*HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY*

**(An Autonomous Institution Affiliated to Anna University, Chennai)**

**(Approved by AICTE, New Delhi, Accredited by NAAC with 'A' Grade)**

**Coimbatore - 641 032.**

# B.E. BIOMEDICAL ENGINEERING

HINDUSTHAN EDUCATIONAL AND CHARITABLE TRUST

HICET

# Curriculum & Syllabus

# 2020-2021

## CHOICE BASED CREDIT SYSTEM

## VISION AND MISSION OF THE INSTITUTION

### VISION

To become a premier institution by producing professionals with strong technical knowledge, innovative research skills and high ethical values.

### MISSION

IM1: To provide academic excellence in technical education through novelteaching methods.

IM2: To empower students with creative skills and leadership qualities.

IM3: To produce dedicated professionals with social responsibility.

## VISION AND MISSION OF THE DEPARTMENT

### VISION

To evolve into a center of excellence in biomedical engineering by nurturing and training interested minds in this diverse technology, thereby striving towards ensuring quality healthcare to the society.

### MISSION

M1: To establish the best learning environment that helps the students to face the challenges of Biomedical Engineering field

M2: To inspire the students to drive the next generation innovation to come up with quality solutions to current healthcare needs.

Chairman BoS
BME - HiCET

HINDUSTHAN COLLEGE OF ENGG & TECH * ACADEMIC COUNCIL * Chairman

Dean (Academics)
HiCET

## PROGRAM OUTCOMES (POs)

**Engineering Graduates will be able to:**

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

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

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

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

PO 5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6. **The engineer and society**: Apply reasoning informed by the contextualknowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professionalengineering practice.

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

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

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

PO10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports anddesign documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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## PROGRAM SPECIFIC OUTCOMES (PSOs)

**Biomedical Engineering Graduates will have ability to:**

PSO1: Design and develop biomedical devices to meet the needs of people by applying the Fundamentals of Biomedical Engineering.

PSO2. Understand and implement various software skills for accurate diagnostic and Therapeutic applications.

PSO3. Innovate new ideas and solutions for the healthcare field by integrating various Biomedical Technology.

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1. To create a strong foundation in engineering and biology for solving the existing Challenges in the healthcare sector.

PEO2. To acquire knowledge in the cutting edge technologies of Biomedical Engineering field and an ability to identify, analyze and solve problems in the field.

PEO3. To instill ethical values, communicative skills, teamwork and leadership skills necessary to function productively and professionally.

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# CURRICULUM

## DETAILS OF CHANGES CARRIED OUT IN CURRICULUM & SYLLABUS

## CBCS PATTERN

## UNDERGRADUATE PROGRAMMES

## B.E. BIOMEDICAL ENGINEERING (UG)

## REGULATION-2016 & 2019

### REGULATION-2019

**For the students admitted during the academic year 2020-2021 and onwards**

### SEMESTER I

| S.No. | Course Code | Course Title | Category | L | T | P | C | CIA | ESE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | | |
| 1 | 19HE1101 | Technical English | HS | 2 | 1 | 0 | 3 | 25 | 75 | 100 |
| 2 | 19MA1103 | Calculus and Differential Equations | BS | 3 | 1 | 0 | 4 | 25 | 75 | 100 |
| **THEORY WITH LAB COMPONENT** | | | | | | | | | | |
| 3 | 19PH1151 | Applied Physics | BS | 2 | 0 | 2 | 3 | 50 | 50 | 100 |
| 4 | 19CY1151 | Chemistry for Engineers | BS | 2 | 0 | 2 | 3 | 50 | 50 | 100 |
| 5 | 19CS1151 | Python Programming and Practices | ES | 2 | 0 | 2 | 3 | 50 | 50 | 100 |
| 6 | 19EE1155 | Basics of Electrical Engineering | ES | 2 | 0 | 2 | 3 | 50 | 50 | 100 |
| **PRACTICAL** | | | | | | | | | | |
| 7 | 19HE1071 | Language Competency Enhancement Course - I | HS | 0 | 0 | 2 | 1 | 100 | 0 | 100 |
| **MANDATORY COURSES** | | | | | | | | | | |
| 8 | 19HE1072 | Career Guidance Level I | EEC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |
| 9 | 19HE1073 | Entrepreneurship and Innovation | EEC | 1 | 0 | 0 | 0 | 100 | 0 | 100 |
| | | | **Total :** | **16** | **2** | **10** | **20** | **550** | **350** | **900** |

**As Per AICTE Norms 3 Weeks Induction Programme is Added in The First Semester as an Audit Course**

## SEMESTER II

| S.No. | Course Code | Course Title | Category | L | T | P | C | CIA | ESE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | | |
| 1 | 19HE2101 | Business English for Engineers | HS | 2 | 1 | 0 | 3 | 25 | 75 | 100 |
| 2 | 19MA2102 | Complex Variables and Transform Calculus | BS | 3 | 1 | 0 | 4 | 25 | 75 | 100 |
| **THEORY WITH LAB COMPONENT** | | | | | | | | | | |
| 3 | 19PH2151 | Material Science | BS | 2 | 0 | 2 | 3 | 50 | 50 | 100 |
| 4 | 19CY2151 | Environmental Studies | BS | 2 | 0 | 2 | 3 | 50 | 50 | 100 |
| 5 | 19CS2152 | Essentials of C&C++Programming | ES | 2 | 0 | 2 | 3 | 50 | 50 | 100 |
| 6 | 19ME2154 | Engineering Graphics | ES | 1 | 0 | 4 | 3 | 50 | 50 | 100 |
| **PRACTICAL** | | | | | | | | | | |
| 7 | 19ME2001 | Engineering Practices | ES | 0 | 0 | 4 | 2 | 50 | 50 | 100 |
| 8 | 19HE2071 | Language Competency Enhancement Course - II | HS | 0 | 0 | 2 | 1 | 100 | 0 | 100 |
| **MANDATORY COURSES** | | | | | | | | | | |
| 9 | 19HE2072 | Career Guidance Level II | EEC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |
| | | | **Total:** | **14** | **2** | **16** | **22** | **500** | **400** | **900** |

**For the students admitted during the academic year 2019-2020 and onwards**

## SEMESTER III

| S.No | Course Code | Course Title | Category | L | T | P | C | CIA | ESE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | | |
| 1 | 19MA3102 | Fourier Analysis and Transforms | BS | 3 | 1 | 0 | 4 | 25 | 75 | 100 |
| 2 | 19BM3201 | Electron Devices and Circuits | PC | 3 | 1 | 0 | 4 | 25 | 75 | 100 |
| 3 | 19BM3202 | Medical Biochemistry | PC | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 4 | 19BM3203 | Human Anatomy and Physiology | PC | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| **THEORY WITH LAB COMPONENT** | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 19BM3251 | Digital Electronics | PC | 2 | 0 | 2 | 3 | 50 | 50 | 100 |
| **PRACTICAL** | | | | | | | | | | |
| 6 | 19BM3001 | Electron Devices andCircuits Laboratory | PC | 0 | 0 | 3 | 1.5 | 50 | 50 | 100 |
| 7 | 19BM3002 | Biochemistry Laboratory | PC | 0 | 0 | 3 | 1.5 | 50 | 50 | 100 |
| **MANDATORY COURSES** | | | | | | | | | | |
| 8 | 19MC3191 | Indian Constitution | MC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |
| | | | **Total** | **17** | **2** | **8** | **20** | **350** | **450** | **800** |

**SEMESTER IV**

| S.No | Course Code | Course Title | Category | L | T | P | C | CIA | ESE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | | |
| 1 | 19BM4201 | Linear IntegratedCircuits | PC | 3 | 1 | 0 | 4 | 25 | 75 | 100 |
| 2 | 19BM4202 | Bio MEMS and Nanotechnology | PC | 3 | 1 | 0 | 4 | 25 | 75 | 100 |
| 3 | 19BM4203 | Pathology andMicrobiology | PC | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| **THEORY WITH LAB COMPONENT** | | | | | | | | | | |
| 4 | 19MA4152 | Statistics and Numerical Methods | BS | 3 | 0 | 2 | 4 | 50 | 50 | 100 |
| 5 | 19BM4251 | Sensors and Measurement | PC | 2 | 0 | 2 | 3 | 50 | 50 | 100 |
| **PRACTICAL** | | | | | | | | | | |
| 6 | 19BM4001 | Integrated Circuits lab | PC | 0 | 0 | 3 | 1.5 | 50 | 50 | 100 |
| 7 | 19BM4002 | Human PhysiologyLaboratory | PC | 0 | 0 | 3 | 1.5 | 50 | 50 | 100 |
| **MANDATORY COURSES** | | | | | | | | | | |
| 8 | 19MC4191 | Essence of IndianTraditional Knowledge | MC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |
| | | | **Total** | **17** | **2** | **10** | **21** | **375** | **425** | **800** |

**REGULATION-2016**

**For the students admitted during the academic year 2018-2019 and onwards**

**SEMESTER V**

| S. No. | Course Code | Course Title | L | T | P | C | CIA | ESE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | |
| 1 | 16BM5201 | Biocontrol systems | 3 | 1 | 0 | 4 | 25 | 75 | 100 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 16BM5202 | BIOMEMS and Nanotechnology | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 3 | 16BM5203 | Hospital Engineering | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 4 | 16BM5204 | Biomedical Instrumentation | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 5 | 16BM5205 | Microprocessors and Microcontrollers | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 6 | 16BM53XX | Professional Elective-I | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| **PRACTICAL** | | | | | | | | | |
| 7 | 16BM5001 | Microprocessors and Microcontrollers Laboratory | 0 | 0 | 4 | 2 | 50 | 50 | 100 |
| 8 | 16BM5002 | Biomedical Instrumentation Laboratory | 0 | 0 | 4 | 2 | 50 | 50 | 100 |
| **Total Credits** | | | **18** | **1** | **8** | **23** | **250** | **550** | **800** |

**Note: Students are supposed to undergo hospital / industrial training compulsorily after VI$^{th}$ semester, for minimum of 15 days and the certificate from the respective hospital has to be produced on the first week of VII$^{th}$ semester.**

**SEMESTER VI**

| S. No. | Course Code | Course Title | L | T | P | C | CIA | ESE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | |
| 1 | 16BM6201 | Biosignal Processing | 3 | 1 | 0 | 4 | 25 | 75 | 100 |
| 2 | 16BM6202 | Diagnostic and Therapeutic Equipment - I | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 3 | 16BM6203 | Radiological Equipment | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 4 | 16BM6204 | Biomechanics | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 5 | 16BM623X | Professional Elective - II | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 6 | 16XX64XX | Open Elective - I | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| **PRACTICAL** | | | | | | | | | |
| 7 | 16BM6001 | Biosignal Processing Laboratory | 0 | 0 | 4 | 2 | 50 | 50 | 100 |
| 8 | 16BM6002 | Diagnostic and Therapeutic Equipment Laboratory | 0 | 0 | 4 | 2 | 50 | 50 | 100 |
| 9 | 16BM6801 | Mini Project | 0 | 0 | 4 | 2 | 50 | 50 | 100 |
| **Total Credits** | | | **18** | **1** | **12** | **25** | **300** | **600** | **900** |

**NOTE: Students are supposed to undergo hospital / industrial training compulsorily after VI$^{th}$ semester, for minimum of 15 days and the certificate from the respective hospital has to be produced on the first week of VII$^{th}$ semester.**

## PROFESSIONAL ELECTIVE-I

| S. No. | Course Code | Course Title | L | T | P | C | CIA | ESE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 16BM5301 | Analog and Digital Communication | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 2. | 16BM5302 | Biomaterials | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 3. | 16BM5303 | Total Quality Management | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 4. | 16BM5304 | Human Rights | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 5 | 16BM5305 | Intelligent Property Rights | 3 | 0 | 0 | 3 | 25 | 75 | 100 |

## PROFESSIONAL ELECTIVE-II

| S. No. | Course | Course Title | L | T | P | C | CIA | ESE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 16BM6301 | Nano Technology and Applications | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 2. | 16BM6302 | Embedded Systems in Medical Devices | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 3. | 16BM6303 | Biophotonics | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 4. | 16BM6304 | Bioinformatics | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| 5 | 16BM6305 | Biomedical Waste Management | 3 | 0 | 0 | 3 | 25 | 75 | 100 |

## LIST OF OPEN ELECTIVES

| S. No. | Course Code | Course Title | L | T | P | C | CIA | ESE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| SEMESTER VI | | | | | | | | | |
| 1 | 16BM6401 | Fundamentals of Biomedical Engineering | 3 | 0 | 0 | 3 | 25 | 75 | 100 |

## CREDIT DISTRIBUTION

**Regulation R2016**

| Semester | I | II | III | IV | V | VI | VII | VIII | Total |
|---|---|---|---|---|---|---|---|---|---|
| Credits | 27 | 25 | 24 | 23 | 23 | 25 | 22 | 18 | 187 |

**Regulation R2019**

| Semester | I | II | III | IV | V | VI | VII | VIII | Total |
|---|---|---|---|---|---|---|---|---|---|
| Credits | 20 | 22 | 20 | 21 | 24 | 24 | 20 | 14 | **165** |

**Chairman, Board of Studies** | **Dean – Academics** | **Principal**

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PRINCIPAL
Hindusthan College of Engineering & Technology
COIMBATORE - 641 032

ACADEMIC COUNCIL
Chairman

# SYLLABUS

## SEMESTER -I

| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19HE1101 | TECHNICAL ENGLISH | 2 | 1 | 0 | 3 |

**Course Objective**

1. Train to maintain coherence in formal communication.
2. Provide Practice to create and interpret descriptive communication.
3. Introduce the professional protocol.
4. Acquire different types of communication and professional etiquette.
5. Educate to improve interpersonal and intrapersonal skills.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **Listening and Speaking** – Opening a conversation, maintaining coherence, turn taking, closing a conversation (excuse, general wishes, positive comments and thanks) **Reading** –Reading articles from newspaper, Reading comprehension **Writing** Chart analysis, process description, Writing instructions **Grammar andVocabulary**- Tenses, Regular and irregular verb, technical vocabulary. | 9 |
| II | **Listening and Speaking-** listening to product description, equipment & work place (purpose, appearance, function) **Reading-** Reading technical articles **Writing-** Letter phrases, writing personal letters, **Grammar and Vocabulary**-articles, Cause & effect, Prepositions. | 9 |
| III | **Listening and Speaking-** - listening to announcements **Reading-** Reading about technical inventions, research and development **Writing-** Letter inviting a candidate for interview, Job application and resume preparation **Grammar and Vocabulary**- Homophones and Homonyms. | 9 |
| IV | **Listening and Speaking-** - Practice telephone skills and telephone etiquette (listening and responding, asking questions).**Reading-** Reading short texts and memos **Writing-** invitation letters, accepting an invitation and declining an invitation **Grammar and Vocabulary**- Modal verbs, Collocation, Conditionals,Subject verb agreement and Pronoun-Antecedent agreement. | 9 |
| V | **Listening and Speaking-** listening to technical group discussions and participating in GDs**Reading-** reading biographical writing **- Writing-** Proposalwriting, Writing definitions, **Grammar and Vocabulary**- Abbreviation and Acronym, Prefixes & suffixes, phrasal verbs. | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1- To gain knowledge about basic grammar and elements of professional communication.
CO2- To understand formal and technical communication.
CO3- Toapply the basic elements of grammar and communication in professional situation.
CO4- To analyse and interpret different styles of correspondence.
CO5- Tocompose official letters and technical proposals and make presentations.

**TEXT BOOKS:**

T1 - Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate",Cambridge University Press,2016.
T2 - Raymond Murphy, "Essential English Grammar", Cambridge University Press, 2019.

**REFERENCE BOOKS :**

R1- Meenakshi Raman and Sangeetha Sharma. "Technical Communication-Principles and Practice", Oxford University Press, 2009.
R2- Raymond Murphy, "English Grammar in Use"-4theditionCambridge University Press, 2004.
R3- KamaleshSadanan "A Foundation Course for the Speakers of Tamil-Part-I &II", Orient Blackswan,2010.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19MA1103 | CALCULUS AND DIFFERENTIAL EQUATIONS | 3 | 1 | 0 | 4 |

**Course Objective**

1. Understand the concept of differentiation.
2. Compute the functions of several variables which are needed in many branches ofengineering.
3. Understand the concept of double integrals.
4. Understand the concept of triple integrals.
5. Solve ordinary differential equations of certain types using Wronskian technique.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **DIFFERENTIAL CALCULUS**<br>Rolle's Theorem – Lagrange's Mean Value Theorem- Maxima and Minima – Taylor's and Maclaurin's Theorem. | 12 |
| II | **MULTIVARIATE CALCULUS (DIFFERENTIATION)**<br>Total derivatives - Jacobians – Maxima, Minima and Saddle points - Lagrange's method of undetermined multipliers – Gradient, divergence, curl and derivatives. | 12 |
| III | **DOUBLE INTEGRATION**<br>Double integrals in Cartesian coordinates– Area enclosed by the plane curves (excluding surface area)– Green's Theorem (Simple Application) - Stoke's Theorem – Simple Application involving cubes and rectangular parellopiped. | 12 |
| IV | **TRIPLE INTEGRATION**<br>Triple integrals in Cartesian co-ordinates – Volume of solids (Sphere, Ellipsoid, Tetrahedron) using Cartesian co-ordinates. Gauss Divergence Theorem – Simple Application involving cubes and rectangular parellopiped. | 12 |
| V | **ORDINARYDIFFERENTIALEQUATIONS**<br>Ordinary differential equations of second order - Second Order linear differential equations with constant coefficients – Cauchy – Euler's Equation - Cauchy – Legendre's Equation - Method of variation of parameters. | 12 |
| | **Total Instructional Hours** | **60** |

**Course Outcome**

CO1: Apply the concept of differentiation in any curve.
CO2: Identify the maximum and minimum values of surfaces. CO3: Apply double integrals to compute the area of plane curves.CO4: Evaluation of triple integrals to compute volume of solids.
CO5: Develop sound knowledge of techniques in solving ordinary differential equations that model engineering problems

**TEXT BOOKS:**

T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi, 2018.

T2 - Veerarajan T, "Engineering Mathematics ", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016.

**REFERENCE BOOKS :**

R1 - Thomas & Finney " Calculus and Analytic Geometry" , Sixth Edition,,Narosa Publishing House, NewDelhi.

R2 - Weir,M.D and Joel Hass, ' Thomas Calculus" 12thEdition,Pearson India 2016.

