Sustainability |
| Fintech Personal Finance and Payments | Human Resource Management for Entrepreneurs | Indian Administrative System | Operation and Supply Chain Analytics | Green Technology |
| Introduction to Fintech | Financing New Business Ventures | Public Policy Administration | Financial Analytics | Environmental Quality Monitoring and Analysis |
| - | - | - | - | Integrated Energy Planning for Sustainable Development |
| - | - | - | - | Energy Efficiency for Sustainable Development |

**(choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)**

## VERTICAL 1: FINTECH AND BLOCK CHAIN

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG331 | Financial Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG332 | Fundamentals of Investment | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG333 | Banking, Financial Services and Insurance | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG334 | Introduction to Blockchain and its Applications | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG335 | Fintech Personal Finance and Payments | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG336 | Introduction to Fintech | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 2: ENTREPRENEURSHIP

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG337 | Foundations of Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG338 | Team Building & Leadership Management for Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG339 | Creativity & Innovation in Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG340 | Principles of Marketing Management For Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG341 | Human Resource Management for Entrepreneurs | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG342 | Financing New Business Ventures | PEC | 3 | 0 | 0 | 3 | 3 |

### VERTICAL 3: PUBLIC ADMINISTRATION

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG343 | Principles of Public Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG344 | Constitution of India | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG345 | Public Personnel Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG346 | Administrative Theories | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG347 | Indian Administrative System | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG348 | Public Policy Administration | PEC | 3 | 0 | 0 | 3 | 3 |

### VERTICAL 4: BUSINESS DATA ANALYTICS

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG349 | Statistics for Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG350 | Datamining for Business Intelligence | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG351 | Human Resource Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG352 | Marketing and Social Media Web Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG353 | Operation and Supply Chain Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG354 | Financial Analytics | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 5: ENVIRONMENTAL AND SUSTAINABILITY

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CES331 | Sustainable infrastructure Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CES332 | Sustainable Agriculture and Environmental Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CES333 | Sustainable Bio Materials | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CES334 | Materials for Energy Sustainability | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CES335 | Green Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CES336 | Environmental Quality Monitoring and Analysis | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | CES337 | Integrated Energy Planning for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | CES338 | Energy Efficiency for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |

**MA3351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C**
**3 1 0 4**

**COURSE OBJECTIVES**

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

**UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9 + 3**

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

**UNIT II FOURIER SERIES 9 + 3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

**UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9 + 3**

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

**UNIT IV FOURIER TRANSFORMS 9 + 3**

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

**UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9 + 3**

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES**

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

CO1:Understand how to solve the given standard partial differential equations.

CO2:Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.

CO3:Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.

CO4:Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.

CO5:Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

**TEXT BOOKS:**

1. Grewal B.S., “Higher Engineering Mathematics", 44thEdition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

**REFERENCES:**

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., “Advanced Engineering Mathematics “Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

**BM3353 FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

The objective of this unit is to make the student learn and understand

- Introduce the concept of diodes, Bipolar Junction Transistors and FET.
- Study the various model parameters of Transistors
- Learn the concept of special semiconductor devices, Power & Display devices
- Impart the knowledge of various configurations, characteristics, applications.
- To have knowledge of display and power devices.

**UNIT I SEMICONDUCTOR DIODE 9**

PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diodes.

**UNIT II BIPOLAR JUNCTION TRANSISTORS 9**

NPN -PNP -Operations-Early effect-Current equations – Input and Output characteristics of CE, CB, CC - Hybrid -π model - h-parameter model, Ebers Moll Model- Gummel Poon- model, Multi Emitter Transistor.

**UNIT III FIELD EFFECT TRANSISTORS 9**

MOSFETs – Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance- Threshold voltage -Channel length modulation, small signal Characteristics, D-MOSFET, E-MOSFET- Characteristics – Comparison of MOSFET with BJT.

**UNIT IV SPECIAL SEMICONDUCTOR DEVICES 9**

Metal-Semiconductor Junction - MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, Point Contact Diode, p-i-n Diode, Avalanche Photodiode, Schottky barrier diode- Zener diode- Varactor diode –Tunnel diode- Gallium Arsenide device, LASER diode, LDR.

**UNIT V POWER DEVICES AND DISPLAY DEVICES 9**

UJT, Thyristor - SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS. LED, LCD, Opto Coupler, Solar cell, CCD.

**COURSE OUTCOMES:**

At the end of the course, the student should be able to:

**CO1:** Analyze the characteristics of semiconductor diodes.
**CO2:** Analyze and solve problems of Transistor circuits using model parameters.
**CO3:** Identify and characterize diodes and various types of transistors.
**CO4:** Analyze the characteristics of special semiconductor devices.
**CO5:** Analyze the characteristics of Power and Display devices.

**TOTAL:45 PERIODS**

**TEXT BOOK**


1. Millman and Halkias, “Electronic Devices and Circuits”, 4th Edition, McGraw Hill, 2015.
2. Mohammad Rashid, “Electronic Devices and Circuits”, Cengage Learning Pvt. Ltd, 2015.
3. Salivahanan. S, Suresh Kumar. N, “Electronic Devices and circuits”, 4th Edition, McGraw Hill, 2016.