R3 - Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19PH1151 | APPLIED PHYSICS | 2 | 0 | 2 | 3 |

**Course Objective**

1. Enhance the fundamental knowledge in properties of matter
2. Analysis the oscillatory motions of particles
3. Extend the knowledge about wave optics
4. Gain knowledge about laser and their applications
5. Conversant with principles of optical fiber, types and applications of optical fiber

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **PROPERTIES OF MATTER** | |
| | Elasticity – Hooke's law – Stress-strain diagram - Poisson's ratio – Bending moment –Depression of a cantilever – Derivation of Young's modulus of the material of the beam by Uniform bending theory and experiment. | 6 |
| | Determination of Young's modulus by uniform bending method | 3 |
| II | **OSCILLATONS** | |
| | Translation motion –Vibration motion – Simple Harmonic motion – Differential Equation of SHM and its solution – Damped harmonic oscillation - Torsion stress and deformations – Torsion pendulum: theory and experiment. | 6 |
| | Determination of Rigidity modulus – Torsion pendulum | 3 |
| III | **WAVE OPTICS** | |
| | Conditions for sustained Interference – air wedge and it's applications - Diffraction of light –Fraunhofer diffraction at single slit –Diffraction grating – Rayleigh's criterionof resolution power - resolving power of grating. | 6 |
| | Determination of wavelength of mercury spectrum – spectrometer grating Determination of thickness of a thin wire – Air wedge method | 3<br>3 |
| IV | **LASER AND APPLICATIONS** | |
| | Spontaneous emission and stimulated emission – Population inversion – Pumping methods – Derivation of Einstein's coefficients (A&B) – Type of lasers – Nd:YAG laser and CO2 laser- Laser Applications – Holography – Construction and reconstruction of images. | 6 |
| | Determination of Wavelength and particl size using Laser | 3 |
| V | **FIBER OPTICS AND APPLICATIONS** | |
| | Principle and propagation of light through optical fibers – Derivation of numerical aperture and acceptance angle – Classification of optical fibers (based on refractive index, modes and materials) – Fiber optical communication link – Fiber optic sensors – Temperature and displacement sensors. | 6 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

**After completion of the course the learner will be able to**

CO1: Illustrate the fundamental properties of matter
CO2: Discuss the Oscillatory motions of particles
CO3: Analyze the wavelength of different colors
CO4: Understand the advanced technology of LASER in the field of EngineeringCO5: Develop the technology of fiber optical communication in engineering field

**TEXT BOOKS:**

T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, Newi, 2017.
T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., Newi, 2015.

**REFERENCE BOOKS:**

R1 - Arthur Beiser "Concepts of Modern Physics" Tata McGraw Hill, New Delhi – 2015
R2 - M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Companyltd., New Delhi 2016
R3 - Dr. G. Senthilkumar "Engineering Physics – I" VRB publishers Pvt Ltd., 2016

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19CY1151 | CHEMISTRY FOR ENGINEERS | 2 | 0 | 2 | 3 |

**Course Objective**

1. The boiler feed water requirements, related problems and water treatment techniques.
2. The principles of polymer chemistry and engineering applications of polymers andcomposites.
3. The principles of electrochemistry and with the mechanism of corrosion and its control.
4. The principles and generation of energy in batteries, nuclear reactors, solar cells, windmills and fuel cells.
5. The important concepts of spectroscopy and its applications.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **WATER TECHNOLOGY**<br>Hard water and soft water- Disadvantages of hard water- Hardness: types of hardness, simple calculations, estimation of hardness of water – EDTA method – Boiler troubles - Conditioning methods of hard water – External conditioning - demineralization process - desalination: definition,reverse osmosis – Potable water treatment – breakpoint chlorination. **Estimation of total, permanent and temporary hardness of water by EDTA** | 6 +3=9 |
| II | **POLYMER & COMPOSITES**<br>polymerization – addition and condensation polymerization – mechanism of free radical addition polymerization – copolymers – plastics: classification – thermoplastics and thermosetting plastics, preparation, properties and uses of commercial plastics – PVC, Bakelite – moulding of plastics (extrusion and compression); Composites: definition, types of composites – polymer matrix composites (PMC) –FRP | 6 |
| III | **ELECTROCHEMISTRY AND CORROSION**<br>Electrochemical cells – reversible and irreversible cells - EMF- Single electrode potential – Nernst equation (derivation only) – Conductometric titrations. Chemical corrosion – Pilling – Bedworth rule – electrochemical corrosion – different types –galvanic corrosion – differential aeration corrosion – corrosion control – sacrificial anode and impressed cathodic current methods - protective coatings – paints – constituents and functions. **Conductometric titration of strong acid vs strong base (HCl vs NaOH). Conductometric precipitation titration using $BaCl_2$ and $Na_2SO_4$. Estimation of Ferrous iron by Potentiometry.** | 6+9 =15 |
| IV | **ENERGY SOURCES AND STORAGE DEVICES**<br>Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power generator- classification of nuclear reactor- light water reactor- breeder reactor. Batteries and<br>fuel cells: Types of batteries- alkaline battery- lead storage battery- lithium battery- fuel cell $H_2$ -$O_2$ fuel cell applications. | 6 |
| V | **ANALYTICAL TECHNIQUES**<br>Beer-Lambert's law – UV-visible spectroscopy and IR spectroscopy – principles – instrumentation (block diagram only) – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry – atomic absorption spectroscopy – principles – instrumentation (block diagram only) – estimation of nickel by atomic absorption spectroscopy.<br>**Determination of iron content of the water sample using spectrophotometer.(1,10 phenanthroline / thiocyanate method).** | 6+3 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: Differentiate hard and soft water and to solve the related problems on water purification and itssignificance in industries and daily life

CO2: Acquire the basic knowledge of polymers, composites and FRP and their significance.

CO3: Develop knowledge on the basic principles of electrochemistry and understand the causes ofcorrosion, its consequences to minimize corrosion to improve industrial design.

CO4: Develop knowledge about the renewable energy resources and batteries along with the need ofnew materials to improve energy storage capabilities.

CO5: Identify the structure and characteristics of unknown/new compound with the help of spectroscopy.

**TEXT BOOKS**

T1 - P. N. Madudeswaran and B.Jeyagowri, "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd,Chennai
T2 - P.C.Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi (2018).

**REFERENCES**

R1 - B.Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2012).
R2 - S.S.Dara "A Text book of Engineering Chemistry" S.Chand& Co. Ltd., New Delhi (2017).

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| Programme/ Sem | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19CS1151 | PYTHON PROGRAMMING AND PRACTICES | 2 | 0 | 2 | 3 |

**Course Objectives**

1. To know the basics of algorithmic problem solving
2. To read and write simple Python programs
3. To develop Python programs with conditionals and loops and to define Python functions and call them
4. To use Python data structures -- lists, tuples, dictionaries
5. To do input/output with files in Python

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **ALGORITHMIC PROBLEM SOLVING**<br>Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation(pscudo code, flow chart, programming language), algorithmic problem solving, simple strategiesfor developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert acard in a list of sorted cards, guess an integer number in a range, Towers of Hanoi. | 9 |
| II | **DATA, EXPRESSIONS, STATEMENTS**<br>Python interpreter and interactive mode; values and types: int, float, boolean, string, and list;variables, expressions, statements, tuple assignment, precedence of operators, comments;modules and functions, function definition and use, flow of execution, parameters and arguments. **Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.** | 7+2 |
| III | **CONTROL FLOW, FUNCTIONS**<br>Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: returnvalues, 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.** | 5+4 |
| IV | **LISTS, TUPLES, DICTIONARIES**<br>Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, listparameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; **Illustrative programs: selection sort, insertion sort, merge sort, histogram.** | 3+6 |
| V | **FILES, MODULES, PACKAGES**<br>Files and exception: text files, reading and writing files, format operator; command line arguments,errors and exceptions, handling exceptions, modules, packages. **Illustrative programs: word count, copying file contents.** | 5+4 |
| | **Total Instructional Hours** | **45** |

**Course Outcomes**

- CO1: Develop algorithmic solutions to simple computational problems
- CO2: Read, write, execute by hand simple Python programs
- CO3: Structure simple Python programs for solving problems and Decompose a Python program into functions
- CO4: Represent compound data using Python lists, tuples, dictionaries
- CO5: Read and write data from/to files in Python Programs.

**TEXT BOOKS:**

T1 - Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2017.

T2 - S.Annadurai, S.Shankar, I.Jasmine Selvakumari Jeya, M.Revathi, Fundamentals of Python Programming, McGraw Hill Publications, 2021.

**REFERENCE BOOKS:**

R1 - Charles Dierbach, —Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

R2 - Timothy A. Budd, —Exploring Pythonl, Mc-Graw Hill Education (India) Private Ltd., 2015

R3 - Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

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| Programme/ Sem | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19EE1155 | BASICS OF ELECTRICALENGINEERING | 2 | 0 | 2 | 3 |

**Course Objective**

1. To introduce the fundamental concepts of electrical circuits and theorems.
2. To understand the basic theory, operational characteristics of AC and DC machines.
3. To study the operating principles of measuring instrument.
4. To observe the electrical power supply sources and understand electrical wiring basics.
5. To create awareness on the methods for electrical safety and protection.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **UNIT I : ELECTRICAL CIRCUITS AND ANALYSIS**<br>Ohm's law, DC and AC circuits fundamentals, Kirchhoff's laws, Mesh andNodal analysis- Theorems and simple problems: Superposition, Thevenins,<br>Maximum power transfer theorem- Experimental analysis of super positiontheorem. | 6+3 |
| II | **UNIT II : ELECTRICAL MACHINES**<br>DC Machines: D.C generators & D.C motors: Principle of operation, constructions, types, Applications - A.C Motors: -Single Phase induction motors: principle of operation, Types and Applications-Single phase Transformers: Principles of operation, Constructional Details, Types and Applications- Implementation of no load test on single phase induction motor and Transformer. | 6+3 |
| III | **UNIT III : BASIC ELECTRICAL INSTRUMENTATION**<br>Introduction, classification of instruments, operating principles, essential features of measuring instruments (elementary Treatment only) - Moving coil, permanent magnet (PMMC) instruments, Moving Iron of Ammeters<br>and Voltmeters - Energy meter- Experimental measurement of voltage, current and power in single phase circuit. | 6+3 |
| IV | **UNIT IV : BASICS OF POWER SUPPLY AND ELECTRICAL WIRING**<br>Introduction to Power supply circuits: Half wave, Full wave Rectifier – SMPS, UPS (online & offline). Wiring types and applications. Service mains, meter board and distribution board - Brief discussion on concealed conduit wiring. One way and two way control- implementation of simple wiring circuit for a household appliance. | 6+3 |
| V | **UNIT V: ELECTRICAL SAFETY**<br>Need for Electrical safety - Electric shock, precautions against shock - Elementary discussion on Circuit protective devices: fuse and Miniature Circuit Breaker (MCB's). Objectives for Neutral and Earthing, types of earthing; pipe and plate earthing, Residual current circuit breaker- Experimental measurement of insulation resistance of electrical equipment. | 6+3 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: Understand the fundamental concepts of electrical circuits and theorems.
CO2: Understand the basic theory, operational characteristics of AC and DC machines
CO3: Understand the operating principles of measuring instrument.
CO4: Understand the electrical power supply sources and electrical wiring basics
CO5: Understand the importance for electrical safety and protection.

**TEXT BOOKS:**

T1 Dr. D P Kothari, Prof I J Nagrath, "Basic Electrical Engineering", 3rd Edition, Tata McGraw-Hill, 2009.

T2 K. S. Dhogal "Basic Practical In Electrical Engineering", 2nd, Reprint 2017, Standard Publishers Distributors

**REFERENCE BOOKS:**

R1 P.C. Sen, "Principles of Electrical Machines and Power Electronics", Wiley, 2016(Reprint)

R2 Vijay kumar Garg, "Basic Electrical Engineering (A complete Solution)", Wiley Reprint2015.

R3 Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford press 2005.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19HE1071 | LANGUAGE COMPETENCY ENHANCEMENT COURSE- I | 0 | 0 | 2 | 1 |

**Course Objective**

1. To enhance student language competency
2. To train the students in LSRW skills
3. To develop student communication skills
4. To empower the trainee in business writing skills.
5. To train the students to react to different professional situations

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **Listening**<br>Listening to technical group discussions and participating in GDs.listening to TED talks. Listen to Interviews & mock interview. Listening short texts and memos. | 3 |
| II | **Reading**<br>Reading articles from newspaper, magazine. Reading comprehension. Reading about technical inventions, research and development. Reading short texts and memos. | 3 |
| III | **Writing**<br>E-mail writing: Create and send email writing (to enquire about some details, to convey important message to all, to place an order, to share your joy and sad moment). Reply for an email writing. | 3 |
| IV | **Speaking**<br>To present a seminar in a specific topic (what is important while choosing or deciding something to do). To respond or answer for general questions (answer for your personal details, about your family, education, your hobbies, your aim etc..). | 3 |
| V | **Speaking**<br>Participate in discussion or interactions (agree or disagree express your statement with a valid reason, involve in discussion to express your perspective on a particular topics). | 3 |
| | **Total Instructional Hours** | **15** |

**Course Outcome**

CO1- Trained to maintain coherence and communicate effectively.
CO2- Practiced to create and interpret descriptive communication.
CO3- Introduced to gain information of the professional world.
CO4- acquired various types of communication and etiquette.
CO5- Taught to improve interpersonal and intrapersonal skills.

**TEXT BOOKS:**

T1- Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press, 2016.

T2- Raymond Murphy, "Essential English Grammar", Cambridge University Press, 2019.

**REFERENCE BOOKS :**

R1- Meenakshi Raman and Sangeetha Sharma. "Technical Communication- Principles and Practice", Oxford University Press, 2009.

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| Programme | Course code | Course title | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19HE1072 | CAREER GUIDANCE LEVEL I<br>Personality, Aptitude and Career Guidance | 2 | 0 | 0 | 0 |

**Course Objectives:**

- Introduce students to building blocks of Logical reasoning and Quantitative Aptitude [SLO 1]
- Train students on essential grammar for placements [SLO 2]
- Introduce students on scientific techniques to pick up skills [SLO 3]
- Provide an orientation for recruiter expectation in terms of non-verbal skills, and for how to build one's career with placements in mind [SLO 4]

**Expected Course Outcome:**

Enable students to approach learning Aptitude with ease, and understand recruiter expectation.

**Student Learning Outcomes (SLO):** 1, 2, 3 and 4

**Module:1** **Lessons on excellence** **2hours** **SLO:**3

Skill introspection, Skill acquisition, consistent practice

**Module:2** **Logical Reasoning** **11 hours** **SLO:**1

**Thinking Skill**

Problem Solving
Critical Thinking
Lateral Thinking

Taught through thought-provoking word and rebus puzzles, and word-link builder questions

**Coding & decoding, Series, Analogy, Odd man out and Visual reasoning**

Coding and Decoding
Series
Analogy
Odd Man Out
Visual Reasoning

**Sudoku puzzles**

Solving introductory to moderate level sudoku puzzles to boost logical thinking and comfort with numbers

**Attention to detail**

Picture and word driven Qs to develop attention to detail as a skill

**Module:3** **Quantitative Aptitude** **11 hours** **SLO:**1

**Speed Maths**

Addition and Subtraction of bigger numbers
Square and square roots
Cubes and cube roots
Vedic maths techniques
Multiplication Shortcuts
Multiplication of 3 and higher digit numbers
Simplifications
Comparing fractions

Shortcuts to find HCF and LCM
Divisibility tests shortcuts

**Algebra and functions**

**Module:4 Recruitment Essentials 2hours SLO:4**

**Looking at an engineering career through the prism of an effective resume**

Importance of a resume - the footprint of a person's career achievements
How a resume looks like?
An effective resume vs. a poor resume: what skills you must build starting today and how?

**Impression Management**

Getting it right for the interview:
Grooming, dressing
Body Language and other non-verbal signs
Displaying the right behaviour

**Module:5 Verbal Ability 4hours SLO:2**

**Essential grammar for placements:**

Nouns and Pronouns
Verbs
Subject-Verb Agreement
Pronoun-Antecedent Agreement
Punctuations

**Verbal Reasoning**

**Total Lecture hours: 30hours**

**Mode of Evaluation**: Assignments, 3 Assessments with End Semester (Computer Based Test)

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19HE1073 | ENTREPRENEURSHIP & INNOVATION | 1 | 0 | 0 | 0 |

**Course Objective:**

1. To acquire the knowledge and skills needed to manage the development of innovation.
2. To recognize and evaluate potential opportunities to monetize these innovations.
3. To plan specific and detailed method to exploit these opportunities.
4. To acquire the resources necessary to implement these plans.
5: To make students understand organizational performance and its importance.

| Module | Description | Instructional Hours |
|---|---|---|
| 1. | Entrepreneurial Thinking | 15 |
| 2. | Innovation Management | |
| 3. | Design Thinking | |
| 4. | Opportunity Spotting / Opportunity Evaluation | |
| 5. | Industry and Market Research | |
| 6. | Innovation Strategy and Business Models | |
| 7. | Financial Forecasting | |
| 8. | Business Plans/ Business Model Canvas | |
| 9. | Entrepreneurial Finance | |
| 10. | Pitching to Resources Providers / Pitch Deck | |
| 11. | Negotiating Deals | |
| 12. | New Venture Creation | |
| 13. | Lean Start-ups | |
| 14. | Entrepreneurial Ecosystem | |
| 15. | Velocity Venture | |
| | **Total Instructional Hours** | **15** |

**Course Outcome**

CO1: Understand the nature of business opportunities, resources, and industries in critical and creative aspects.
CO2: Understand the processes by which innovation is fostered, managed, and commercialized.
CO3: Remember effectively and efficiently the potential of new business opportunities.
CO4: Assess the market potential for a new venture, including customer need, competitors, and industry attractiveness..
CO5: Develop a business model for a new venture, including revenue. Margins, operations, working capital, and investment.

**TEXT BOOKS:**

T1: Arya Kumar "Entrepreneurship – Creating and leading an Entrepreneurial Organization", Pearson, Second Edition (2012).
T2: Emrah Yayici "Design Thinking Methodology", Artbiztech, First Edition(2016).

**REFERENCE BOOKS:**

R1: Christopher Golis "Enterprise & Venture Capital", Allen & Unwin Publication, Fourth Edition 2007
R2: Thomas Lock Wood & Edger Papke "Innovation by Design", Career Press.com, Second (2017).
R3: Jonahan Wilson "Essentials of Business Research", Sage Publication, First Edition, (2010).