**REFERENCES**


1. Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” Pearson Prentice Hall, 11th Edition, 2014.
2. Bhattacharya and Sharma, “Solid State Electronic Devices”, 2nd Edition, Oxford University Press, 2014.
3. R.S.Sedha, “A Textbook of Electronic Devices and Circuits”, 2nd Edition, S.Chand Publications, 2008.
4. David A. Bell, “Electronic Devices and Circuits”, 5th Edition, Oxford University Press, 2008.


**BM3301 SENSORS AND MEASUREMENTS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle of transduction, classifications and the characteristics of different transducers
- To learn the different bridges for measurement.
- To know the different display and recording devices.
- To understand various type of biosensors.

**UNIT I FUNDAMENTALS OF MEASUREMENTS 9**

Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis- methods of error analysis,- uncertainty analysis-expression of uncertainty: accuracy and precision index, propagation of errors– Calibration - Primary and secondary standards.

**UNIT II DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS 9**

Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gage. Capacitive transducer - various arrangements, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Active type: Thermocouple - characteristics.

**UNIT III PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS 9**

Phototube, scintillation counter, photo multiplier tube (PMT), photovoltaic, photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers. Optical displacement sensors and optical encoders. Piezoelectric active transducer- Equivalent circuit and its characteristics.

**UNIT IV SIGNAL CONDITIONING CIRCUITS AND METERS 9**

Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, Impedance matching circuits, AC and DC Bridges - wheat stone bridge, Kelvin, Maxwell, Hay, Schering, Q-meter, PMMC, MI and dynamometer type instruments - DC potentiometer- Digital voltmeter – Multi meter.

**UNIT V RECORDING DEVICES AND ADVANCED SENSORS 9**

CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder. Biosensors: transduction mechanism in a biosensor and Classification - Electronic nose.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Measure various electrical parameters with accuracy, precision, resolution.

**CO2:** Select appropriate passive or active transducers for measurement of physical phenomenon.

**CO3:** Select appropriate light sensors for measurement of physical phenomenon

**CO4:** Use AC and DC bridges for relevant parameter measurement.

**CO5:** Employ multimeter, CRO and different types of recorders for appropriate measurement.

**TOTAL:45 PERIODS**

**TEXT BOOKS**

1. A.K.Sawhney, “Electrical & Electronics Measurement and Instrumentation”,10th edition, Dhanpat Rai & Co, New Delhi, 19th Revised edition 2011, Reprint 2014.
2. John G. Webster, “Medical Instrumentation Application and Design”, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015
3. Ernest O Doebelin and Dhanesh N Manik, “Measurement systems, Application and design”, 6th edition, McGraw-Hill, 2012

**REFERENCES**

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, 3rd edition,Tata McGraw-Hill, New Delhi, 2014.
2. Leslie Cromwell, “Biomedical Instrumentation and measurement”, 2nd edition, Prentice hall of India, New Delhi, 2015.
3. Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques”, Prentice Hall of India, 1st edition, 2016.

**BM3352 ELECTRIC CIRCUIT ANALYSIS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the basic concepts of DC and AC circuits behavior
- To study the transient and steady state response of the circuits subjected to step and sinusoidal excitations.
- To introduce different methods of circuit analysis using Network theorems, duality and topology

**UNIT I BASIC CIRCUITS ANALYSIS 9**

Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Laws, Mesh current and node voltage method of analysis for D.C and A.C. circuits. The single Node – Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis.

**UNIT II NETWORK THEOREM AND DUALITY 9**

Useful Circuit Analysis techniques - Linearity and superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, application of Network theorems. Network reduction: voltage and current division, source transformation, Delta-Wye Conversion. Duals, Dual circuits.

**UNIT III SINUSOIDAL STEADY STATE ANALYSIS 9**

Sinusoidal Steady – State analysis , Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power Factor, Complex Power.

**UNIT IV TRANSIENTS AND RESONANCE IN RLC CIRCUITS 9**

Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, The Unit-Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.

**UNIT V COUPLED CIRCUITS AND TOPOLOGY 9**

Magnetically Coupled Circuits, mutual Inductance, the Linear Transformer, the Ideal Transformer, An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

CO1: Comprehend and design ac/dc circuits.
CO2 : Apply circuit theorems in real time.
CO3 : Evaluate ac/dc circuits.
CO4 : Analyse the electrical circuits
CO5 : Develop and understand ac/dc circuits.

**TOTAL:45 PERIODS**

**TEXT BOOKS**

1. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", Mc Graw Hill education, 9th Edition, 2018.
2. Joseph Edminister and Mahmood Nahvi, "Electric Circuits", Schaum's Outline Series, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016.

**REFERENCES**


1. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014.
2. John O Mallay, Schaum's Outlines "Basic Circuit Analysis", The Mc Graw Hill companies, 2nd Edition, 2011.
3. Charles.K.Alexander, Mathew N.O.Sadiku,"Fundamentals of Electric Circuits", McGraw Hill, 5th Edition, 2012.
4. Allan H.Robbins, Wilhelm C.Miller, "Circuit Analysis Theory and Practice", Cengage Learning, Fifth Edition, 1st Indian Reprint 2013.


**BM3351 ANATOMY AND HUMAN PHYSIOLOGY L T P C**
**3 0 2 4**

**COURSE OBJECTIVE**

- To integrate the individual functions of all the cells and tissues and organs into functional whole, the human body.
- Function is dependent on a structure, the curriculum lays stress on functional anatomy of the organs.
- Emphasizes on the cardiovascular, respiratory, urinary and nervous system and their interrelatedness.
- Stimulate the students to understand the basic functioning of every system and the resultant unified organization.

**UNIT I BASIC ELEMENTS OF HUMAN BODY 9**

Cell – Cell Structure and organelles - Functions of each component in the cell. Cell membrane – transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions.

**UNIT II SKELETAL AND MUSCULAR SYSTEM 9**

Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton -Types of joints and function – Types of cartilage and function. –Types of muscles – Structure and Properties of Skeletal Muscle- Changes during muscle contraction- Neuromuscular junction.

**UNIT III CARDIOVASCULAR AND RESPIRATORY SYSTEM 9**

Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood: Composition – Functions - Haemostasis – Blood groups and typing. Blood Vessels – Structure and types - Blood pressure - Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.

**UNIT IV DIGESTIVE AND EXCRETORY SYSTEMS 9**

Structure and functions of gastrointestinal system - secretory functions of the alimentary tract - digestion and absorption in the gastrointestinal tract - structure of nephron - mechanism of urine formation - skin and sweat gland - temperature regulation.

**UNIT V NERVOUS AND SENSORY SYSTEM 9**

Structure and function of nervous tissue – Brain and spinal cord – Functions of CNS – Nerve conduction and synapse – Reflex action – Somatic and Autonomic Nervous system. Physiology of Vision, Hearing, Integumentary, Olfactory systems. Taste buds.

**TOTAL : 45 PERIODS**

**LIST OF EXPERIMENTS**

1. Collection of Blood Samples
2. Identification of Blood groups (Forward and Reverse)
3. Bleeding and Clotting time
4. Estimation of Hemoglobin
5. Total RBC and WBC Count
6. Differential count of Blood cells
7. Estimation of ESR, PCV, MCH, MCV, MCHC
8. Hearing test – Tuning fork
9. Visual Activity – Snellen's Chart and Jaeger's Chart

**TOTAL: 30 PERIODS**

**LAB REQUIREMENT FOR A BATCH OF 30 STUDENTS:**

**Requirement for a batch of 30 students**

| | |
|---|---|
| Microscope | 2 Nos |
| Centrifuge Normal | 1 No |
| Wintrobe's tube | 2 Nos. |
| PCV tube | 2 Nos |
| Neubaur's Chamber | 2 Nos. |
| Heparinized Syringe | 1box |
| Haemoglobinometer | 1 No |
| Blood grouping kit | 1 No |
| Capillary tubes | 1 box |
| Ophthalmoscope | 1 No |
| Tuning fork | (256Hz to 512Hz) 5 Nos. |
| Microslides | 2 packets |
| Lancet | 5 boxes |

**TOTAL:75 PERIODS**

**COURSE OUTCOMES:**

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

| | |
|---|---|
| **CO1** | Identify and explain basic elements of human body |
| **CO2** | Explain the functions of skeletal and muscular system |
| **CO3** | Describe the structure, function of cardiovascular system and respiratory system |
| **CO4** | Discuss the structure of digestive and excretory system. |
| **CO5** | Describe the physiological process of Nervous and sensory system |

**TEXT BOOKS:**

1. Elaine.N. Marieb, "Essential of Human Anatomy and Physiology", Ninth Edition, Pearson Education, New Delhi, 2018.
2. Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine", Third edition Springer, 2006. (Unit 2,3,4)

**REFERENCES:**

1. Guyton & Hall, "Text book of Medical Physiology", 13th Edition, Saunders, 2015.
2. Ranganathan T S, "Text book of Human Anatomy", S.Chand& Co. Ltd., New Delhi, 2012.
3. SaradaSubramanyam, K MadhavanKutty, Singh H D, "Textbook of Human Physiology", S. Chand and Company Ltd, New Delhi, 2012.

**CS3391 OBJECT ORIENTED PROGRAMMING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand Object Oriented Programming concepts and basics of Java programming language
- To know the principles of packages, inheritance and interfaces
- To develop a java application with threads and generics classes
  To define exceptions and use I/O streams
- To design and build Graphical User Interface Application using JAVAFX

**UNIT I INTRODUCTION TO OOP AND JAVA 9**

Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors-Methods -Access specifiers - Static members- JavaDoc comments

**UNIT II INHERITANCE, PACKAGES AND INTERFACES 9**

Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.

**UNIT III EXCEPTION HANDLING AND MULTITHREADING 9**

Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java's Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication-Suspending –Resuming, and Stopping Threads –Multithreading. Wrappers – Auto boxing.

**UNIT IV I/O, GENERICS, STRING HANDLING 9**

I/O Basics – Reading and Writing Console I/O – Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class.