**WEB RESOURCES:**

W1: https://blof.forgeforward.in/tagged/startup-lessons
W2: https://blof.forgeforward.in/tagged/entrepreurship
W3: https://blof.forgeforward.in/tagged/minimum-viable-product
W4: https://blof.forgeforward.in/tagged/minimum-viable-product
W5: https://blof.forgeforward.in/tagged/innovation
W6:https://www.youtube.com/watch?v=8vEyL7uKXs&list=PLmP9QrmTNPqBEvKbMSXvwlwn7fdnXe6

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19HE2101 | BUSINESS ENGLISH FOR ENGINEERS | 2 | 1 | 0 | 3 |

**Course Objectives**

1. To introduce to business communication.
2. To train the students to react to different professional situations.
3. To make the learner familiar with the managerial skills
4. To empower the trainee in business writing skills.
5. To learn to interpret and expertise different content.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **Listening and Speaking** – listening and discussing about programme and conference arrangement **Reading** –reading auto biographies of successful personalities **Writing** Formal & informal email writing, Recommendations **Grammar and Vocabulary-** Business vocabulary, Adjectives & adverbs | 9 |
| II | **Listening and Speaking-** listening to TED talks **Reading-** Making and interpretation of posters **Writing-** Business letters: letters giving good and bad news, Thank you letter, Congratulating someone on a success" **Grammar and Vocabulary-** Active & passive voice, Spotting errors (Tenses, Preposition, Articles) | 9 |
| III | **Listening and Speaking-**travel arrangements and experience **Reading-** travel reviews **Writing-** Business letters (Placing an order, making clarification & complaint letters). **Grammar and Vocabulary-** Direct and Indirect speech. | 9 |
| IV | **Listening and Speaking-** Role play - **Reading-** Sequencing of sentence **Writing-** Business report writing (marketing, investigating) **Grammar and Vocabulary-** Connectors, Gerund & infinitive | 9 |
| V | **Listening and Speaking-** Listen to Interviews & mock interview **Reading-** Reading short stories, reading profile of a company **- Writing-** Descriptive writing (describing one's own experience) **Grammar and Vocabulary**- Editing a passage(punctuation, spelling & number rules) | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcomes**

CO1- Introduced to different modes and types of business communication.
CO2- Practiced to face and react to various professional situations efficiently.
CO3- learnt to practice managerial skills.
CO4- Familiarized with proper guidance to business writing.
CO5- Trained to analyze and respond to different types of communication.

**TEXT BOOKS:**

T1 - Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate",Cambridge University Press, 2016.

T2- Ian Wood and Anne Willams. "Pass Cambridge BEC Preliminary", Cengage Learning press 2015.

**REFERENCE BOOKS :**

R1 - Michael Mc Carthy, "Grammar for Business", Cambridge University Press, 2009

R2- Bill Mascull, "Business Vocabulary in use: Advanced 2nd Edition", Cambridge University Press, 2009.

R3- Frederick T. Wood, "Remedial English Grammar For Foreign Students", Macmillan publishers, 2001.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19MA2102 | COMPLEX VARIABLES AND TRANSFORM CALCULUS | 3 | 1 | 0 | 4 |

**Course Objective**

1. Develop the skill to use matrix algebra techniques that is needed by engineers for practical applications.
2. Identify effective mathematical tools for the solutions of partial differential equations.
3. Describe the construction of analytic functions and conformal mapping.
4. Illustrate Cauchy's integral theorem and calculus of residues.
5. Analyze the techniques of Laplace and Inverse laplace transform.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **MATRICES**<br>Eigen values and Eigen vectors of a real matrix– Properties of Eigenvalues and Eigenvectors (without proof)Cayley - Hamilton Theorem (excluding proof) - Orthogonal matrices–Definition – Reduction of a quadratic form to canonical form by orthogonal transformation. | 12 |
| II | **PARTIAL DIFFERENTIAL EQUATIONS**<br>Formation of partial differential equations by the elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations of the form f(p,q)=0, Clairaut's type : z = px+qy +f(p,q) – Lagrange's linear equation. | 12 |
| III | **COMPLEX DIFFERENTIATION**<br>Functions of complex variables – Analytic functions – Cauchy's – Riemann's equations and sufficient conditions (excluding proof) – Construction of analytic functions – Milne –Thomson's method – Conformal mapping w = A+z , Az, 1/z and bilinear transformations. | 12 |
| IV | **COMPLEX INTEGRATION**<br>Cauchy's integral theorem – Cauchy's integral formula –Taylor's and Laurent's series (statement only) –Residues - Cauchy's Residue theorem. | 12 |
| V | **TRANSFORM CALCULUS**<br>Laplace transform–Basic properties – Transforms of derivatives and integrals of functions-Transform of periodic functions - Inverse Laplace transform-Convolution theorem (without proof) – Solution of linear ODE of second order with constant coefficients using Laplace transforms.. | 12 |
| | **Total Instructional Hours** | **60** |

**Course Outcome**

CO1: Calculate Eigen values and Eigen vectors for a matrix which are used to determine the natural frequencies.
CO2: Solve Partial Differential Equations using various methods.
CO3: Infer the knowledge of construction of analytic functions and conformal mapping.
CO4: Evaluate real and complex integrals over suitable closed paths or contours.
CO5: Apply Laplace transform and its properties to solve certain linear differential equations.

**TEXT BOOKS:**

T1- Ravish R Singh, Mukul Bhatt, "Engineering Mathematics", McGraw Hill education (India) Private Ltd.,Chennai,2017.
T2- Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi,2018.

**REFERENCE BOOKS :**

R1- Bali N.P &Manish Goyal,"A Textbook of Engineering Mathematics",8th Edition, Laxmi Pub. Pvt. Ltd.2011.
R2- Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.
R3- Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage learning,2012.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19PH2151 | MATERIAL SCIENCE | 2 | 0 | 2 | 3 |

**Course Objective**

1. Acquire fundamental knowledge of semiconducting materials which is related to the engineering program.
2. Extend the knowledge about the magnetic materials.
3. Explore the behavior of super conducting materials.
4. Gain knowledge about Crystal systems.
5. Understand the importance of ultrasonic waves.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **SEMICONDUCTING MATERIALS** | |
| | Introduction – Intrinsic semiconductor – Compound and elemental semiconductor - direct andindirect band gap of semiconductors. Carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination. Optical properties of semiconductor – Light through optical fiber(Qualitative). | 6 |
| | Determination of band gap of a semiconductor | 3 |
| | Determination of acceptance angle and numerical aperature in an optical fiber | 3 |
| II | **MAGNETIC MATERIALS** | |
| | Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – anti ferromagnetic materials – Ferrites and its applications. | 6 |
| | B – H curve by Magnetic hysteresis experiment | 3 |
| III | **SUPERCONDUCTING MATERIALS** | |
| | Superconductivity : properties(Messiner effect, effect of magnetic field, effect of current and isotope effects) – Type I and Type II superconductors – High Tc superconductors – Applications of superconductors –Cryotron and magnetic levitation. | 6 |
| IV | **CRYSTAL PHYSICS** | |
| | Crystal systems - Bravais lattice - Lattice planes - Miller indices - Interplanar spacing in cubic lattice - Atomic radius, Coordination number and Packing factor for SC,BCC and FCC crystal structures. | 6 |
| V | **ULTRASONICS** | |
| | Production – Magnetostrictive generator – Piezoelectric generator – Determination of velocityusing acoustic grating – Cavitations – Viscous force – co-efficient of viscosity. Industrialapplications – Drilling and welding – Non destructive testing – Ultrasonic pulse echo system. | 6 |
| | Determination of velocity of sound and compressibility of liquid – Ultrasonic wave | 3 |
| | Determination of Coefficient of viscosity of a liquid –Poiseuille's method | 3 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: Understand the purpose of acceptor or donor levels and the band gap of a semiconductor

CO2: Interpret the basic idea behind the process of magnetism and its applications in everyday

CO3: Discuss the behavior of super conducting materials

CO4: Illustrate the types and importance of crystal systems

CO5: Evaluate the production of ultrasonics and its applications in NDT

**TEXT BOOKS:**

T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.

T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi,2015.

**REFERENCE BOOKS:**

**R1** - Arthur Beiser "Concepts of Modern Physics" Tata McGraw Hill, New Delhi – 2015

**R2** - M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., NewDelhi 2016

**R3** - Dr. G. Senthilkumar "Engineering Physics – II" VRB publishers Pvt Ltd., 2016

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19CY2151 | ENVIRONMENTAL STUDIES | 2 | 0 | 2 | 3 |

**Course Objective**

1. The importance of environmental education, ecosystem and biodiversity.
2. The knowledge about environmental pollution – sources, effects and control measures ofenvironmental pollution.
3. The natural resources, exploitation and its conservation
4. Scientific, technological, economic and political solutions to environmental problems.
5. An awareness of the national and international concern for environment and its protection.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY**<br>Main objectives and scope of environmental studies-Importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – food chain, food web and ecological pyramids - energy flow in the ecosystem – ecological succession processes - Introduction, types, characteristic features, structure and function of the forest and ponds ecosystem – Introduction to biodiversity definition: types and value of biodiversity – hot-spots of biodiversity – threats to biodiversity– endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. | 6 |
| II | **NATURAL RESOURCES**<br>Renewable and Non renewable resources - Forest resources: Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forests and tribal people - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture – Energy resources: Renewable and non renewable energy sources – Solar energy and wind energy - role of an individual in conservation of natural resources. | 6 |
| III | **ENVIRONMENTAL POLLUTION**<br>Definition – causes, effects and control measures of: Air pollution- Water pollution – Water quality parameters- Soil pollution - Noise pollution- Nuclear hazards – role of an individual in prevention of pollution.<br>**Determination of Dissolved Oxygen in sewage water by Winkler's method.**<br>**Estimation ofalkalinity of water sample by indicator method.**<br>**Determination of chloride content of water sampleby argentometric method.** | 6+9=15 |
| IV | **SOCIAL ISSUES AND THE ENVIRONMENT**<br>From unsustainable to sustainable development – urban problems related to energy- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- Municipal solid waste management. Global issues – Climatic change, acid rain, greenhouse effect and ozone layer depletion – Disaster Management – Tsunami and cyclones.<br>**Determination of pH in beverages.** | 6+3=9 |
| V | **HUMAN POPULATION AND THE ENVIRONMENT**<br>Population growth, variation among nations – population explosion – family welfare programme – environment and human health – effect of heavy metals – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- GIS-remote sensing-role of information technology in environment and human health.<br>**Estimation of heavy metal ion (copper) in effluents by EDTA.** | 6+3=9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO2: Understand the causes of environmental pollution and hazards due to manmade activities.
CO3: Develop an understanding of different natural resources including renewable resources.
CO4: Demonstrate an appreciation for need for sustainable development and understand the various social issues and solutions to solve the issues.
CO5: Gain knowledge about the importance of women and child education and know about the existing technology to protect environment

**TEXT BOOKS:**


T1- S.Annadurai and P.N. Magudeswaran, "Environmental studies", Cengage Learning India Pvt.Ltd, Delhi,2020
T2 – Anubha Kaushik and C. P. Kaushik, "Perspectives in Environmental studies", Sixth edition, New AgeInternational Publishers, New Delhi, 2019.


**REFERENCES:**


R1 – ErachBharucha, "Textbook of environmental studies" University Press (I) Pvt.ltd, Hyderabad, 2015.
R2 - G.Tyler Miller, Jr and Scott E. Spoolman"Environmental Science" Thirteenth Edition, Cengage Learning,2010.
R3 - Gilbert M. Masters and Wendell P. Ela "Introduction to Environmental Engineering and Science", 3rd edition, Pearson.Education, 2013.


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19CS2152 | ESSENTIAL OF C AND C++ PROGRAMMING | 2 | 0 | 2 | 3 |

**Course Objective**

1. To Learn and develop basics of C programming.
2. To understand Object Oriented Programming concepts and basic characteristics of C++.
3. Be familiar with the constructors and operator overloading.
4. To understand the concepts of inheritance, polymorphism and virtual function.
5. To learn and define concept of templates and exception handling.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **BASICS OF 'C' PROGRAMMING**<br>Fundamentals of ' C' programming – Structure of a 'C' program – Constants - Variables – Data Types – Expressions using operators in 'C' – Managing Input and Output operations-Branching and Looping - Arrays – One dimensional and Two dimensional arrays.<br>**Programs: 1. Write a C program to calculate sum of individual digits of a given number.**<br>**2. Write a C program to count no. of positive numbers, negative numbers and zeros in the array. 3. Write a C program to find sum of two numbers using functions with arguments and without return type.** | 3+6 |
| II | **BASICS OF 'C++' PROGRAMMING**<br>Introduction to C++ – structures and unions- Object oriented programming concepts–Defining a Class – creating objects - access specifiers – Function in C++ - function and data members default arguments – function overloading – Inline functions - friend functions – constant with class – static member of a class – nested classes – local classes.<br>**Program: Write a C++ program to accept the student detail such as name and 3 differentmarks by get_data() method and display the name and average of marks using display() method. Define a friend class for calculating the average of marks using the method mark_avg().** | 6+3 |
| III | **CONSTRUCTOR AND OPERATOR OVERLOADING**<br>Constructors - Default, Copy, Parameterized, Dynamic constructors, Default argument – Destructor. - Function overloading- Operator overloading-Unary, Binary - Binary operators using friend function.<br>**Program: Write a C++ program to calculate the volume of different geometric shapes like cube, cylinder and sphere and hence implement the concept of Function Overloading.** | 7+2 |
| IV | **INHERITANCE AND POLYMORPHISM**<br>Inheritance – Public, Private and Protected derivations– Single– Multiple– Multilevel– Hybrid– Hierarchical - Virtual base class – abstract class – composite objects- Runtime polymorphism – virtual functions – pure virtual functions.<br>**Program: Demonstrate Simple Inheritance concept by creating a base class FATHER with data members SurName and BankBalance and creating a derived class SON, which inherits SurName and BankBalance feature from base class but provides its own feature FirstName and DOB. Create and initialize F1 andS1 objects with appropriate constructors and display the Father & Son details. (Hint : While creating S1 object, call Father base class parameterized constructor through derived class by sending values).** | 7+2 |
| V | **TEMPLATES AND EXCEPTION HANDLING**<br>Function and class templates - Exception handling – try-catch-throw paradigm – exception specification – terminate and Unexpected functions – Uncaught exception.<br>**Program: Write a C++ program to create a template function for Bubble Sort and demonstrate sorting of integers and doubles.** | 7+2 |
| | **Total Instructional Hours** | **45** |

**Course Outcomes**

CO1: Develop simple applications in C using basic constructs.
CO2: Apply solutions to real world problems using basic characteristics of C++.
CO3: Write object-oriented programs using operator overloading, constructors and destructors.
CO4: Develop programs with the concepts of inheritance and polymorphism.
CO5: Understand and define solutions with C++ advanced features such as templates and exception handling.

**TEXT BOOKS:**

T1 - E.Balagurusamy, "Programming in ANSI C", 7th Edition, McGraw Hill Publication, 2016.
T2 - E.Balagurusamy, "Object Oriented Programming with C++", 7th Edition, McGraw Hill Publication, 2017.

**REFERENCE BOOKS:**

R1 - Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011.
R2 - RohitKhurana, "Object Oriented Programming with C++", Vikas Publishing, 2nd Edition, 2016.
R3 - B. Trivedi, "Programming with ANSI C++", Oxford University Press, 2007.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19ME2154 | ENGINEERING GRAPHICS | 1 | 0 | 4 | 3 |

**Course Objective**

1. To gain the knowledge of Engineer's language of expressing complete details about objects and construction of conics and special curves.
2. To learn about the orthogonal projections of straight lines and planes.
3. To aquire the knowledge of projections of simple solid objects in plan and elevation.
4. To learn about the projection of sections of solids and development of surfaces.
5. To study the isometric projections of different objects.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **PLANE CURVES**<br>Importance of engineering drawing; drafting instruments; drawing sheets – layout and folding; Lettering and dimensioning, BIS standards, scales.<br>Geometrical constructions, Engineering Curves Conic sections – Construction of ellipse, parabola and hyperbola by eccentricity method. Construction of cycloids and involutes of square and circle – Drawing of tangents and normal to the above curves. | 12 |
| II | **PROJECTIONS OF POINTS, LINES AND PLANE SURFACES**<br>Introduction to Orthographic projections- Projection of points. Projection of straight lines inclined to both the planes, Determination of true lengths and true inclinations by rotating line method.<br>Projection of planes (polygonal and circular surfaces) inclined to both the planes by rotating object method (First angle projections only). | 12 |
| III | **PROJECTIONS OF SOLIDS**<br>Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is perpendicular and inclined to one plane by rotating object method. | 12 |
| IV | **SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES**<br>Sectioning of simple solids with their axis in vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other – Obtaining true shape of section.<br>Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinder and cone. Development of lateral surfaces of truncated solids. | 12 |
| V | **ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS**<br>Isometric views and projections simple and truncated solids such as - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions. Free hand sketching of multiple views from a pictorial drawing. Basics of drafting using AutoCAD software. | 12 |
| | **Total Instructional Hours** | **60** |

**Course Outcome**

CO1: Understand and interpret the engineering drawings in order to visualize the objects and draw the conics and special curves.

CO2: Draw the orthogonal projections of straight lines and planes.

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CO3: Interpret the projections of simple solid objects in plan and elevation.
CO4: Draw the projections of section of solids and development of surfaces of solids.
CO5: Draw the isometric projections and the perspective views of different objects.

**TEXT BOOK:**

1. K.Venugopal, V.Prabu Raja, "Engineering Drawing, AutoCAD, Building Drawings", 5th edition New Age International Publishers, New delhi 2016.