**UNIT V JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS 9**

JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, ToggleButton – RadioButtons – ListView – ComboBox – ChoiceBox – Text Controls – ScrollPane. Layouts – FlowPane – HBox and VBox – BorderPane – StackPane – GridPane. Menus – Basics – Menu – Menu bars – MenuItem.

**COURSE OUTCOMES:**

On completion of this course, the students will be able to

**CO1:**Apply the concepts of classes and objects to solve simple problems

**CO2:**Develop programs using inheritance, packages and interfaces

**CO3:**Make use of exception handling mechanisms and multithreaded model to solve real world problems

**CO4:**Build Java applications with I/O packages, string classes, Collections and generics concepts

**CO5:**Integrate the concepts of event handling and JavaFX components and controls for developing GUI based applications

**TOTAL:45 PERIODS**

**TEXT BOOKS**

1. Herbert Schildt, "Java: The Complete Reference", 11 th Edition, McGraw Hill Education, New Delhi, 2019
2. Herbert Schildt, "Introducing JavaFX 8 Programming", 1 st Edition, McGraw Hill Education, New Delhi, 2015

**REFERENCES:**

1. Cay S. Horstmann, "Core Java Fundamentals", Volume 1, 11 th Edition, Prentice Hall, 2018.

**BM3361 FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS LABORATORY**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**COURSE OBJECTIVE:**

- To supplement the theory courses Semiconductor Devices and Basic Electrical Engineering.
- To assist the students in obtaining a better understanding of the operation of electronic circuits and devices
- To provide experience in analyzing network theorems.

**LIST OF EXPERIMENTS**

1. Characteristics of PN and zener diode.
2. Characteristics of CE, CB configurations.
3. Half wave and Full wave rectifier with capacitor filter.
4. Voltage regulation using zener diode.
5. Study of characteristics of photo diodes
6. Study of characteristics of SCR
7. Verification of KVL and KCL
8. Verification of Thevenin's and Norton's Theorems.
9. Verification of superposition Theorem.
10. Verification of Maximum power transfer and reciprocity theorems.
11. Frequency response of RLC series and parallel resonance circuits.

**LIST OF EQUIPMENTS:(30 STUDENTS PER BATCH)**

1. DSO (50MHz)
2. DC Digital Ammeter
3. DC Digital Voltmeter
4. Function Generator (3MHz)
5. Analog IC Tester
6. Digital IC Tester
7. Digital IC Trainer Kit
8. Dual Regulated Power supply (0-30) V/2A
9. Multiple Regulated Power suppy (+5) V/2A, (015)V/2A
10. Single Regulated Power supply (0-30) V/2A
11. Decade Inductance Box (6Dial)
12. Variable Resistance Box (6Dial)
13. Decade Capacitance Box (6Dial)
14. Analog Ammeter (0-1) mA
15. Analog Voltmeter
16. Digital Multimeter

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Experiment and determine the VI characteristics of given PN junction diode, Zener diode, Photo diode and Silicon Controlled Rectifier.
2. Experiment and determine the Input & output characteristics of BJT
3. Experiment and test half wave and full wave rectifier circuit using PN Junction diode and obtain the ripple factor, rectifier efficiency and experiment and test voltage regulation characteristics using Zener diode voltage regulator circuit.
4. Experiment and test the given electric circuit using Kirchhoff's laws and obtain the mesh current & node voltage and obtain the load current for the given circuit using Superposition, Thevenin's, and Norton's and Reciprocity theorems.
5. Construct and test RLC series and parallel circuits to compute the resonant frequency and bandwidth by plotting the frequency response.

**BM3311 SENSORS AND MEASUREMENTS LABORATORY L T P C**

**0 0 3 1.5**

**COURSE OBJECTIVES:**

- To introduce the relevance of this course to the existing technology through demonstrations, simulations with a futuristic vision along with socio-economic impact and issues.
- To study the characteristics of sensors, signal conditioning circuits and display devices.

**LIST OF EXPERIMENTS:**

1. Calibration of voltmeter and ammeter using shunt type Potentiometer
2. Characteristics of thermistor
3. Characteristics of thermocouple
4. Characteristics of LDR
5. Characteristics of Photo Diode
6. Characteristics of Photo transistor
7. Characteristics of RTD
8. Characteristics of LVDT
9. Measurement of unknown Resistance using Kelvin Double Bridge and Wheatstone bridge
10. Measurement of unknown Capacitance using Schering Bridge
11. Measurement of unknown Inductance using Maxwell's & Hay's Bridge
12. Characteristics of Hall effect transducer
13. Characteristics of strain gauge
14. Study of Electronic nose
15. Demonstration of CRO & DSO
16. Characteristics of Piezoelectric Transducer

**LAB REQUIREMENTS FOR 30 STUDENTS**:

1. Thermocouple-- 15 Nos

2. RTD-- 15 Nos

3. Strain Gauge (bonded and unbounded type)-15each

4. Photo transister, photo diode—15 Nos each

5. Resistors-Range between 1-0.0001 ohm – 30 Nos/each
6. CRO-10
7. DSO-5
8. LVDT – 5
9. Hall effect transducer - 15 Nos
10. Piezoelectric Transducer- 15 Nos

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

CO1: design and understand characteristics and calibration of various transducers.
CO2: design and develop bridge circuits to find unknown variables.
CO3: select proper transducer for various applications.
CO4: understand various read out and display devices.
CO5: design a measurement system for various applications.

| CS3381 | OBJECT ORIENTED PROGRAMMING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |

**COURSE OBJECTIVES**

- To build software development skills using java programming for real-world applications.
- To understand and apply the concepts of classes, packages, interfaces, inheritance, exception handling and file processing.
- To develop applications using generic programming and event handling

**LIST OF EXPERIMENTS**

1. Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion)
2. Develop stack and queue data structures using classes and objects.
3. Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.
4. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea( ) that prints the area of the given shape.
5. Solve the above problem using an interface.
6. Implement exception handling and creation of user defined exceptions.
7. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number.
8. Write a program to perform file operations.
9. Develop applications to demonstrate the features of generics classes.

10. Develop applications using JavaFX controls, layouts and menus.
11. Develop a mini project for any application using Java concepts.

**Lab Requirements: for a batch of 30 students**

Operating Systems: Linux / Windows

Front End Tools: Eclipse IDE / Netbeans IDE

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of this course, the students will be able to

CO1 : Design and develop java programs using object oriented programming concepts

CO2 : Develop simple applications using package, exceptions, multithreading, and generics concepts

CO3 : Create GUIs and event driven programming applications for real world problems

| MA3355 | RANDOM PROCESSES AND LINEAR ALGEBRA | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES :**

- To introduce the basic notions of vector spaces which will then be used to solve related problems.
- To understand the concepts of vector space, linear transformations , inner product spaces and orthogonalization..
- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To provide necessary basics in probability that are relevant in applications such as random signals, linear systems in communication engineering.
- To understand the basic concepts of probability, one and two dimensional random
- variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon.

**UNIT - I : PROBABILITY AND RANDOM VARIABLES 9 + 3**

Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions - Functions of a random variable.

**UNIT - II : TWO - DIMENSIONAL RANDOM VARIABLES 9 + 3**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

**UNIT – III : RANDOM PROCESSES 9 + 3**

Classification – Stationary process – Markov process - Poisson process - Discrete parameter Markov chain – Chapman Kolmogorov equations (Statement only) - Limiting distributions .

**UNIT - IV : VECTOR SPACES 9 + 3**

Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear independence and linear dependence – Bases and dimensions.

**UNIT - V : LINEAR TRANSFORMATION AND INNER PRODUCT SPACES 9 + 3**

Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformations - Inner product - Norms - Gram Schmidt orthogonalization process - Adjoint of linear operations - Least square approximation.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES :**

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

CO1:Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.

CO2:Demonstrate accurate and efficient use of advanced algebraic techniques.

CO3:Apply the concept of random processes in engineering disciplines.

CO4:Understand the fundamental concepts of probability with a thorough knowledge of standard distributions that can describe certain real-life phenomenon.

CO5:Understand the basic concepts of one and two dimensional random variables and apply them to model engineering problems.

**TEXT BOOKS :**


1. Gross, D., Shortle, J.F, Thompson, J.M and Harris. C.M., “Fundamentals of Queueing Theory", Wiley Student 4th Edition, 2014.
2. Ibe, O.C., “Fundamentals of Applied Probability and Random Processes", Elsevier,1st Indian Reprint, 2007.
3. Friedberg. A.H., Insel. A.J. and Spence. L., “Linear Algebra”, Prentice Hall of India, New Delhi, 4th Edition, 2004.


**REFERENCE BOOKS :**


1. Hsu, "Schaum’s Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
2. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
3. Yates, R.D. and Goodman. D. J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.
4. Kolman. B. Hill. D.R., “Introductory Linear Algebra”, Pearson Education, New Delhi, First Reprint, 2009.
5. Kumaresan. S., “Linear Algebra – A Geometric Approach”, Prentice – Hall of India, New Delhi, Reprint, 2010.
6. Strang. G., “Linear Algebra and its applications”, Thomson (Brooks/Cole), New Delhi, 2005.


**BM3491 BIOMEDICAL INSTRUMENTATION L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the origin of various biological signals and electrode configurations specific to bio-potential measurements.
- To understand the characteristics of Bio signals.
- To understand the design of bioamplifiers
- To explain the different techniques used for measurement of non-electrical bio-parameters

- To explain the biochemical measurement techniques as applicable for diagnosis and treatment.

**UNIT I ELECTRODE CONFIGURATIONS 9**

Bio signals characteristics – Origin of bio potential and its propagation. Frequency and amplitude ranges. Electrode configurations: Electrode-electrolyte interface, electrode–skin interface impedance, polarization effects of electrode – non-polarizable electrodes. Unipolar and bipolar configuration, classification of electrodes.

**UNIT II BIOSIGNAL CHARACTERISTICS 9**

Bio signals characteristics – ECG-frequency and amplitude ranges – Einthoven's triangle, standard 12 lead system. EEG - EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. EMG - Electrode configuration -unipolar and bipolar mode.