2. K.V.Natarajan, "A textbook of Engineering Graphics", Dhanlaksmi Publishers, Chennai 2016.

**REFERENCES:**

1. Basant Agrawal and C.M.Agrawal, "Engineering Drawing", Tata McGraw Hill Publishing company Limited,New Delhi 2013.

2. N.S. Parthasarathy, Vela Murali, "Engineering Drawing", Oxford University PRESS, India 2015.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19ME2001 | ENGINEERING PRACTICES | 0 | 0 | 4 | 2 |

**Course Objective**: To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

## GROUP A (CIVIL & MECHANICAL)

## CIVIL AND MECHANICAL ENGINEERING PRACTICES

| S.No | Description of the Experiments |
|---|---|
| 1 | Preparation of Single pipe line and Double pipe line connection by using valves, taps, couplings, unions, reducers and elbows. |
| 2 | Arrangement of bricks using English bond for 1brick thick wall and 11/2 brick thick wall for right angle corner junction. |
| 3 | Arrangement of bricks using English bond for 1brick thick wall and 11/2 brick thick wall for T junction. |
| 4 | Preparation of arc welding of Butt joints, Lap joints and Tee joints. |
| 5 | Practice on sheet metal Models– Trays and funnels |
| 6 | Hands-on-exercise in wood work, joints by sawing, planning and cutting. |
| 7 | Practice on simple step turning, taper turning and drilling. |
| 8 | Demonstration on Smithy operation. |
| 9 | Demonstration on Foundry operation. |
| 10 | Demonstration on Power tools. |

**Total Practical Hours** **45**

## GROUP B (ELECTRICAL)

## ELECTRICAL ENGINEERING PRACTICES

| S.No | Description of the Experiments |
|---|---|
| 1 | Residential house wiring using switches, fuse, indicator, lamp and energy meter. |
| 2 | Fluorescent lamp wiring |
| 3 | Stair case wiring. |
| 4 | Measurement of Electrical quantities – voltage, current, power & power factor in single phase circuits. |
| 5 | Measurement of energy using single phase energy meter. |
| 6 | Soldering practice using general purpose PCB. |
| 7 | Measurement of Time, Frequency and Peak Value of an Alternating Quantity using CRO and Function Generator. |
| 8 | Study of Energy Efficient Equipment's and Measuring Instruments. |

**Total Practical Hours** **45**

**Course Outcome**

CO1: Fabricate wooden components and pipe connections including plumbing works.
CO2: Fabricate simple weld joints.
CO3: Fabricate different electrical wiring circuits and understand the AC Circuits.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19HE2071 | LANGUAGE COMPETENCY ENHANCEMENT COURSE- II | 0 | 0 | 2 | 1 |

**Course Objective**

1. To introduce to business communication.
2. To train the students to react to different professional situations.
3. To make the learner familiar with the managerial skills
4. To empower the trainee in business writing skills.
5. To learn to interpret and expertise different content.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **Listening and Speaking** – listening and discussing about programme and conference arrangement **Reading** –reading auto biographies of successful personalities **Writing** Formal & informal email writing, Recommendations **Grammar and Vocabulary-** Business vocabulary, Adjectives & adverbs. | 3 |
| II | **Listening and Speaking-** listening to TED talks **Reading-**Making and interpretation of posters**Writing-** Business letters: letters giving good and bad news, Thank you letter, Congratulating someone on a success" **Grammar and Vocabulary**- Active & passive voice, Spotting errors (Tenses, Preposition, Articles). | 3 |
| III | **Listening and Speaking-**travel arrangements and experience **Reading-** travel reviews **Writing-** Business letters (Placing an order, making clarification & complaint letters). **Grammar and Vocabulary**- Direct and Indirect speech. | 3 |
| IV | **Listening and Speaking-**Role play- **Reading-** Sequencing of sentence **Writing-** Business report writing (marketing, investigating) **Grammar and Vocabulary-** Connectors, Gerund & infinitive. | 3 |
| V | **Listening and Speaking-** Listen to Interviews & mock interview **Reading-** Reading short stories, reading profile of a company **- Writing-** Descriptive writing (describing one's own experience) **Grammar and Vocabulary**- Editing a passage(punctuation, spelling & number rules). | 3 |
| | **Total Instructional Hours** | **15** |

**Course Outcome**

CO1- Introduced to different modes and types of business communication.
CO2- Practiced to face and react to various professional situations efficiently.
CO3- learnt to practice managerial skills.
CO4- Familiarized with proper guidance to business writing.
CO5- Trained to analyze and respond to different types of communication.

**TEXT BOOKS:**

T1 - Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate",Cambridge University Press, 2016.

T2- Ian Wood and Anne Willams. "Pass Cambridge BEC Preliminary", Cengage Learning press 2015.

**REFERENCE BOOKS :**

R1 - Michael Mc Carthy, "Grammar for Business", Cambridge University Press, 2009.

R2- Bill Mascull, "Business Vocabulary in use: Advanced 2nd Edition", Cambridge University Press, 2009.

R3-Frederick T. Wood, "Remedial English Grammar For Foreign Students", Macmillan publishers, 2001.

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| Programme | Course code | Course title | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19HE2072 | CAREER GUIDANCE LEVEL II<br>Personality, Aptitude and Career Development | 2 | 0 | 0 | 0 |

**Course Objectives:**

- Solve Logical Reasoning questions of easy to intermediate level [SLO 6]
- Solve Quantitative Aptitude questions of easy to intermediate level [SLO 7]
- Solve Verbal Ability questions of easy to intermediate level [SLO 8]

**Expected Course Outcome:**

Enable students to solve questions on Verbal, Logical and Quantitative Aptitude of placement level

**Student Learning Outcomes (SLO):** 6, 7, 8

**Module:1 Logical Reasoning** **8 hours** **SLO:**6

**Word group categorization questions**

Puzzle type class involving students grouping words into right group orders of logical sense

**Cryptarithmetic**

**Data arrangements and Blood relations**

- Linear Arrangement
- Circular Arrangement
- Multi-dimensional Arrangement
- Blood Relations

**Module:2 Quantitative Aptitude** **12 hours** **SLO:**7

**Ratio and Proportion**

- Ratio
- Proportion
- Variation
- Simple equations
- Problems on Ages
- Mixtures and alligations

**Percentages, Simple and Compound Interest**

- Percentages as Fractions and Decimals
- Percentage Increase / Decrease
- Simple Interest
- Compound Interest
- Relation Between Simple and Compound Interest

**Number System**

- Number system
- Power cycle
- Remainder cycle
- Factors, Multiples
- HCF and LCM

**Module:3 Verbal Ability** **10hours** **SLO:**8

**Essential grammar for placements**

- Prepositions
- Adjectives and Adverbs
- Tenses
- Forms and Speech and Voice

- Idioms and Phrasal Verbs
- Collocations, Gerund and Infinitives

**Reading Comprehension for placements**

- Types of questions
- Comprehension strategies
- Practice exercises

**Articles, Prepositions and Interrogatives**

- Definite and Indefinite Articles
- Omission of Articles
- Prepositions
- Compound Prepositions and Prepositional Phrases
- Interrogatives

**Vocabulary for placements**

- Exposure to solving questions of
- Synonyms
- Antonyms
- Analogy
- Confusing words
- Spelling correctness

**Total Lecture hours: 30hours**

**Mode of Evaluation**: Assignments, 3 Assessments with End Semester (Computer Based Test)

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## SEMESTER III

| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19MA3102 | FOURIER ANALYSIS AND TRANSFORMS | 3 | 1 | 0 | 4 |

**Course Objective**

1. Analyze Fourier series which is central to many applications in engineering.
2. Apply the effective tools for the solutions of one dimensional boundary value problems.
3. Apply the effective tools for the solutions of two dimensional heat equations.
4. Apply Fourier transform techniques in various situations.
5. Analyze Z transform techniques for discrete time systems.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **FOURIER SERIES**<br>Dirichlet's conditions- General Fourier Series – Odd and Even Functions – Half range sine and cosine series – Change of Interval - Parseval's Identity - Harmonic analysis. | 12 |
| II | **BOUNDARY VALUE PROBLEMS**<br>Classification of PDE - Solutions of one dimensional wave equation - One dimensional equation of heat conduction (excluding insulated edges). | 12 |
| III | **TWO DIMENSIONAL HEAT EQUATIONS**<br>Steady state solution of two dimensional equation of heat conduction in infiniteplate and semi circular plate. | 12 |
| IV | **FOURIER TRANSFORMS**<br>Fourier Transform Pairs - Fourier sine and cosine transforms – Properties -Transforms of Simple functions – Convolution Theorem (Statement only) – Parseval's identity(Statement only). | 12 |
| V | **Z - TRANSFORMS AND DIFFERENCE EQUATIONS**<br>Z- Transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Convolution theorem( excluding proof)– Solution of difference equations using Z – transform. | 12 |
| **Total Instructional Hours** | | **60** |

**Course Outcome**

CO1: Understand the principles of Fourier series which helps them to solve physical problemsof engineering.
CO2: Employ Fourier series in solving the boundary value problems.
CO3: Understand Fourier series in solving the two dimensional heat equations.
CO4: Apply Fourier transform techniques which extend its applications.
CO5: Illustrate the Z- transforms for analyzing discrete-time signals and systems.

**TEXT BOOKS:**

T1 - Veerarajan. T.,"Transforms and Partial Differential Equations", Tata McGraw HillEducation Pvt. Ltd., Second reprint, New Delhi, 2012.

T2 - Bali. N.P and Manish Goyal & Watkins, "Advanced Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007

**REFERENCE BOOKS :**

R1 - C.Roy Wylie " Advance Engineering Mathematics" Louis C. Barret, 6th Edition, Mc GrawHill Education India Private Limited, New Delhi 2003.

R2 - Kandasamy P., Thilagavathy K. and Gunavathy K.,"Engineering Mathematics Volume III",S.Chand & Company Ltd., New Delhi, 1996.

R3 - Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers,Delhi,2018.

R4 - Ramana. B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2018.

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| Programme | Course code | Name of the course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM3201 | ELECTRON DEVICES AND CIRCUITS | 3 | 1 | 0 | 4 |

**Course Objective**

1. To be familiar with the theory, construction, and operation of Semiconductor diodes.
2. To impart knowledge on the configurations and operation of transistors.
3. To give an insight of the operation of amplifiers.
4. To be familiar with the concept of multistage amplifiers anddifferential amplifiers.
5. To impart knowledge on feedback amplifiers and oscillators.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **PN JUNCTION**<br>PN junction diode –structure, operation and V-I characteristics, diffusionand transient capacitance – Rectifiers – Half Wave and Full Wave Rectifier,– Display devices- LED, Laser diodes- Zener diode-characteristics-Zener Reverse characteristics – Zener as regulator | 12 |
| II | **TRANSISTORS**<br>BJT, JFET, MOSFET- structure, operation, characteristics and BiasingUJT, Thyristor and IGBT – Structure and characteristics | 12 |
| III | **AMPLIFIERS**<br>BJT small signal model – Analysis of CE amplifiers- Gain and frequency response – MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency Model | 12 |
| IV | **DIFFERENTIAL AMPLIFIER AND POWER AMPLIFIER**<br>BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers –Types (Qualitative analysis). | 12 |
| V | **FEEDBACK AMPLIFIERS AND OSCILLATORS**<br>Advantages of negative feedback – voltage / current, series , Shunt feedback – positive feedback – Condition for oscillations, phase shift –Wien bridge, Hartley, Colpitts and Crystal oscillators | 12 |
| | Total Instruction hours | 60 |

**Course Outcome**

CO1: Ability to explain the theory, construction, and operation of PN junctiondiodes.
CO2: Ability to demonstrate the theory, construction, and operation oftransistors.
CO3: To understand the working of amplifiers.
CO4: To understand the working multistage amplifiers and differentialamplifiers.
CO5: To differentiate different types of feedback amplifiers and oscillators.

**TEXT BOOKS:**


1. David A. Bell ,"Electronic Devices and Circuits", Fifth edition, Prentice Hall of India,2008.
2. Sedra and smith, "Microelectronic Circuits", Seventh Edition, Oxford University Press,2017.


**REFERENCES:**


1. Floyd, "Electron Devices" Pearson Education India, 9th Edition, 2015.
2. Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rdEdition, 2006.
3. Robert L.Boylestad, "Electronic Devices and Circuit theory", 11th Edition, PearsonEducation India , 2015.
4. Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits toBiomedical Instrumentation", 2nd Edition, CRC Press, 2017


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM3202 | MEDICAL BIOCHEMISTRY | 3 | 0 | 0 | 3 |

**Course Objective**

**The student should be conversant with**

1. To study the basic fundamentals of biochemistry
2. To study structural and functional properties of carbohydrates
3. To study structural and functional properties of lipids.
4. To study structural and functional properties of proteins, and nucleic acids
5. To emphasize the role of enzymes in human body.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **INTRODUCTION TO BIOCHEMISTRY**<br>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 | 9 |
| II | **CARBOHYDRATES**<br>Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates Isomerism, racemisation and mutarotation. Digestion and absorption of carbohydrates. Metabolic pathways and bioenergetics – Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle and electron transport chain. Oxidative phosphorylation. Biochemical aspect of Diabetes mellitus and Glycogen storage Disease. | 9 |
| III | **LIPIDS**<br>Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat..Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulationof fatty acid metabolism, ketogenesis, Biosynthesis of Cholesterol. Disorders of lipid metabolism | 9 |
| IV | **NUCLEIC ACID & PROTEIN**<br>Structure of purines and pyrimidines, nucleoside, nucleotide, DNA act as agenetic material, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Metabolism and Disorder of purines and pyrimidines nucleotide Classification, structure and properties of proteins, structural organization of proteins, classification and properties of amino acids. Separation of protein, Inborn Metabolic error of amino acid metabolism | 9 |
| V | **ENZYME AND ITS CLINICAL APPLICATION**<br>Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Kinetics of enzymes - Michaelis-Menten equation.Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Inhibitors of enzyme action: Competitive, non- competitive, irreversible | 9 |

**Total Instructional Hours** **45**

**Course Outcome**

After the completion of the course, the learner will be able to

CO1: Explain the fundamentals of biochemistry
CO2: Explain structural and functional properties of carbohydrates
CO3: Explain structural and functional properties of lipids.
CO4: Explain structural and functional properties of proteins, and nucleic acids
CO5: Discuss the role of enzymes in human body.

**TEXT BOOKS:**


1. RAFI MD —Text book of biochemistry for Medical Studentl Second Edition, University Press, 2014.
2. Victor. W.Rodwell, David A Bender et al —Harper's Illustrated Biochemistry, 31st edition, LANGEMedical Publications,2018.


**REFERENCES:**


1. Keith Wilson & John Walker, —Practical Biochemistry - Principles & Techniquesl, Seventn Edition,Oxford University Press, 2010.
2. Pamela.C.Champe & Richard.A.Harvey, —Lippincott Biochemistry Lippincott's Illustrated Reviews,Raven publishers,1994


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM3203 | HUMAN ANATOMY ANDPHYSIOLOGY | 3 | 0 | 0 | 3 |

**Course Objective**

1 To identify all the organelles of an animal cell and their function.
2: To understand structure and functions of the skeletal, muscular and respiratorysystems.
3: To understand structure and functions of the cardiovascular and lymphaticsystems.
4: To understand structure and functions nervous and endocrine systems.
5: To understand structure and functions of the digestive and urinary systems.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **CELL AND TISSUE STRUCTURE**<br>Structure of Cell – structure and functions of sub organelles – Cell Membrane – Transport of Across Cell Membrane - Action Potential – Cell to Cell Signaling – Cell Division. Types of Specialized tissues– Functions | 9 |
| II | **SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS**<br>**Skeletal:**:Types of Bone and function – Physiology of Bone formation – Division of Skeleton – Types of joints and function – Types of cartilage and function. **Muscular:** Parts of Muscle – Movements. **Respiratory:** Parts of Respiratory Systems – Types of respiration - Mechanisms of Breathing – Regulation of Respiration | 9 |
| III | **CARDIOVASCULAR AND LYMPHATIC SYSTEMS**<br>**Cardiovascular:** Components of Blood and functions.- Blood Groups and importance – Structure of Heart – Conducting System of Heart – Properties of Cardiac Muscle - Cardiac Cycle - Heart Beat – Types of Blood vessel – Regulation of Heart rate and Blood pressure. **Lymphatic:** Parts and Functions of Lymphatic systems – Types of Lymphatic organs and vessels | 9 |
| IV | **NERVOUS AND ENDOCRINE SYSTEMS AND SENSE ORGANS**<br>**Nervous:** Cells of Nervous systems – Types of Neuron and Synapses – Mechanisms of Nerve impulse – Brain : Parts of Brain – Spinal Cord – Tract and Pathways of Spines – Reflex Mechanism – Classification of Nerves - Autonomic Nervous systems and its functions. **Endocrine - Pituitary** and thyroid gland,<br>Sense Organs: Eye and Ear | 9 |

| | | |
|---|---|---|
| | **DIGESTIVE AND URINARY SYSTEMS** | |
| V | Digestive: Organs of Digestive system – Digestion and Absorption. Urinary: Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulationof Blood pressure by Urinary System – Urinary reflex | 9 |
| **Total Instructional Hours** | | **45** |

**Course Outcome**

CO1: Explain the basic structure and functions of cell
CO2: Learn about the structure and functions of the skeletal, muscular and respiratorysystems
CO3: Understand about the cardiovascular and lymphatic systems
CO4: Learn about the nervous and endocrine systems.
CO5: Explain about the structure and functions of the digestive and urinary systemsurinary systems

**TEXT BOOKS:**

1. Prabhjot Kaur. Text Book of Anatomy and Physiology. Lotus Publsihers. 2014

2. Elaine.N. Marieb , —Essential of Human Anatomy and Physiology‖, Ninth Edition,Pearson Education, New Delhi, 2016.

**REFERENCES:**

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomyand Physiology. Eleventh edition, Pearson Publishers, 2017

2. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2013

3. William F.Ganong, —Review of Medical Physiology‖, 22nd Edition, Mc Graw Hill,New Delhi, 2010

4. Eldra Pearl Solomon, —Introduction to Human Anatomy and Physiology‖, W.B. Saunders Company, 2015

5. Guyton & Hall, —Medical Physiology‖, 13th Edition, Elsevier Saunders, 2015

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| Programme | CourseCode | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM3251 | DIGITAL ELECTRONICS | 2 | 0 | 2 | 3 |