**UNIT III BIOAMPLIFIERS 9**

Need for bio-amplifier - Differential bio-amplifier – Single ended amplifier - Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference

**UNIT IV MEASUREMENT OF BIO SIGNALS 9**

Temperature, respiration rate and pulse rate measurements. Blood Pressure - indirect methods: auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurements

**UNIT V BIOCHEMICAL MEASUREMENTS 9**

Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors. Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

CO1 : Illustrate the origin of various biological signals and their characteristics.

CO2: Gain knowledge on characteristics of bio signals.

CO3: Gain knowledge on various amplifiers involved in monitoring and transmission of biosignals.

CO4: Explain the different measurement techniques for non-electrical bio-parameters

CO5: Explain the biochemical measurement techniques as applicable for diagnosis and further treatment.

**TOTAL:45 PERIODS**

**TEXT BOOKS:**

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.

**REFERENCE BOOKS**

1. John Enderle, Susan Blanchard, Joseph Bronzino, “Introduction to Biomedical Engineering”, second edition, Academic Press,2005.
2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson Education, 2004.

**BM3402 ANALOG AND DIGITAL INTEGRATED CIRCUITS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To study the circuit configuration and introduce practical applications of linear integrated circuits.
- To introduce the concept of application of ADC and DAC in real time systems and Phase Locked Loop with applications.
- To introduce the design of various combinational digital circuits using logic gates
- To bring out the analysis and design procedures for synchronous and asynchronous sequential circuits

**UNIT I INTRODUCTION TO OPERATIONAL AMPLIFIER AND ITS APPLICATIONS 9**

Operational amplifier –ideal characteristics, Performance Parameters, Linear and Nonlinear Circuits and their analysis- voltage follower, Inverting amplifier, Non-inverting Amplifiers, Differentiator, Integrator, Voltage to Current converter, Instrumentation amplifier, Low pass, High pass filter and band pass filters, Comparator, Multivibrator and Schmitt trigger, Triangular wave generator.

**UNIT II DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS AND PLL 9**

Analog switches, High speed sample and hold circuit and IC‘s, Types of D/A converter -Weighted resistor, R-2R ladder DAC, D/A Accuracy and Resolution. A/D converter - Flash, Dual slope, Successive approximation, A/D Accuracy and Resolution. Voltage controlled oscillator, Voltage to Frequency converters. PLL-Closed loop analysis of PLL, Frequency multiplication/ division, FSK demodulator**.**

**UNIT III THE BASIC GATES ANDCOMBINATIONAL LOGIC CIRCUITS 9**

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, 84-2-1, 2421, Excess 3, Biquinary, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map and Tabulation methods. Logic families- TTL, MOS, CMOS, BiCMOS - Comparison of Logic families.

**UNIT IV COMBINATIONAL LOGIC CIRCUITS 9**

Problem formulation and design of combinational circuits - Code-Converters, Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Mux/Demux.

**UNIT V SEQUENTIAL LOGIC CIRCUITS 9**

Flip flops – SR, JK, T, D, Master/Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – state minimization, state assignment, circuit implementation. Counters, Ripple Counters, Ring Counters. Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In -Serial Out, Parallel In - Parallel Out, Universal Shift Register.

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

CO1: design new analog linear circuits and develop linear IC based Systems.

CO2: Apply the concept of ADC and DAC in real time systems and Phase Locked Loop with applications.

CO3: Use Boolean algebra and apply it to digital systems.

CO4: Design various combinational digital circuits using logic gates.

CO5: Bring out the analysis and design procedures for synchronous and asynchronous sequential circuits.

**TOTAL:45 PERIODS**

**TEXT BOOKS**

1. Sergio Franco, "Design with operational amplifiers and analog integrated circuits", Mc Graw Hill Education, 3rd Edition, 2017
2. John.F.Wakerly, "Digital design principles and practices", Pearson Education, 5th Edition, 2018

**REFERENCES**

1. Taub and Schilling, "Digital Integrated Electronics", Mc Graw Hill, 2017.
2. Charles H.Roth, Jr, "Fundamentals of Logic Design", Jaico Books, 7th Edition, 2013.
3. M. Morris Mano and Michael D.Ciletti, "Digital Design", Pearson, 5th Edition, 2013.
4. S Salivahanan and V S Kanchana Bhaaskaran, Linear Integrated Circuits, McGraw Hill Education, 3rd Edition, 2018

**BM3451 BIO CONTROL SYSTEMS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

The objective of this course is to enable the student to

- Understand the concept behind feedback and continuum in various systems and subsystems and the need for mathematical modeling of various systems.
- Analyze the systems in time and frequency domains
- Understand the concept of stability of various systems.
- Apply mathematical modeling principles in understanding the various fundamental biological systems.

**UNIT I INTRODUCTION 9**

Open and Closed loop Systems, Mathematical Modeling of systems, Block diagram and signal flow graph representation of systems - reduction of block diagram and signal flow graph, Introduction to Physiological control systems- Illustration, Linear models of physiological systems, Difference between engineering and physiological control systems.

**UNIT II TIME RESPONSE ANALYSIS 9**

Step and impulse responses of first order and second order systems - time domain specifications of first and second order systems - steady state error constants.

**UNIT III STABILITY ANALYSIS 9**

Definition of stability, Routh- Hurwitz criteria of stability, Root locus technique - construction of root locus and study of stability.

**UNIT IV FREQUENCY RESPONSE ANALYSIS 9**

Frequency domain specifications - Polar plots - Bode plots - Nyquist plot - Nyquist stability criterion, closed loop stability - Constant M and N circles - Nichol's chart.

**UNIT V BIOLOGICAL CONTROL SYSTEM ANALYSIS 8**

Simple models of muscle stretch reflex action - steady state analysis of muscle stretch reflex action, transient response analysis of neuromuscular reflex model action, frequency response of circulatory control model, Stability analysis of Pupillary light reflex.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

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

CO1: Interpret the need for mathematical modeling of various systems, representation of systems in block diagrams and signal flow graphs and are introduced to biological control systems

CO2: Determine the time response of various systems

CO3: discuss the concept of system stability

CO4: Examine the frequency response characteristics of various systems using different charts

CO5: Appraise the concept of modeling basic physiological systems

**TEXT BOOKS**

1. I.J. Nagarath and M. Gopal, Control Systems Engineering, New Age International Publishers, 1st September, 2018.
2. Michael C K Khoo, Physiological Control Systems, IEEE Press, Prentice Hall India, 2005.

**REFERENCES:**

1. Salivahanan S. Rengaraj R. and Venkatakrishnan G. R., Control Systems Engineering, Pearson Education India, 2015.
2. Benjamin C. Kuo, Automatic Control Systems, Prentice Hall of India, 1995.
3. Ogata, Katsuhiko and Yanjuan Yang, Modern control engineering, Vol 4, Prentice-Hall, 2002.

**ONLINE RESOURCES**

1. https://nptel.ac.in/courses/108/101/108101037/
2. https://nptel.ac.in/content/storage2/courses/112104158/lecture14.pdf
3. https://nptel.ac.in/content/storage2/courses/112104158/lecture16.pdf
4. https://nptel.ac.in/content/storage2/courses/112104158/lecture17.pdf

**BM3401 SIGNAL PROCESSING L T P C**

**3 0 2 4**

**COURSE OBJECTIVES:**

- To understand about the continuous time and discrete time signals and systems.
- To learn the analysis of LTI systems using Laplace and Z transform.
- To represent the signal in frequency domain using FFT.
- To gain knowledge about the design of IIR and FIR filters.

**UNIT I FUNDAMENTALS OF SIGNALS AND SYSTEMS 9**

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.

**UNIT II ANALYSIS OF LTI SYSTEMS 9**

Fourier Series - Fourier Transform and Properties, Analysis of Continuous Time LTI Systems - Z Transform - Properties of ROC– Inverse Z Transform – DTFT - Analysis of Discrete Time LTI Systems

**UNIT III DISCRETE FOURIER TRANSFORM 9**

DFT and its properties, magnitude and phase representation-Linear Convolution- Correlation-Circular Convolution, Overlap-add and overlap-save methods. FFT - Decimation in Time Algorithm, Decimation in Frequency Algorithm. Use of FFT in Linear Filtering.

**UNIT IV INFINITE IMPULSE RESPONSE FILTERS 9**

Analog filters – Butterworth filters, Chebyshev Type I filters (upto 3rd order), Analog Transformation of prototype LPF to BPF /BSF/ HPF. Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method - Realization structures for IIR filters – direct, cascade and parallel forms.

**UNIT V FINITE IMPULSE RESPONSE FILTERS AND MULTIRATE SIGNAL PROCESSING 9**

Design of linear phase FIR filters - windowing and Frequency sampling methods. Realization structures for FIR filters – Transversal and Linear phase structures, Comparison of FIR and IIR. Introduction to DSP processors. Introduction to Multirate signal Processing – Decimation and Interpolation.

**COURSE OUTCOMES:**

CO1: To classify the continuous time and discrete time signals and systems.
CO2: To analyze the signals in both continuous time and discrete time
CO3: To apply DFT for the analysis of digital signals & systems
CO4: To design IIR filter to process real world signals.
CO5: To design FIR filter to process real world signals.

**TOTAL::45 PERIODS**

**PRACTICALS:**

1. Construction of signals with different Frequencies.
2. Analyse the stability of a CT System with various inputs.
3. Analyse the stability of a DT System with various inputs.
4. Reconstruct a signal from samples and study the effect of Aliasing.
5. Spectrum Analysis using FFT
6. Filter Design & Analysis.
7. Finite word length effect.
8. Multirate Signal Processing.
9. DSP Processor Implementation. (Linear and Convolution, FFT implementation, IIR and FIR filters implementation)

**Equipment required for 30 students**

1. Computers with MATLAB / Equivalent software- 15 Numbers
2. TMS320C5416 Processors – 5 Numbers

**PERIODS:30**
**TOTAL:75 PERIODS**

**TEXT BOOKS**


1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, “Signals and Systems”, Pearson, Indian Reprint, 2nd Edition, 2015.
2. John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Pearson, 4 th Edition, 2014.