**Course Objective**

1. To understand different methods used for the simplification of Boolean functions.
2. To study combinational circuits.
3. To learn synchronous sequential circuits.
4. To understand asynchronous sequential circuits.
5. To study the fundamentals of HDL.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **MINIMIZATION TECHNIQUES**<br>Number systems: Decimal, Binary, Octal, Hexadecimal-Number-Base conversion-Complements of Numbers: 1's and 2's complements- Boolean algebra and laws-De-Morgan's Theorem-Principle of Duality-Minimization of Boolean expressions – Minterm – Maxterm – Sum of Products (SOP) – Product of Sums (POS) – Karnaugh map Minimization– Don't care conditions (2variable,3variable&4-variable)-Tabulation method. | 6 |
| II | **COMBINATIONAL CIRCUITS**<br>Circuits for arithmetic operations: adder: Half adder, Full adder, subtractor: Half subtractor, Fullsubtractor-BCD adder-Magnitude comparator-Encoders, Decoders-Multiplexers, **Demultiplexers, Code converters: Binary to Gray, Gray to Binary**<br>**1. Experimental Design and implementation of Half Adder & Half Subtractor.**<br>**2. Experimental Design and implementation of Binary to Gray and Gray to Binary Conversion.**<br>**3. Experimental Design and implementation of Multiplexers and Demultiplexers** | 9+6(P) |
| III | **SYNCHRONOUS SEQUENTIAL CIRCUITS**<br>Flip flops:SR,JK,D,T - Design of synchronous sequential circuits: State diagram - State table – State minimization - State assignment. Shift registers:SISO,SIPO,PIPO,PISO – Counters:BCD,Up down counter.<br>**Experimental Design and implementation of Synchronous and Asynchronous Counters** | 6+3(P) |
| IV | **ASYNCHRONOUS SEQUENTIAL CIRCUITS**<br>Analysis and design of asynchronous sequential circuits-Reduction of state and flow tables–Race-free state assignment–Hazards. | 6 |
| V | **MEMORY DEVICES AND HDL**<br>ROM-PROM-EPROM-EEPROM-RAM-FPGA-Programmable Logic Device-Introduction to Hardware Description Language (HDL)- HDL for combinational circuits- Half adder, Full adder, Multiplexer, De-multiplexer, Counters<br>1.Coding Combinational/Sequential circuits using HDL | 6+3(P) |
| | **Total Instructional Hours** | **45** |

| | |
|---|---|
| **Course Outcome** | CO1: Simplify Boolean functions using different methods.<br>CO2: Analyze, design and implement combinational logic circuits.<br>CO3: Analyze, design and implement Synchronous sequential logiccircuits.<br>CO4: Analyze, design and implement Asynchronous sequential logiccircuits<br>CO5: Simulate and implement combinational and sequential circuits usingHDL. |

**TEXT BOOKS:**

T1 - Morris Mano M. and Michael D. Ciletti, "Digital Design with an Introduction to theVerilog HDL", V Edition, Pearson Education, 2013.ISBN-13: 978-0-13-277420-8

**REFERENCE BOOKS :**

R1-.S. Salivahanan and S. Arivazhagan, "Digital Circuits and Design",FourthEdition, VikasPublishing House Pvt. Ltd, New Delhi, 2012.ISBN: 978-93-259-6041-1

R2-.Thomas L. Floyd, "Digital Fundamentals", Pearson Education, Inc, New Delhi, 2013 ISBN:978-1-292-07598-3.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM3001 | ELECTRON DEVICES AND CIRCUITS LAB | 0 | 0 | 3 | 1.5 |

**Course Objective**

1. To learn the characteristics of PN junction diode.
2. To understand the characteristics of Zener diode.
3. To learn the characteristics of Transistors and frequency response of amplifiers.
4. To learn the basic laws and network reduction theorems.
5. To learn the working of oscillators.

| S.No | Description of the Experiments |
|---|---|
| 1 | PN Junction Diode Characteristics |
| 2 | Zener Diode Characteristics |
| 3 | Common Emitter transistor, Input-Output Characteristics |
| 4 | JFET Characteristics |
| 5 | Frequency Response analysis of CE amplifier |
| 6 | RC Phase shift oscillator |
| 7 | Verification Of Thevenin's and Norton's Theorem |
| 8 | Verification of KVL & KCL |
| 9 | Verification of Super Position Theorem |
| 10 | Verification of Maximum Power Transfer |
| | **Total Instructional Hours** 45 |

**Course Outcome**

- To understand the characteristics of PN junction diode, Zener diode and transistors.
- To understand the concept of amplifiers and Oscillators.
- Apply the concept of basic laws and network reduction theorems.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM3002 | BIOCHEMISTRY LABORATORY | 0 | 0 | 3 | 1.5 |

**Description of Experiments**

1. General guidelines for working and functional component of biochemistry lab.
2. Units of volume, weight, density and concentration measurements ad their range in biological.measurements. Demonstration of proper use of volume and weight measurement devices.
3. Preparation of buffer-titration of a weak acid and a weak base.
4. Qualitative tests for carbohydrates-distinguishing reducing from non-reducing sugras andketo from aldo sugars.
5. Spectroscopy: Determination of absorption maxima (λmax) of a given solution
6. Estimation of blood glucose.
7. Estimation of Haemoglobin.
8. Estimation of creatinine.
9. Estimation of urea.
10. Estimation of cholesterol.
11. Preparation of serum and plasma from blood.
12. Separation of proteins by SDS electrophoresis(Demo)
13. Separation of amino acids by thin layer chromatography (Demo).

**Course Outcome**

CO1: Understand the Biochemistry laboratory functional components
CO2: Understand the basics knowledge of Biochemical parameter andtheir interpretation in Blood sample.
CO3: Understand the basics principle of preparation of buffers

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19MC3191 | INDIAN CONSTITUTION | 2 | 0 | 0 | 0 |

**COURSE OBJECTIVES**

1. Sensitization of student towards self, family (relationship), society and nature.
2. Understanding (or developing clarity) of nature, society and larger systems, on the basisof human relationships and resolved individuals.
3. Strengthening of self reflection.
4. Development of commitment and courage to act.

| Unit | Description | Instructional Hours |
|---|---|---|
| **UNIT I : BASIC FEATURES AND FUNDAMENTALE PRINCIPLES** | | 4 |
| | Meaning of the constitution law and constitutionalism – Historical perspective of the constitution of India – salient features and characteristics of the constitution of India. | |
| **UNIT II : FUNDAMENTAL RIGHTS** | | 4 |
| | Scheme of the fundamental rights – fundamental duties and its legislative status – The directive principles of state policy – its importance and implementation - Federal structure and distribution of legislative and financial powers between the union and states. | |
| **UNIT III : PARLIAMENTARY FORM OF GOVERNMENT** | | 4 |
| | The constitution powers and the status of the president in India. – Amendement of the constitutional powers and procedures – The historical perspective of the constitutional amendment of India – Emergency provisions : National emergency, President rule, Financial emergency. | |
| **UNIT IV: LOCAL GOVERNANCE** | | 4 |
| | Local self government -constitutional scheme of India – Scheme of fundamental right to equality – scheme of fundamental right to certain freedom under article19 – scope of the right tolife and personal liberty under article 21. | |
| **UNIT V : INDIAN SOCIETY** | | 4 |
| | Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections. | |
| | **Total instructional hours : 20** | |

**COURSE OUTCOMES:**

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

1. Understand the functions of the Indian government
2. Understand and abide the rules of the Indian constitution.

**TEXT BOOKS:**

T1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, NewDelhi.

T2. R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi. T3. Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi. T4. K.L.Sharma, (1997) "Social Stratification in India: Issues and Themes", Jawaharlal

Nehru University, New Delhi.

**REFERENCE BOOKS:**

R1. Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.

R2. U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.R3. R.N.

Sharma, "Indian Social Problems ", Media Promoters and Publishers Pvt. Ltd

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SEMESTER IV

| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19MA4152 | STATISTICS & NUMERICAL METHODS | 3 | 0 | 2 | 4 |

**Course Objective**

1. Illustrate the relation between two random variables by using correlation conceptsalong with R studio
2. Employ some basic concepts of statistical methods for testing the hypothesistogether with R studio.
3. Analyze the design of experiment techniques to solve various engineering problemsaccompanying with R studio
4. Apply various methods to find the intermediate values for the given data
5. Explain concepts of numerical differentiation and numerical integration of theunknown functions.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **CORRELATION AND REGRESSION**<br>Correlation – Karl Pearson's correlation coefficient – Spearman's RankCorrelation – Regression lines (problems based on Raw data only).<br>**Introduction to R programming, Applications of Correlation andRegression** | 9+3 |
| II | **HYPOTHESIS TESTING**<br>Tests based on t (for single mean and difference of means) - F distribution –for testing difference of variance, Chi – Square test for Contingency table (Test for Independency) – Goodness of fit<br>**Application of F test, Application of Chi – square test** | 9+6 |
| III | **ANALYSIS OF VARIANCE**<br>Introduction, analysis of variance, completely randomized design, randomized block design, Latin square design. **ANOVA – completely randomized designANOVA – randomized block design** | 9+6 |
| IV | **INTERPOLATION**<br>Interpolation: Newton's forward and backward difference formulae Lagrangian interpolation for unequal intervals – Divided differences- Newton's divideddifference formula. | 9 |
| V | **NUMERICAL DIFFERENTIATION AND INTEGRATION**<br>Differentiation using interpolation formula – Newton's forward and backward interpolation formulae for equal intervals – Newton's divided difference formula for unequal intervals - Numerical integration by Trapezoidal andSimpson's 1/3 rules. | 9 |

**Total Instructional Hours : 45+15=60**

**Course Outcome**

CO1: Compute correlation and predict unknown values using regression together with Rstudio.
CO2: Understand the concepts of statistical methods for testing the hypothesisalong with R studio.
CO3: Apply Design of Experiment techniques to solve various engineering problems inaddition with R studio.
CO4: Understand the concept of interpolation in both cases of equal and unequalintervals.
CO5: Identify various methods to perform numerical differentiation and integration.

**TEXT BOOKS:**


T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India PrivateLtd., New Delhi, 2018.

T2 - Medhi J," stochastic Processes", New Age International Publishers,New Delhi,2014


**REFERENCE BOOKS :**


R1 - Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics forEngineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.

R2 - Grewal B.S. and Grewal J.S. "Numerical Methods in Engineering and Science ", 6thEdition , Khanna publishers, New Delhi 2004.

R3 - S.K.Gupta, Numerical Methods for Engineers", New Age International Pvt.LtdPublishers,2015.


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM4201 | LINEAR INTEGRATED CIRCUITS | 3 | 1 | 0 | 4 |

**Course Objective**

CO1. To introduce the basic concepts of OPAMP.
CO2. To impart knowledge on various applications of OPAMP.
CO3. To understand the working of comparators and waveform generators.
CO4. To learn the design concepts of ADC and DAC.
CO5. To understand the working of PLL and voltage regulators.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **BASICS OF OPERATIONAL AMPLIFIERS**<br>Basic information about op-amps – Ideal Operational Amplifier - General operational amplifier stages ,DC and AC performance characteristics, slew rate, Open and closed loop configurations. | 12 |
| II | **APPLICATIONS OF OPERATIONAL AMPLIFIERS**<br>Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.. | 12 |
| III | **COMPARATORS AND WAVEFORM GENERATORS**<br>Comparators, Schmitt trigger, Sine-wave generators, Multivibrators , Triangular wave generator, Saw-tooth wave generator, Frequency to Voltage and Voltage to Frequency converters. | 12 |
| IV | **ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS**<br>Analog and Digital Data Conversions, D/A converter – specifications - weightedresistor type, R-2R Ladder type, Voltage Mode and Current-Mode -R - 2R Ladder types -switches for D/A converters, high speed sample and hold circuits,A/D Converters –specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type . | 12 |
| V | **SPECIALISED ICs AND APPLICATIONS**<br>IC regulators - 723 (block diagram, typical low voltage regulator circuit), 78XX, 79XX, 317 - applications. Timers - 555 – Functional block diagram- Astable and monostable multivibrators using 555 - applications. VCO – 566. PLL - Block diagram and derivation of capture range, lock range and pull in time capture and lock range - 565 – applications. | 12 |

**Total Instructional Hours:60**

| | |
|---|---|
| **Course Outcome** | CO1. To analyse the characteristics of opamp.<br>CO2. To design various applications of opamp.<br>CO3. To design various wave generating and shaping circuits.<br>CO4. To select ADC and DAC for various applications.<br>CO5. To design PLL and voltage regulators. |

**TEXT BOOKS:**

T1 - D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", 4th Edition ,New AgeInternational Pvt. Ltd., 2010.

T2 - Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Pearson Education,2015 .

**REFERENCE BOOKS** :

R1 - S.Salivahanan & V.S. Kanchana Bhaskaran, "Linear Integrated Circuits", 2nd edition McGrawHill, 2014.

R2 - Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rdEdition, Tata Mc Graw-Hill, 2007

R3 - Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear IntegratedCircuits", Sixth Edition, 2001

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM4202 | BioMEMS AND NANOTECHNOLOGY | 3 | 1 | 0 | 4 |

Course Objectives

1. Learn about MEMS and Nanotechnology.
2. Learn various MEMS and Nanotechnology fabrication techniques.
3. Understand different types of sensors and actuators and their principles of operation.
4. Learn about Microfluidic systems.
5. Know the application of MEMS and Nanotechnology in different field of medicine.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **INTRODUCTION TO MEMS & NANOTECHNOLOGY** | 9 |

Introduction to BioMEMS and Nanotechnology, Development of MEMS technology- Comparison of microsystems and microelectronics - Materials for MEMS-Smart Materials and Structures- Applications of MEMS

**II MICRO AND NANOFABRICATION TECHNIQUES** 9

Nanotechnology, Bottom up and top down methods of synthesis- Self-assembly- lithography techniques, etching - Ion implantation, surface micromachining- LIGA process-CVD technique

**III MEMS SENSORS AND ACTUATORS** 9

Sensing and Actuation- Piezoresistive and Capacitive sensing -Electrostatic actuation -Pressuresensors - Accelerometers, Gyroscopes- Interfacing with Sensors and Actuators-Nano pore sensors-magnetic sensors, Thermal sensors and actuators

**IV MICRO-OPTO ELECTROMECHANICAL SYSTEMS & MICROFLUIDICS** 9

Fundamental principle of MOEMS Technology - Light Modulators, Beam splitter , Micro-lens, Micro-mirrors - Digital Micro-mirror Device, Light detectors - Important Consideration on Micro-scale fluid, Properties of fluid - Fluid Actuation Methods ,

Micro-pumps - Typical Micro-fluidic Channel, Micro-fluid Dispenser

**V APPLICATIONS OF MEMS AND NANOTECHNOLOGY IN MEDICINE** 9

Biochip-Micro Total Analysis Systems detection and measurement methods-DNA sensor-Drug delivery system, Ampero-metric Biosensor - Multi-analyte measurement, Micro-dialysis - Monitoring of Glucose & Lactate with a micro-dialysis probe , Ammonia Monitoring - Electronic Nose, Biomolecular sensing for cancer diagnostics using carbon nanotubes, Carbon nanotube biosensors, Magnetic nanoparticles for MR Imaging, Nano-devices in biomedical applications

**TotalInstructional Hours** 45

**Course Outcomes:**

CO1 : Understand the fundamentals of micro and nanotechnology

CO2 : Explain fabrication techniques of micro and nanotechnology

CO3 : Learn about different types of MEMS sensor and actuators

CO4 : Discuss about the Micro-Opto Electromechanical Systems & Micro fluidics

CO5 : Describe the recent applications of MEMS and Nanotechnology in Medicine

**TEXT BOOKS:**


T1. Tai Ran Hsu, —MEMS and Microsystems Design and Manufacture‖, Tata McGraw HillPublishing Company, New Delhi, 2002. (Unit I, II, III & IV).

T2. Wanjun Wang, Stephen A.Soper, ‖BioMEMS: Technologies and Applications‖, CRC Press,New York, 2007.(Unit V).


**REFERENCES:**


R1. Marc J. Madou —Fundamentals of Microfabrication: the Science of Miniaturization‖,CRC Press,2002.

R2. Nadim Maluf, Kirt Williams. —An introduction to Microelectro Mechancial SystemsEngineering‖, Second Edition, Artech House Inc, MA, 2004.

R3. Chang Liu,' Foundations of MEMS', Pearson Education International, New Jersey,USA,2006

R4. Nitaigour Premchand Mahalik, —MEMS‖, Tata McGraw Hill Publishing Company, NewDelhi, 2007


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM4203 | PATHOLOGY AND MICROBIOLOGY | 3 | 0 | 0 | 3 |

**Course Objective**

1. Gain a knowledge on the structural and functional aspects of living organisms.
2. Know the etiology and remedy in treating the pathological diseases.
3. To study the structure of disease causing organisms.
4. To study about the working of microscope.
5. Empower the importance of public health.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **CELL DEGENERATION, REPAIR AND NEOPLASIA**<br>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. | 9 |
| II | **FLUID AND HEMODYNAMIC DERANGEMENTS**<br>Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, Chronic venous congestion. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas Haemorrhage. . | 9 |
| III | **MICROBIOLOGY**<br>Structure of Bacteria and Virus. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria and virus, growth curve, identification of bacteria , culture media and its types , culture techniques and observation of culture. Disease caused<br>by bacteria, fungi, protozoal, virus and helminthes | 9 |
| IV | **MICROSCOPES**<br>Light microscope – bright field, dark field, phase contrast, fluorescence, Electron microscope (TEM & SEM). Preparation of samples for electron microscope. Staining methods – simple, gram staining and AFB staining. | 9 |
| V | **IMMUNOPATHOLOGY**<br>Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonization, phagocytosis, inflammation, Secondary immunodeficiency including HIV infection. Auto-immune disorders: Basic concepts and classification, SLE.Antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies | 9 |
| | **Total Instructional Hours** | 45 |

**Course Outcome**

CO1: Analyze structural and functional aspects of living organisms.
CO2: Analyze the structure of disease causing organism.
CO3: Describe methods involved in treating the pathological diseases.
CO4: Explain the function of microscope
CO5: Discuss the importance of public health.

**TEXT BOOKS:**


1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, —Pathologic Basis of Diseases, 7thedition,WB Saunders Co. 2005 .
2. Ananthanarayanan & Panicker, —Microbiology| Orientblackswan, 2017 10th edition


**REFERENCES:**


1. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
2. Dubey RC and Maheswari DK. —A Text Book of Microbiology| Chand & Company Ltd,2007
3. Prescott, Harley and Klein, —Microbiology|, 10th edition, McGraw Hill, 2017


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM4251 | SENSORS AND MEASUREMENT | 2 | 0 | 2 | 3 |

**The student should be conversant with**

**Course Objective**

1. Understand the purpose of measurement, the methods of measurements, errors associated with measurements.
2. Know the principle of transduction, classifications and the characteristics of different transducers
3. Know the different bridges for measurement.
4. Know the different display and recording devices.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **SCIENCE OF MEASUREMENT**<br>Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis – Calibration - Primary and secondary standards. | 9 |
| II | **DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS**<br>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.<br>**Experiments:**<br>*1. Characteristics of various temperature sensors – RTD, Thermistor and Thermocouple*<br>*Displacement measurement using LVDT.* | 6+(3)P |
| III | **PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS**<br>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.<br>**Experiments:** *Characteristics of various light sensors – LDR, Photodiode and Phototransistor* | 6+(3)P |
| IV | **SIGNAL CONDITIONING CIRCUITS**<br>Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, Impedance matching circuits, AC and DC Bridges - wheat stone bridge, Kelvin, Maxwell, Hay, Schering **Experiments:**<br>*Measurement of resistance using DC bridges*<br>*Measurement of inductance using Maxwell bridge*<br>*Measurement of capacitance using Schering bridge* | 6+(3)P |

V **DISPLAY AND RECORDING DEVICES** 9

Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servorecorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermalrecorder.

**Total Instructional Hours** **45**

**Course Outcome**

After the completion of the course, the learner 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.

**TEXT BOOKS:**

1. A.K.Sawhney, —Electrical & Electronics Measurement and Instrumentation,10th edition,DhanpatRai& Co, New Delhi, 19th Revised edition 2011, Reprint 2014.
2. John G. Webster, —Medical Instrumentation Application and Design, 4th edition, WileyIndia Pvt Ltd,New Delhi, 2015.

**REFERENCES:**

1. Ernest O Doebelin and Dhanesh N Manik, Measurement systems, Application and design, 6thedition, McGraw-Hill, 2012.
2. Khandpur R.S, —Handbook of Biomedical Instrumentationl, 3rdedition,Tata McGraw-Hill,New Delhi, 2014.
3. Leslie Cromwell, —Biomedical Instrumentation and measurementl, 2nd edition, Prentice hallof India, New Delhi, 2015.
4. Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation andMeasurement Techniquesl, Prentice Hall of India, 1stedition, 2016.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19MC4191 | VALUE EDUCATION-ESSENCE OF INDIAN TRADITIONAL KNOWLEDEGE | 2 | 0 | 0 | 0 |

**Course Objectives:**

1) The course aims at imparting basic principles of thought process, reasoning and inferencing.
2) Sustainability is at the core of Indian Traditional Knowledge Systems connecting societyand nature.
3) Holistic life style of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions.
4) The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific world-view, basic principles of Yoga and holistic health care system, Indian philosophical traditions,Indian linguistic tradition and Indian artistic tradition.

| UNIT | DESCRIPTION | INSTRUCTIONAL HOURS |
|---|---|---|
| UNIT I : | Basic Structure of Indian Knowledge System | 4 |
| UNIT II : | Modern Science and Indian Knowledge System | 4 |
| UNIT III : | Yoga and Holistic Health care | 4 |
| UNIT IV : | Philosophical tradition | 4 |
| UNIT V: | Indian linguistic tradition (Phonology, Morphology, Syntax and semantics),Indian artistic tradition and Case Studies. | 4 |

**TOTAL INSTRUCTIONAL HOURS : 20**

**Course Outcomes:**

1) Ability to understand the structure of Indian system of life.
2) Connect up and explain basics of Indian Traditional knowledge in modern scientificperspective.

**REFERENCE BOOKS:**


R1. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya VidyaBhavan, Mumbai, 5th Edition, 2014

R2. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya BhavanR3. Fritzof Capra, Tao of Physics

R4. Fritzof Capra, The wave of Life.

R5. V N Jha ( Eng. Trans.), Tarkasangraha of Annam Bhatta, Inernational Chinmay Foundation,Velliarnad, Amaku,am

R6. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta.

R7. GN Jha ( Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, VidyanidhiPrakasham, Delhi,2016.

R8. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, VidyanidhiPrakasham, Delhi, 2016.

R9. P R Sharma ( English translation), Shodashang Hridayam.


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM4001 | INTEGRATED CIRCUITS LABORATORY | 0 | 0 | 3 | 1.5 |

**Description of the Experiments**

1 Design and Testing of Voltage Follower, Inverting & Non inverting amplifiers using741 op-amp.
2 Design and Testing of Active low-pass, High-pass and band-pass filters using 741opamp.
3 Design and Testing of Astable multivibrator , Monostable multivibrator and SchmittTrigger using 741 op-amp.
4 Design and Testing of Phase shift and Wien bridge oscillators using 741 op-amp.
5 Design and Testing of Astable and Monostable multivibrators using NE555 Timer.
6 Design Function Generator using ICL8038.
7 Simulate Integrator and Differentiator using SPICE.
8 Simulate Astable & Monostable multivibrators with NE555 Timer using SPICE.
9 Simulate Phase shift and Wien bridge oscillators with op-amp using SPICE.
10 Simulate D/A and A/D converters using SPICE.

**Total Practical Hours: 45**

**Course Outcome**

CO1: Design oscillators using operational amplifiers.
CO2: Design amplifiers using operational amplifiers.
CO3: Design filters using Op-amp and plot frequency response.
CO4: Analyse the performance of oscillators using SPICE.
CO5: Analyse the performance of multivibrators using SPICE

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 19BM4002 | HUMAN PHYSIOLOGY LABORATORY | 0 | 0 | 3 | 1.5 |

**Description of Experiments**

i. Study of parts of compound microscope
ii. Peripheral smear study
iii. Estimation of RBC count.
iv. Estimation of WBC count.
v. Estimation of ESR.
vi. Hemoglobin estimation.
vii. Blood grouping.
viii. Bleeding time/ clotting time.
ix. Hearing test using Audiometer.
x. Respiratory parameter measurement.
xi. Manual paraffin tissue processing and section cutting (demonstration)
xii. Cryo processing of tissue and cryosectioning (demonstration)

**Total Practical Hours: 45**

**REFERENCES:**

1. Ghai C L, —Textbook of Practical Physiology, Eight edition, Jaypee Brothers, MedicalPublisher's Pvt. Ltd., New York, 2013.
2. Stuart Ira Fox, —Laboratory Guide to Human Physiology, Tata McGraw Hill, 2002.
3. Richard G P Flanzer, —Experimental and Applied Physiology Laboratory Manual, TataMcGraw Hill, Columbus, 2005.

**Course Outcome**
CO1: Identification and enumeration of blood cells
CO2: Enumeration of haematological parameters

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## SEMESTER V

| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5201 | BIOCONTROL SYSTEMS | 3 | 1 | 0 | 4 |

**Course Objectives**

1. To understand the concept behind feedback and continuum in various systems and subsystems.
2. To analyse the systems in time and frequency domain and to understand the concept of stability
3. To apply mathematical modelling principles in understanding the various fundamental biological systems
4. To understand biological system models
5. To analyse biological control systems.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **INTRODUCTION**<br>Open and Closed loop Systems, Block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph. | 12 |
| II | **TIME RESPONSE ANALYSIS**<br>Standard test signals, time response of first order and second order systems, time domain specifications, steady State errors. | 12 |
| III | **FREQUENCY RESPONSE ANALYSIS**<br>Determination of closed loop response from open loop response, Bode plot, Nichol's chart, Polar plot. | 12 |
| IV | **STABILITY ANALYSIS**<br>Characteristic equation, Location of roots in s-plane for stability, Routh Hurwitz criterion, Root locus techniques -Construction, Gain margin and phase margin, Nyquist stability criterion. | 12 |
| V | **PHYSIOLOGICAL CONTROL SYSTEM ANALYSIS**<br>Difference between engineering and physiological control system- Model development of Cardiovascular system- Heart model-circulatory model - Simple models of muscle stretch reflex action- Stability analysis of Pupillary light reflex - Regulation of cardiac output, Regulation of ventilation. | 12 |
| **Total Instructional Hours** | | **60** |

**Course Outcomes**

CO1: Understand 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: Analyze the time response of various systems and discuss the concept of system stability

CO3: Analyze the frequency response characteristics of various systems using different

charts

CO4: Understand the concept of modeling basic physiological systems

CO5: Comprehend the application aspects of time and frequency response analysis in physiological control systems.

**TEXT BOOKS:**

T1.I.J.Nagarath and M. Gopal —Control Systems Engineering", Fifth Edition, Anshan Publishers, 2008.(UNIT

T2. Michael C K Khoo, —Physiological Control Systemsl, IEEE Press, Prentice Hall of India, 2005

**REFERENCES:**

R1. Benjamin C. Kuo, —Automatic Control Systemsl, Prentice Hall of India, 1995.

R2. John Enderle Susan Blanchard, Joseph Bronzino —Introduction to Biomedical Engineeringl, second edition, Academic Press, 2005.

R3. Richard C. Dorf, Robert H. Bishop, —Modern control systemsl, Pearson, 2004.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5202 | BIOMEMS AND NANOTECHNOLOGY | 3 | 0 | 0 | 3 |

**Course Objectives**

1. Learn about MEMS and Nanotechnology.
2. Learn various MEMS and Nanotechnology fabrication techniques.
3. Understand different types of sensors and actuators and their principles of operation.
4. Learn about Microfluidic systems.
5. Know the application of MEMS and Nanotechnology in different field of medicine.

| Unit | Description | Instructional Hours |
|---|---|---|

**I INTRODUCTION TO MEMS & NANOTECHNOLOGY** 9

Introduction to BioMEMS and Nanotechnology, Development of MEMS technology- Comparison of microsystems and microelectronics - Materials for MEMS-Smart Materials and Structures-Applications of MEMS

**II MICRO AND NANOFABRICATION TECHNIQUES** 9

Nanotechnology, Bottom up and top down methods of synthesis- Self-assembly- lithography techniques, etching - Ion implantation, surface micromachining- LIGA process-CVD technique

**III MEMS SENSORS AND ACTUATORS** 9

Sensing and Actuation- Piezoresistive and Capacitive sensing -Electrostatic actuation -Pressure sensors -Accelerometers, Gyroscopes- Interfacing with Sensors and Actuators-Nanoporesensors-magnetic sensors,Thermal sensors and actuators

**IV MICRO-OPTO ELECTROMECHANICAL SYSTEMS & MICROFLUIDICS** 9

Fundamental principle of MOEMS Technology - Light Modulators, Beam splitter , Micro-lens, Micro-mirrors - Digital Micro-mirror Device, Light detectors - Important Consideration on Micro-scale fluid, Properties of fluid - Fluid Actuation Methods , Micro-pumps - Typical Micro-fluidic Channel, Micro-fluid Dispenser

**V APPLICATIONS OF MEMS AND NANOTECHNOLOGY IN MEDICINE** 9

Biochip-Micro Total Analysis Systems detection and measurement methods-DNA sensor-Drug delivery system, Ampero-metric Biosensor - Multi-analyte measurement, Micro-dialysis - Monitoring of

Glucose & Lactate with a micro-dialysis probe , Ammonia Monitoring - Electronic Nose, Biomolecular sensing for cancer diagnostics using carbon nanotubes, Carbon nanotube biosensors, Magnetic nanoparticles for MR Imaging, Nano-devices in biomedical applications

**Total Instructional Hours 45**

**Course Outcome:**

CO1: Understand the fundamentals of micro and nanotechnology

CO2: Explain fabrication techniques of micro and nanotechnology

CO3: Learn about different types of MEMS sensor and actuators

CO4: Discuss about the Micro-Opto Electromechanical Systems & Micro fluidics

CO5: Describe the recent applications of MEMS and Nanotechnology in Medicine

**TEXT BOOKS:**

T1. Tai Ran Hsu, —MEMS and Microsystems Design and Manufacture‖, Tata McGraw Hill Publishing Company, New Delhi, 2002. (Unit I, II, III & IV).

T2. Wanjun Wang, Stephen A.Soper, ‖BioMEMS: Technologies and Applications‖, CRC Press, New York, 2007.(Unit V).

**REFERENCES:**

R1. Marc J. Madou —Fundamentals of Microfabrication: the Science of Miniaturization‖, CRC Press,2002.

R2. Nadim Maluf, Kirt Williams. —An introduction to Microelectro Mechancial Systems Engineering‖,Second Edition, Artech House Inc, MA, 2004.

R3. Chang Liu,' Foundations of MEMS', Pearson Education International, New Jersey, USA,2006

R4. Nitaigour Premchand Mahalik, —MEMS‖, Tata McGraw Hill Publishing Company, New Delhi, 2007

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5203 | HOSPITAL ENGINEERING | 3 | 0 | 0 | 3 |

**Course Objective**

1. Identify various areas of hospitals and Discuss about effective hospital management.
2. Develop knowledge of hospital building maintenance, equipment and systems for health care.
3. Develop knowledge regarding plant operations, clinical engineering, biomedical engineering, safety technology and hospital information system.
4. Maintain various medical records and information management system.
5. Students shall be well trained to solve the rising challenges and specific necessities of modern day hospitals.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **Introduction to hospital engineering**<br>Distinction between hospital and industry , history of engineering and technology in health care-staff structure in hospitals- careers, roles and responsibilities. Hospital planning-equipment planning-functional planning. | 9 |
| II | **CLASSIFICATION OF HOSPITAL & ARCHITECTURE**<br>Overview of Health Care Sector in India – Primary care – Secondary care – Tertiary care – Rural Medical care – urban medical care – curative care – Preventive care – General & special Hospitals-Understanding the Hospital Management – Role of Medical, Nursing Staff, Paramedical and Supporting Staff - Health Policy - Population Policy - Drug Policy – Medical Education Policy | 9 |
| III | **ENGINEERING SERVICES OF HOSPITAL**<br>Biomedical engineer's role in hospital, Maintenance department, MRO, Clinical engineering preventive maintenance of equipment, Electrical system, Power supply system, Electrical safety, Centralized gas supply system, Air conditioning system, Hospital waste management system, Fire safety and threat alarm system. | 9 |
| IV | **HOSPITAL MANAGEMENT AND INFORMATION SYSTEM**<br>Role of HMIS, Functional areas, Modules forming HMIS, HMIS and Internet, Centralized data record system, computerized patient record system, Health information system. | 9 |
| V | **QUALITY AND SAFETY ASPECTS IN HOSPITAL**<br>FDA regulation, ISO certification– Environment Management Systems. NABA, JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance and Managing Health Care – Medical Audit. | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: Develop an understanding of criteria regarding assessment, management, administration and regulation of healthcare technology.

CO2: Improve the clinical effectiveness, efficiency and safety of technology use, considering the importance and impact of various services on patient care.
CO3: To gain knowledge about the role of a biomedical engineer in hospitals and various services at large.
CO4: To understand about the various hospital management and information systems in hospitals
CO5: Students shall be well trained to solve the rising challenges and specific necessities of modern day hospitals.

**TEXT BOOKS:**


1. R.C. Goyal, Handbook of Hospital Personal Management, Prentice Hall of India, 2003
2. Hans Pfeiff, Vera Dammann (Ed.), Hospital Engineering in Developing Countries, Z report Eschbom, 2006


**REFERENCE BOOKS:**


1. Cesar A. Caceres and Albert Zara, The practice of clinical engineering, Academic Press, 1977.
2. Webster, J. G and Albert M. Cook, Clinical Engineering Principles and Practices, Prentice Hall Inc. Englewood Cliffs, 1979 .
3. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press, San Diego 1988 .
4. Richard L Miller , Earl S Swensson , J. Todd Robinson by "Hospital and Healthcare Facility Design" ,Third Edition, 2011


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5204 | BIOMEDICAL INSTRUMENTATION | 3 | 0 | 0 | 3 |

**Course Objective**

1. To Illustrate about the measurement systems.
2. To design bio amplifier for various physiological recordings
3. Detection of physiological parameters using impedance techniques
4. To learn the different measurement techniques for non-physiological parameters
5. To Summarize different patient safety procedures.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **MEASUREMENT SYSTEMS**<br>Specifications of instruments- static & dynamic characteristics- classification of errors-statistical analysis- Introduction to reliability- accuracy-fidelity-speed of response-linearization of technique-data acquisition system. | 9 |
| II | **BIOELECTRIC AMPLIFIERS**<br>Special features of bioelectric amplifiers- safety requirements-realization of bioelectric amplifiers- carrier amplifiers- chopper amplifiers- phase sensitive detector- isolation amplifiers- and instrumentation amplifiers. | 9 |
| III | **DETECTION OF PHYSIOLOGICAL PARAMETERS USING IMPEDANCE TECHNIQUES**<br>Impedance and current distribution- bipolar and tetra polar circuits- skin impedance-galvanic skin response measurement- total body impedance-cardiac output- neural activity- respiratory activity- impedance plethysmography - resistance and capacitance type. | 9 |
| IV | **MEASUREMENT OF NON-ELECTRICAL PARAMETER**<br>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 measurement. | 9 |
| V | **PATIENT SAFETY AND ELECTROMEDICAL EQUIPMENT**<br>Physiological effects of electrical currents- macroshock and microshock-preventive measures to reduce shock hazards- Leakage current- isolation of patient circuits- safety of electrically susceptible patients-radiation hazards and safety-shielding- open ground problem and earthing methods. | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: To understand the various concepts of measurement systems.
CO2: To understand the method of of designing bioamplifiers.
CO3: To understand about the Detection of physiological parameters using impedance techniques.
CO4: To understand about measurement of non electric parameter.

CO5: To understand about Patient safety and electromedical equipment.

**TEXT BOOKS:**

T1 - Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology",Pearson Education India, Delhi, 2004

T2 - . Cromwell, "Biomedical Instrumentation and Measurements", Prentice Hall of India, New Delhi, 2007

**REFERENCE BOOKS:**

R1-Khandpur. R. S., "Handbook of Biomedical Instrumentation", Prentice Hall of India, New Delhi, 2003.