**REFERENCES**


1. S. Haykin and B. Van Veen, "Signals and Systems", Wiley, 2 nd Edition, 2007
2. B. P. Lathi, “Principles of Linear Systems and Signals”, Oxford, 2nd Edition, 2009.
3. Emmanuel Ifeachor, Barrie Jervis, “Digital Signal Processing- A practical approach”, Pearson, 2 nd Edition, 2002.
4. M. H. Hayes, “Digital Signal Processing, Schaum’s outlines”, Tata McGraw Hill, 2nd Edition, 2011.


**GE3451 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY L T P C**
**2 0 0 2**

**UNIT I ENVIRONMENT AND BIODIVERSITY 6**

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

**UNIT II ENVIRONMENTAL POLLUTION 9**

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

**UNIT III RENEWABLE SOURCES OF ENERGY 6**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

**UNIT IV SUSTAINABILITY AND MANAGEMENT 6**

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

**UNIT V SUSTAINABILITY PRACTICES 6**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

**TOTAL: 30 PERIODS**

**TEXT BOOKS:**


1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.


**REFERENCES :**


1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.




**BM3411 BIOMEDICAL INSTRUMENTATION LABORATORY L T P C**

**0 0 3 1.5**

**COURSE OBJECTIVES:**

**The student should be made to**

- To study and design Bio amplifiers.
- To provide hands on training on Measurement of physiological parameters.

**LIST OF EXPERIMENTS:**

1. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable IC's

2. Design of ECG Amplifiers with appropriate filter to remove power line and other artifacts.

3. Design of EMG amplifier
4. Design a suitable circuit to detect QRS complex and measure heart rate
5. Design of frontal EEG amplifier
6. Design of EOG amplifier to detect eye blink
7. Design a right leg driven ECG amplifier.
8. Design and study the characteristics of optical Isolation amplifier
9. Design a Multiplexer and Demultiplexer for any two biosignals.
10. Measurement of pulse-rate using Photo transducer.
11. Measurement of pH and conductivity.
12. Measurement of blood pressure using sphygmomanometer.
13. Measurement and recording of peripheral blood flow
14. Design a PCB layout for any bio amplifier using suitable software tool.

**List of Equipment:(30 Students per Batch)**

1. pH meter and conductivity meter: 1 No.
2. Photo transducer for pulse measurement: 1 No.
3. Sphygmomanometer and Stethoscope: 1 No.
4. Blood flow measurement system: 1 No.
5. Multiparameter (ECG, EMG, EEG) Simulator: 2 No.
6. Function generator, DSO, Regulated Power supplies, Bread boards – 8 each
7. IC LM 324, AD 620, INA series (126,128 etc.), 555 Timer: 20 each
8. Opto Isolator IC: MCT2E – 1 No.
9. Software tool for PCB design: 1

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**On successful completion of this course, the student will be able to**

CO1: Design the amplifier for Bio signal measurements
CO2: Measure heart rate and heart sounds.
CO3: Record and analyze pulse rate and respiration rate
CO4: Measure blood pressure and blood flow
CO5: Design isolation amplifier

**BM3412 ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**COURSE OBJECTIVES:**

**The student should be made to**

- To design digital logic and circuits
- To learn the function of different ICs
- To understand the applications of operation amplifier.

- To learn the working of multivibrators
- To design circuits for generating waveforms using ICs.

**LIST OF EXPERIMENTS:**

1. Inverting, non-inverting amplifier and comparator
2. Integrator and Differentiator
3. Design and analysis of active filters using opamp
4. Schmitt trigger using operational amplifier
5. Instrumentation amplifier using operational amplifier
6. RC and LC oscillators
7. Multivibrators using IC555 Timer
8. Study of logic gates, Half adder and Full adder
9. Encoder and BCD to 7 segment decoder
10. Multiplexer and demultiplexer using digital ICs
11. Universal shift register using flip flops
12. Design of mod-N counter
13. Simulation and analysis of circuits using software

**LIST OF EQUIPMENT:(30 Students per Batch)**

1. CRO/DSO (30MHz) – 15 Nos.
2. Signal Generator /Function Generators (3 MHz) – 15 Nos
3. Dual Regulated Power Supplies ( 0 – 30V) – 15 Nos.
4. Standalone desktop PCs with SPICE software – 15 Nos.
5. Transistor/FET (BJT-NPN-PNP and NMOS/PMOS) – 50 Nos
6. Components and Accessories: Resistors, Capacitors, Inductors, diodes, Zener Diodes, Bread Boards, Transformers.
7. SPICE Circuit Simulation Software: (any public domain or commercial software)

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**On successful completion of this course, the student will be able to**

CO1: Design Combinational Circuits using logic gates
CO2: Design and implement arithmetic circuits for different applications using opamp
CO3: Design Sequential Circuits using logic gates
CO4: Design wave form generators and analyse their characteristics
CO5: Simulate and analyse circuits using ICs