R2 - Jacobson B and Webster J G Medical and Clinical Engineering – Prentice Hall of India New

R3- John. G. Webster. "Medical Instrumentation, Application and Design"Fourth Edition. Wiley & sons, Inc, New York.2011.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5205 | MICROPROCESSOR AND MICROCONTROLLERS | 3 | 0 | 0 | 3 |

**Course Objective**

1. Demonstrate the Architecture of 8086 microprocessor.
2. Interpret the system bus structure and Multi processor configuration of 8086 microprocessor.
3. Apply the design aspects of I/O and Memory Interfacing circuits.
4. Examine the Architecture of 8051 microcontroller
5. Practice the design aspect of interfacing circuits with 8051 microcontroller

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **8086 MICROPROCESSOR**<br>Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines. | 9 |
| II | **8086 SYSTEM BUS STRUCTURE AND MULTIPROCESSOR CONFIGURATIONS**<br>Basic 8086 configurations – System bus timing –Bus Standards – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors. | 9 |
| III | **PERIPHERAL DEVICES AND THEIR INTERFACING**<br>Address space portioning-Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface -D/A and A/D Interface - Timer - Keyboard /display controller – Interrupt controller – DMA controller | 9 |
| IV | **8051 MICROCONTROLLER**<br>Over view of 8051 family-Architecture of 8051 –I/O Pins Ports Circuits and I/O Port Programming - Instruction set - Addressing modes - Assembly language programming. | 9 |
| V | **8051 MICROCONTROLLER INTERFACING WITH PERIPHERAL DEVICE**<br>8051 Timers Programming - Serial Port Programming - Interrupts Programming – LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Interfacing with 8255- Stepper Motor Interfacing, Practical applications-Water level indicator and Zigbee interfacing. | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

**CO1:** Write Assembly Language programs using 8086 microprocessor.
**CO2:** Point out System Bus Structure and Multiprocessor Configuration.
**CO3:** Analyze the various peripheral devices interfacing with 8086 microprocessor.
**CO4:** Model and implement 8051 microcontroller based systems.
**CO5:** Experiment programs on 8051 microcontroller for interfacing various peripheral devices

**TEXT BOOKS:**


T1 Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design", Second Edition, Prentice Hall of India, 2007.

T2 Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education,2011


**REFERENCE BOOKS:**


R1 Doughlas V.Hall, "Microprocessors and Interfacing, Programming and Hardware,TMH,2012

R2 A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata McGrawHill, 2012

R3 N. Senthil Kumar, M. Saravanan, S. Jeevananthan, "Microprocessors and Microcontrollers" ,Oxford University Press,2000.

R4 B. Ram ," Micro processors and Micro controllers", 8th Edition, Dhanpat Rai Publications Pvt. Ltd., 2015.


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5001 | MICROPROCESSORS AND MICROCONTROLLERS LABORATORY | 0 | 0 | 4 | 2 |

**Description of the Experiments**

1. Simple arithmetic operations: addition / subtraction / multiplication / division.
2. Programming with control instructions:
   (i) Ascending / Descending order, Maximum / Minimum of numbers
   (ii) Programs using Rotate instructions
   (iii) Hex / ASCII / BCD code conversions.
3. Interface Experiments: with 8085
   (i) A/D Interfacing. & D/A Interfacing.
4. Traffic light controller.
5. I/O Port / Serial communication
6. Programming Practices with Simulators/Emulators/open source
7. Read a key, interface display
8. Demonstration of basic instructions with 8051 Micro controller execution, including:
   (i) Conditional jumps, looping (ii) Calling subroutines.
9. Programming I/O Port 8051
   (i) study on interface with A/D & D/A (ii) study on interface with DC & AC motor.
10. Mini project development with processors.

**Practical Hours: 45**

**Course Outcome**

CO1: understand the basic arithmetic operations in 8085

CO2: Ability to understand and analyze, about 8085 microprocessors

CO3: understanding of various interfacing techniques in microcontrollers

CO4: understand the basic arithmetic operations in 8051

CO5: Analyze and demonstrate a mini project using microcontroller.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5002 | BIOMEDICAL INSTRUMENTATION LABORATORY | 0 | 0 | 4 | 2 |

**Description of the Experiments**

1. To study the different types of electrodes.
2. To study the Electrocardiogram System.
3. Bed side monitor
4. Evoked Potential Monitoring System
   (With Auditory, Photic and Electric Stimulus)
5. Measurement of pulse-rate using Photo transducer.
6. Measurement of pH and conductivity.
7. Surgical diathermy
8. GSR Measurement setup with Software and Accessories
   (PC based) - Without PC Workstation
9. Ultrasound Doppler Blood Flow Monitor
10. To study Plethysmograph System.
11. To study Phonocardiograph System.
12. To study X-ray produced by X-ray machine.

**Practical Hours: 45**

**Course Outcome**

CO1: Identify various Bio-potential and their specifications in terms of amplitude and frequency.
CO2: Understand principle and working of various Biomedical Instruments for vital parameter monitoring
CO3: Decide the applications of therapeutic instruments for treatment purpose.
CO4: Understand applications of imaging instruments and the modalities involved in each technique.
CO5: Understand applications of imaging instruments and the modalities involved in each technique.

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## SEMESTER VI

| Unit | Description | | | | | Instructional Hours |
|---|---|---|---|---|---|---|
| Programme | Course Code | Name of the Course | L | T | P | C | |
| B.E. | 16BM6201 | BIOSIGNAL PROCESSING | 3 | 1 | 0 | 4 | |

**Course Objective**

1. To study about discrete time signals and its applications.
2. To understand the concept of filter designing in signal processing
3. To study about the various biomedical signals and artifact removal techniques.
4. To learn about power spectrum estimation.
5. To understand the basic concepts of wavelet transforms.

| | | |
|---|---|---|
| I | **INTRODUCTION TO DIGITAL SIGNAL PROCESSING:** Review of sampling and reconstruction, discrete-time signals & systems –correlation of discrete time signals DFT and its properties. FFT algorithms & its application to convolution, Overlap-add & overlap-save methods. Introduction to random process-definition, methods of description, stationarity, time averaging and ergodicity. | 9 |
| II | **FILTER DESIGN** Digital Processing of Continuous Time Signals, Analog Filter Design-Analog butterworth,Chebyshev LPF Design, Transformations -Analog frequency Transformation, Digital Filter Structures-IIR Realizations ,All Pass Realizations,IIR Filter Design- IIR Design by Bilinear Transformation, Digital to Digital Frequency Transformation, FIR Design-FIR Design by Windowing & Frequency Sampling. | 9 |
| III | **BIOMEDICAL SIGNALS & ARTIFACT REMOVAL:** Nature of biomedical signals, characteristics of various bio-signals: interference associated with each bio-signal, computer aided diagnosis. Time domain filtering: synchronous averaging, moving average filters, derivative based ,frequency domain filtering-FIR,IIR –notch,comb - optimal filtering - adaptive filtering using LMS algorithm-applications . | 9 |
| IV | **POWER SPECTRUM ESTIMATION AND EVENT DETECTON**: Introduction – Non parametric methods - The Periodogram – Modified Periodogram - Bartlett, Welch & Blackman - Tukey methods - Performance comparison. Event detection- ECG, correlation analysis of EEG channels, Homomorphic filtering. | 9 |
| V | **INTRODUCTION TO WAVELET TRANSFORM:** Wavelets Introduction- Continuous wavelet transform, wavelet time-frequency characteristics, Discrete wavelet transform and orthogonal wavelet decomposition, orthonormal wavelets, filter banks-Applications- wavelet de-noising, discontinuity detection, feature detection : wavelet packets ,wavelet compression. | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

| | |
|---|---|
| CO1 | Understand the concepts of discrete time signals and its properties |
| CO2 | Understand the steps involved in filter designing. |
| CO3 | Develop knowledge on biomedical signals and the various processes involved in removing artifacts from the signal. |
| CO4 | Understand the concepts of power spectrum estimation. |
| CO5 | Understand the concepts of wavelets and its application in signal processing. |

**TEXT BOOKS:**


1. Rangaraj M Rangayyan: Biomedical Signal Analysis, John Wiley, 2002.
2. John G Proakis & Dimitris G Manolakis: Digital Signal Processing – Principles, Algorithms and Applications, Prentice Hall of India, 2005.


**REFERENCE BOOKS:**


1. Andreas Antonion: Digital Filters Analysis & Design, Prentice Hall of India, 2002.
2. P. Ramesh Babu: Digital Signal Processing, Scitech Publications,India 2004.
3. R Rabiner & B. Gold: Theory & Application of Digital Signal processing, Prentice Hall of India, 2000.
4. Alan V. Oppenheim & Ronald W Schafer: Digital Signal Processing, Prentice Hall of India, 2004.


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6202 | DIAGNOSTIC AND THERAPEUTIC EQUIPMENT – I | 3 | 0 | 0 | 3 |

**Course Objective**

1. Gather basic knowledge about measurements of parameters related to patient monitoring.
2. Learn techniques of blood gas analyzers and oximeters.
3. Understand blood rheology parameters.
4. Know ultrasound imaging technique and its use in diagnosis.
5. Know the importance of special diagnostic techniques.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **PATIENT MONITORING SYSTEMS AND BIOTELEMETRY**<br>Patient monitoring systems - ICU/CCU Equipment, Infusion pumps, bed side monitors, Central monitoring console. Architecture of Biotelemetry system – single and multi-channel Biotelemetry -. Concept of m-Health 2.0, Point of care devices. | 9 |
| II | **BLOOD GAS ANALYZERS AND OXIMETERS**<br>Blood pH measurement, Blood pCO2 measurement, Blood pO2 measurement, a complete blood gas analyzer-Fiber optic based blood gas sensors, Oximetry- - Pulse oximeter. | 9 |
| III | **BLOOD CELL COUNTERS AND DIATHERMY**<br>Methods of cell counting-Flow cytometry- Coulter Counters- automatic recognition and differential counting of cells, Diathermy: IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy. | 9 |
| IV | **CORONARY CARE EQUIPMENTS**<br>Cardiac pacemakers: different modes of operation- external and implantable pacemakers- pacemaker standard codes -Defibrillator: AC and DC defibrillator - Implantable defibrillator and automated external defibrillator (AED) - Pacer- cardioverter defibrillator- defibrillator analysers | 9 |
| V | **EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES**<br>Need for heart lung machine, Functioning of bubble, Disc type and membrane type oxygenators, finger pump, roller pump. Hemodialyser unit, Peritoneal dialyser unit, Lithotripsy, Cryogenic technique, Thermography – Recording Principle and clinical application. Audiometer- Beksey's type, Pure tone, Speech. | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

**CO1**: Explain about measurements of parameters related to Patient Monitoring Systems.
**CO2:** Describe the measurement techniques of Blood gas analyzers and Oximeters.
**CO3:** Analyze different types and uses of Blood cell counters and Blood Flow meters.
**CO4:** Discuss about the various coronary care equipments used in hospitals.
**CO5:** Outline the different surgical and therapeutic equipments used in hospitals.

**TEXT BOOKS:**


T1 Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.

T2 Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007


**REFERENCE BOOKS:**


R1 Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.

R2 L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.

R3 John G. Webster, "Bioinstrumentation", John Willey and sons, New York, 2004.

R4 Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", Mc Graw Hill, 2003.


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6203 | RADIOLOGICAL EQUIPMENT | 3 | 0 | 0 | 3 |

**Course Objective**

1. Understand generation of x-rays and its uses in imaging.
2. Learn different types of radio diagnostic techniques.
3. Know techniques used for visualizing different sections of the body.
4. Understanding about different nuclear imaging techniques.
5. Learn radiation therapy methodologies and the radiation safety.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **MEDICAL X-RAY EQUIPMENT**<br>Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Digital Radiography- discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography. Mammography. | 9 |
| II | **COMPUTED TOMOGRAPHY**<br>Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors-Viewing systems- spiral CT scanning – Ultra fast CT scanners. Image reconstruction techniques- back projection and iterative method. | 9 |
| III | **MAGNETIC RESONANCE IMAGING**<br>Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system- system magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), and shim coils, Electronic components, fMRI. | 9 |
| IV | **NUCLEAR MEDICINE SYSTEM**<br>Radio Isotopes- alpha, beta, and gamma radiations. Radio Pharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors, Gamma camera- Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit, pulse height analyzer. Principles of SPECT and PET. | 9 |
| V | **RADIATION THERAPY AND RADIATION SAFETY**<br>Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT,-Recent Techniques in radiation therapy - 3DCRT – IMRT – IGRT and Cyber knife- radiation measuring instruments-Dosimeter, film badges, Thermo Luminescent dosimeters-electronic dosimeter- Radiation protection in medicine- radiation protection principles | 9 |
| **Total Instructional Hours** | | **45** |

**Course Outcome**

**CO1:** Explain theory underlying machine learning.
**CO2:** Construct algorithms to Learn ANN.
**CO3:**Implement single layer feed forward networks.
**CO4:** Construct Algorithms To learn multi- layer feed forward networks.
**CO5:** Applyassociative memories learning techniques for real life problems

**TEXT BOOKS:**

T1 Steve Webb, The Physics of Medical Imaging, Adam Hilger, Philadelpia, 2008 (Units I, II, III & IV).

T2 R.Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002.

**REFERENCE BOOKS:**

R1 Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine"- Third edition Springer, 2006.

R2 B.H.Brown, PV Lawford, R H Small wood , D R Hose, D C Barber, "Medical physics and biomedical Engineering", - CRC Press, 1999.

R3 Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.

P.Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6204 | BIOMECHANICS | 3 | 0 | 0 | 3 |

**Course Objectives**

Upon completion of this course, the students will be familiar with

1. Explain the principles of mechanics.
2. Discuss the mechanics of physiological systems.
3. Explain the mechanics of joints.
4. Illustrate the mathematical models used in the analysis of biomechanical systems.
5. Describe biomechanics of joints

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **INTRODUCTION** Scope of mechanics in medicine, mechanics of bone structure, determination of in-vivo elastic modulus. Bio fluid mechanics, flow properties of blood. Anthropometry. | 9 |
| II | **MECHANICS OF PHYSIOLOGICAL SYSTEMS** Heart valves, power developed by the heart, prosthetic valves. Constitutive equations for soft tissues, dynamics of fluid flow in cardiovascular system and effect of vibration - shear stresses in extra-corporeal circuits.. | 9 |
| III | **ORTHOPAEDIC MECHANICS** Mechanical properties of cartilage, diffusion properties of articular cartilage, mechanical properties of bone, kinetics and kinematics of joints, Lubrication of joints. | 9 |
| IV | **MATHEMATICAL MODELS** Introduction to Finite Element Analysis, Mathematical models - pulse wave velocities in arteries, determination of in-vivo elasticity of blood vessel, dynamics of fluid filled catheters.. | 9 |
| V | **ORTHOPAEDICAPPLICATIONS** Dynamics and analysis of human locomotion - Gait analysis (determination of instantaneous joint reaction analysis), occupant response to vehicular vibration. Mechanics of knee joint during standing and walking.. | 9 |
| **Total Instructional Hours** | | **45** |

**Course Outcomes**

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

CO1: Understand the use of mechanics in medicine.
CO2: Understand the mechanics of physiological systems.
CO3: Distinguish the reason for abnormal patterns.
CO4: Analyze the biomechanical systems using mathematical models.
CO5: Design and develop the models specific to orthopedic applications.

**TEXT BOOKS:**

1. Y.C.Fung,—Bio-Mechanics, "Mechanical Properties ofTissues'',Springer-Verilog,1998.
2. C. Ross Ether and Craig A.Simmons, "Introductory Biomechanics from cells to organisms", Cambridge University Press, New Delhi, 2009.

**REFERENCES:**

1. Susan J Hall, "Basics of Biomechanics'', Mc Graw Hill Publishing.co. New York, 5th Edition, 2007.
2. Dhanjoo N.Ghista, "Orthopaedic Mechanics", Academic Press, 1990.
3. Joseph D.Bronzino, "Biomedical Engineering Fundamentals", Taylor& Francis, 2006.
4. John Enderle, Susanblanchard, Joseph Bronzino, "Introduction to Biomedical Engineering'', Elsevier, 2005.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6001 | BIOSIGNAL PROCESSING LABORATORY | 0 | 0 | 4 | 2 |

**Description of Experiments**

1. MATLAB familiarization
2. Acquisition of bio signals to the system
3. Implementation of filters.
4. Processing of ECG signals for acquiring parameters like heart rate, QRS complex, P wave etc
5. Arrhythmia analysis.
6. Analysis of plethysmography signal.
7. Automated detection of systolic and diastolic pressure from cuff pressure and peripheral pulse.
8. Signal Classification using neural networks.
9. 50 Hz interference rejection in ECG signals.
10. Event detection in EEG signals
11. Spectral analysis of EEG, EMG signals.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6002 | DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY | 0 | 0 | 4 | 2 |

**Description of the Experiments**

1. To analyze the therapeutic application of Shortwave Diathermy Unit
2. To analyze the therapeutic application of Medical Stimulator
3. Measurement of vital parameters using Patient Monitoring System
4. To demonstrate the Pacemaker System with Patient Simulator
5. To demonstrate the Defibrillator Trainer Unit with Defibrillator Simulator
6. To study and analyze about the Haemodialysis Machine – Electronic principle study unit
7. To study and analyze about the Heart Lung Machine –Electronic principle study unit
8. To study and analyze about the working of syringe pump and infusion pump
9. To study and analyze about the Ventilator –Electronic principle study unit
10. To study and analyze about the Ultrasound Scanner - Refurbished Unit

**Course Outcome**

CO1: Identify various equioments used for rehabilitation purposes.
CO2: Understand principle and working of various Biomedical Instruments for vital parameter monitoring
CO3: Decide the applications of therapeutic instruments for treatment purpose.
CO4: Understand applications of syring eand infusion pump.
CO5: Understand applications of critical care equipments.

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## PROFESSIONAL ELECTIVE I

| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5301 | ANALOG AND DIGITAL COMMUNICATION | 3 | 0 | 0 | 3 |

**Course Objective**

1. To understand analog and digital communication techniques.
2. To learn data and pulse communication techniques.
3. To understand digital communication techniques
4. To familiarized with source and Error control coding.
5. To gain knowledge on multi-user radio communication.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **ANALOG COMMUNICATION** | 12 |
| | **Introduction** to Communication Systems - Modulation – Types - Need for Modulation. Theory of Amplitude Modulation - Evolution and Description of SSB and DSBSC Techniques - Theory of Frequency and Phase Modulation – Comparison of Analog Communication Systems (AM – FM – PM). | |
| II | **PULSE AND DATA COMMUNICATION** | 12 |
| | **Pulse Communication:** Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) - Comparison of various Pulse Communication System (PAM – PTM – PCM). | |
| | **Data Communication:** History of Data Communication - Standards Organizations for Data Communication- Data Communication Circuits - Data Communication Codes - Data communication Hardware - serial and parallel interfaces. | |
| III | **DIGITAL COMMUNICATION** | 12 |
| | Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK)–Phase Shift Keying (PSK) – BPSK – QPSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM). | |
| IV | **SOURCE AND ERROR CONTROL CODING** | 12 |
| | Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, mutual information, channel capacity, Error Control Coding, linear block codes, cyclic codes - ARQ Techniques. | |
| V | **MULTI-USER RADIO COMMUNICATION** | 12 |
| | Global System for Mobile Communications (GSM) - Code division multiple access (CDMA) – Cellular Concept and Frequency Reuse - Channel Assignment and Handover Techniques - Overview of Multiple Access Schemes - Satellite Communication – Bluetooth | |
| | **Total Instructional Hours** | **60** |

**Course Outcome**

After the completion of the course, the learner will be able to

CO1: Understand the concept of analog communication.
CO2: Understand the various analog and digital communication techniques.
CO3: Understand the use of data and pulse communication techniques.
CO4: Analyze Source and Error control coding.
CO5: Utilize multi-user radio communication.

**TEXT BOOK:**

1. Wayne Tomasi, —Advanced Electronic Communication Systems, 6th Edition, Pearson Education, 2009.
2. Simon Haykin, —Communication Systems, 2nd Edition, John Wiley & Sons, 2007

**REFERENCES:**

1 B. P.Lathi, —Modern Analog and Digital Communication Systemsl, 3rd Edition, Oxford University Press, 2007.
2 Blake, —Electronic Communication Systemsl, Thomson Delmar Publications, 2002.
3. Martin S.Roden, —Analog and Digital Communication Systeml, 3rd Edition, Prentice Hall of India, 2002.
4. B.Sklar, —Digital Communication Fundamentals and Applicationsl 2nd Edition Pearson Education 2007.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5302 | BIOMATERIALS | 3 | 0 | 0 | 3 |

**Course Objectives**

Upon completion of this course, the students will be familiar with

1. Learn characteristics and classification of Biomaterials
2. Understand different metals, ceramics and its nanomaterial's characteristics as biomaterials
3. Learn polymeric materials and its combinations that could be used as a tissue replacement implants
4. Get familiarized with the concepts of Nano Science and Technology
5. Understand the concept of biocompatibility and the methods for biomaterials testing

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **INTRODUCTION TO BIO-MATERIALS**<br>Definition and classification of bio-materials, mechanical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, Nano scale phenomena. | 9 |
| II | **METALLIC AND CERAMIC MATERIALS**<br>Metallic implants - Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics. | 9 |
| III | **POLYMERIC IMPLANT MATERIALS**<br>Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and Blood oxygenation, electro spinning: a new approach. | 9 |
| IV | **TISSUE REPLACEMENT IMPLANTS**<br>Small intestinal sub mucosa and other decullarized matrix biomaterials for tissue repair: Extra cellular Matrix. Softtissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, tissue scaffolding and engineering using Nano biomaterials. | 9 |
| V | **TESTING OF BIOMATERIALS**<br>Biocompatibility, blood compatibility and tissue compatibility tests, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and Invivo testing; Sterilisation of implants and devices: ETO, gamma radiation, autoclaving. Effects of sterilization. | 9 |
| **Total Instructional Hours** | | **45** |

**Course Outcomes**

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

CO1: Analyze different types of Biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use.

CO2: Identify significant gap required to overcome challenges and further development in metallic and ceramic materials

CO3: Identify significant gap required to overcome challenges and further development in polymeric materials

CO4: Create combinations of materials that could be used as a tissue replacement implant.

CO5: Understand the testing standards applied for biomaterials.

**TEXT BOOKS:**


T1. Sujata V. Bhatt, —Biomaterials‖, Second Edition, Narosa Publishing House, 2005.

T2. Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O.Soboyejo, -Biomaterials: A Nano Approach‖, CRC Press, 2010.


**REFERENCES:**


R1. Myer Kutz, —Standard Handbook of Biomedical Engineering & Design‖, McGraw Hill, 2003

R2. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, —Introduction to Biomedical Engineering‖, Elsevier, 2005.

R3. Park J.B., —Biomaterials Science and Engineering‖, Plenum Press, 1984.

R4. A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran,—Woodhead Medical Textiles and Biomaterials for Healthcare‖, Publishing Limited 2006.


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | | TOTAL | | | | |
| | 16BM5303 | QUALITY MANAGEMENT | 3 | 0 | 0 | 3 |

**Course Objectives**

Upon completion of this course, the students will be familiar with

1. To facilitate the understanding of Quality Management frame work.
2. Understand TQM principles.
3. Learn TQM Tools and Techniques.
4. Know Quality Function Deployment (QFD), Taguchi quality loss function.
5. Understand Quality Management System.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **INTRODUCTION**<br>Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention. | 9 |
| II | **TQM PRINCIPLES**<br>Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating. | 9 |
| III | **TQM TOOLS AND TECHNIQUES I**<br>The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types. | 9 |
| IV | **TQM TOOLS AND TECHNIQUES II**<br>Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures. | 9 |
| V | **QUALITY MANAGEMENT SYSTEM**<br>Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS. | 9 |

| | | |
|---|---|---|
| **Total Instructional Hours** | | **45** |
| **Course Outcomes** | CO1: The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.<br>CO2: Discuss TQM principles.<br>CO3: Able to use TQM Tools and Techniques.<br>CO4: Apply Quality Function Deployment (QFD), Taguchi quality loss function.<br>CO5:The student would be able to apply the Quality Management System. | |

**TEXT BOOKS:**

T1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, —Total Quality Managementl, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

**REFERENCES:**

R1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
R2. Janakiraman.B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
R3.Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
R4.ISO9001-2015 standards.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5304 | HUMAN RIGHTS | 3 | 0 | 0 | 3 |

**Course Objectives**

Upon completion of this course, the students will be familiar with

1. Learn various Rights in Human Rights.
2. To sensitize the Engineering students to various aspects of Human Rights.
3. Understand UN Laws and Agencies.
4. Understand Constitutional Provisions / Guarantees.
5. Learn human rights of variety of people.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights. | 9 |
| II | Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights. | 9 |
| III | Theories and perspectives of UN Laws – UN Agencies to monitor and compliance. | 9 |
| IV | Human Rights in India – Constitutional Provisions / Guarantees. | 9 |
| V | Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements. | 9 |
| **Total Instructional Hours** | | **45** |

**Course Outcomes**

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

CO1: Engineering students will acquire the basic knowledge of human rights.
CO2: Know about various Rights in Human Rights.
CO3: Knowledge about UN Laws and Agencies.
CO4: Students will acquire the basic knowledge of Constitutional Provisions / Guarantees.
CO5: Knowledge about human rights of variety of people.

**TEXT BOOKS:**

T1. Kapoor S.K., —Human Rights under International law and Indian Lawsl, Central LawAgency, Allahabad, 2014.

**REFERENCES:**

R1. Chandra U., —Human Rightsl, Allahabad Law Agency, Allahabad, 2014.
R2. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.2013

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM5305 | INTELLECTUAL PROPERTY RIGHTS | 3 | 0 | 0 | 3 |

**Course Objectives**

Upon completion of this course, the students will be familiar with

1. To give an idea about IPR, Patents and Copyrights.
2. Understand registration of IPRs.
3. Understand Agreements and Legislations.
4. To know Digital products and Law.
5. Discuss IPR and its enforcement.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **INTRODUCTION**<br>Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights,Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR. | 9 |
| II | **REGISTRATION OF IPRs**<br>Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad. | 10 |
| III | **AGREEMENTS AND LEGISLATIONS**<br>International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act. | 10 |
| IV | **DIGITAL PRODUCTS AND LAW**<br>Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies. | 9 |
| V | **ENFORCEMENT OF IPRs**<br>Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies. | 7 |
| **Total Instructional Hours** | | **45** |

**Course Outcomes**

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

CO1: Ability to manage Intellectual Property portfolio to enhance the value of the firm.
CO2: Discuss registration of IPRs.
CO3: Able to use Agreements and Legislations of IPR.
CO4: Use Digital products and Law.
CO5: Acquire knowledge of IPR and its enforcement.

**TEXT BOOKS:**

T1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
T2. S. V. Satakar, —Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.

**REFERENCES:**

R1. Deborah E. Bouchoux, —Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secretsl, Cengage Learning, Third Edition, 2012.
R2. Prabuddha Ganguli,IIntellectual Property Rights: Unleashing the Knowledge Economyl, McGraw Hill Education, 2011.
R3.Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

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## PROFESSIONAL ELECTIVE II

| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6301 | NANOTECHNOLOGY AND APPLICATIONS | 3 | 0 | 0 | 3 |

**Course Objective**

1. To provide a broad view of the nascent field of nanoscience and to undergraduates
2. To explore the basics of nanomaterial synthesis and characterization.
3. To introduce the applications of nanotechnology
4. To understand nano structures.
5. To study various applications of Nanotechnology.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **INTRODUCTION TO NANOTECHNOLOGY** Basic Structure of Nanoparticles- Kinetics in Nanostructured Materials- Zero dimensional, size and shape of nanoparticles; one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors, bionano-particles | 9 |
| II | **FABRICATION AND CHARACTERIZATION OF NANOMATERIALS** Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Buckyballs, Nanotubes); Gas, liquid, and solid –phase synthesis of nanomaterials; Lithography techniques (Photolithography, Dip-pen and Electron beam lithography); Thin film deposition; Electrospinning. Bio-synthesis of nanomaterials. | 9 |
| III | **PROPERTIES AND MEASUREMENT OF NANOMATERIALS** Optical Properties: Absorption, Fluorescence, and Resonance; Methods for the measurement of nanomaterials; Microscopy measurements: SEM, TEM, AFM and STM. Confocal and TIRF imaging. | 9 |
| IV | **NANO STRUCTURES** Carbon Nanotubes, Fullerenes, Nanowires, Quantum Dots. Applications of nanostructures. Reinforcement in Ceramics, Drug delivery, Giant magnetoresistance, etc. Cells response to Nanostructures. | 9 |
| V | **APPLICATIONS OF NANOTECHNOLOGY** Nano electronics, Nanosensors, Nanotechnology in Diagnostics applications, Environmental and Agricultural Applications of nanotechnology, Nano technology for energy systems | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: Describe the basic science behind the properties of materials.
CO2: Interpret the creation, characterization, and manipulation of nanoscale materials.
CO3: Comprehend the exciting applications of nanotechnology at the leading edge of scientific research
CO4: Apply their knowledge of nanotechnology to identify how they can be exploited for new applications.
CO5: Apply applications of n**anotechnology.**

**TEXT BOOKS:**

1. Springer Handbook of Nanotechnology by Bharat Bhushan 2004.(Unit I – V)
2. Encyclopedia of Nanotechnology - Hari Singh Nalwa 2004. (Unit I – V)

**REFERENCES:**

1. Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009
2. Handbook of Nanophase and Nanostructured Materials (in four volumes), Eds: Z.L. Wang, Y. Liu, Z. Zhang, Kluwer Academic/Plenum Publishers, 2003
3. Handbook of Nanoceramics and their Based Nanodevices (Vol. 2) Edited by Tseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6302 | EMBEDDED SYSTEMS IN MEDICAL DEVICES | 3 | 0 | 0 | 3 |

**Course Objective**

1. Understand overview of Processors and hardware units.
2. Understand Intel MCS51 Architecture.
3. Learn PIC Microcontroller.
4. Understand Embedded system evolution trends.
5. Discuss applications of embedded system.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **Introduction to embedded systems**<br>Definition and Classification – Overview of Processors and hardware units in an embedded system – Software Embedded into the System – Complex System Design and the various Processors - Concept of Design Process in Embedded Systems - Design Examples – Classifications in Embedded Systems and Skills required for an Embedded Systems Designer | 9 |
| II | **Interfacing with microcontrollers**<br>Interfacing of 8051 with ADC, sensors, stepper motor, key board, & DAC - Introduction to Arduino UNO R3 Hardware setup – I/O functions – Real time Application | 9 |
| III | **Introduction to PIC Microcontroller**<br>PIC Microcontroller - Introduction, CPU architecture, registers, instruction sets addressing modes Loop timing, timers, Interrupts, Interrupt timing, I/o Expansion, I 2C Bus Operation Serial EEPROM, Analog to digital converter, UART-Baud Rate- Data Handling, Special Features | 9 |
| IV | **Real time Operating system Concepts**<br>Recursion, Debugging strategies, Simulators. Task and Task States, tasks and data, semaphores and shared Data Operating system Services-Message queues-TimerFunction- Events-Memory Management, Interrupt Routines in anRTOS environment, basic design Using RTOS | 9 |

| | | |
|---|---|---|
| V | **Embedded systems application in Medical devices**<br>Embedded medical applications: Ophthalmology - Glaucoma screening device, Medical Imaging Acquisition User Interface, Drug delivery systems, Patient monitoring Systems. | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: Explain overview of Processors and hardware units.
CO2: Apply Intel MCS51 Architecture.
CO3: Describe PIC Microcontroller.
CO4: Explain Embedded system evolution trends.
CO5: Apply applications of embedded system.

**TEXT BOOKS:**

1. Rajkamal, Embedded Systems Architecture, Programming and Design, TATA McGraw-Hill, First reprint Oct.2003
2. M A Mazidi & Mazidi, The 8051 micro controllers, PearsonEducation, 2005

**REFERENCES:**

1. Tim Wilmshusrst, Designing Embedded Systems with PIC, Newnes publishing,2007
2. Steve Heath, Embedded Systems Design, Second Edition-2003,Newnes,
3. David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6303 | BIOPHOTONICS | 3 | 0 | 0 | 3 |

**Course Objective**

1. Understand Optics principle.
2. Understand Light-matter interactions.
3. Learn Optical Imaging
4. Learn Optical Imaging in biomedical.
5. Understand various applicatons of optical biosensors.

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **Introductory Optics.** Geometric, Wave, EM and Quantum Picture of Light.Concept of phase, polarization and coherence. Diffraction and Interference | 9 |
| II | **Light-matter interactions.** Energy level picture of materials.Photons, Photoelectric effect, Interaction of photons with materials.Phosphorescence and fluorescence. Stimulated emission of photons.Principle of laser action.Laser types and applications (CW, Pulsed, Ultra- fast, Solid state, Gas, Dye …). Spectroscopy: Types and applications (UV-Vis, Infrared, Raman, FTIR …). | 9 |
| III | **Optical Imaging I.** Basic imaging theory, concept of diffraction limit. Optical microscope.Methods for contrast-generation (Dark-field, Phase contrast, DIC, Polarization).Fluorescence microscopy.Fluorescence techniques (FRET, FLIM, FRAP, FCS …). Nanoparticle fluorescence.3D sectioning: Confocal and multi-photon imaging. Advanced Topics.Nanoparticle fluorescence. Super-resolution techniques (STED, STEM, STORM, PALM …).Super-resolution image reconstruction methods. | 9 |
| IV | **Optical Imaging II.** Biomedical (Physiological Imaging). Light Scattering phenomena.Tomographic techniques: OCT. Image reconstruction techniques | 9 |
| V | **Other applications.** Optical biosensors.Optical manipulation of biological materials.Opticaltweezers. Laser dissection and surgery. Neural excitation. | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: Discuss Optics principle.
CO2: Describe Light-matter interactions.
CO3: Analyze Optical Imaging
CO4: Apply Optical Imaging in biomedical.
CO5: Apply new applications of optical biosensors

**TEXT BOOKS:**

1. Bahaa Saleh and Malvin Teich, *Fundamentals of Photonics*, Wiley & Sons (2002).
2. ParasN.Prasad,*Introduction to Biophotonics,* Wiley& Sons(2003).

**REFERENCES:**

1. P.N.Prasad,IntroductiontoBiophotonics,Wiley,2003
2. J.R.Lakowicz,Principlesoffluorescencespectroscopy,3rdedition,Springer,2006
3. J.Mertz, Introduction to opticalmicroscopy,Roberts&Co.Publishers,2009.

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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6304 | BIOINFORMATICS | 3 | 0 | 0 | 3 |

**Course Objective**

1. To understand the significance of string alignment To construct the phylogenetic tree
2. To understand the fundamentals of protein structure prediction and microarray analysis
3. Learn database search algorithms
4. Know Molecular Phylogeny Analysis
5. Understand structure prediction of proteins

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **NETWORK PROTOCOLS AND BIOLOGICAL DATABASES**<br>Operating systems: types, UNIX commands; Network Protocols: OSI, TCP/IP, ftp; Introduction to biological databases: Primary nucleotide databases (EMBL, Gene Bank and DDBJ), Primary protein databases (SwissProt, TrEMBL and PIR); EST Database; Genome annotation; Composite protein sequence database: OWL, NRDB; Secondary protein databases (PROSITE, BLOCKS and Profiles); Structural databases: SCOP and CATH | 9 |
| II | **STRING MATCHINGAND DYNAMIC PROGRAMMING**<br>Introduction: strings, substrings, identity, similarity, INDEL; Gaps: biological significance, different types of gap penalties; Overview of basic algorithms: Naïve, Boyer – Moore; Algorithm of dot matrix analysis;Introduction to pairwise sequence alignment: global vs. local; Dynamic programming: Needleman – Wunsch algorithm, Smith – Waterman algorithm; Parametric and suboptimal alignments. | 9 |
| III | **DATABASE SEARCH ALGORITHMS**<br>Substitution matrices: PAM, BLOSUM; Position specific scoring matrices (PSSM); Database search algorithms and applications: FASTA, BLAST, PSI BLAST; Algorithm of multiple sequence alignments (msa): Sums of pairs method (SP), CLUSTAL W, PILEUP; Overview of iterative msa methods; SAGA; Expectation – Maximization (EM) algorithm; Machine learning – Hidden Markov models. | 9 |
| IV | **MOLECULAR PHYLOGENY ANALYSIS AND GENE PREDICTION**<br>Molecular Clock theory (old and new); Jukes-Cantor and Kimura's models; Algorithm of distance matrix methods: Unweighted pair group method of arithmetic mean (UPGMA), Fitch-Margoliasch algorithm (FM), Neighbor – Joining method (NJ); Character based methods: Maximum parsimony, maximum likelihood; Bootstrapping technique; Comparative genomics; Prokaryotic and eukaryotic gene prediction methods: Feature and homology based methods. | 9 |

| | | | |
|---|---|---|---|
| V | **STRUCTURE PREDICTION OF PROTEINS**<br>Microarray analysis: spotted and oligonucleotide arrays; Clustering gene expression profiles: hierarchical clustering, nearest neighboring clustering, unweighted pair group clustering; Algorithm of protein secondary structure prediction: Chow-Fasman method, GOR method, *ab initio* approach, threading method; Systems biology: Introduction to metabolic pathways; Introduction to computer aided drug design (CAD). | | 9 |
| | | **Total Instructional Hours** | **45** |

**Course Outcome**

| | |
|---|---|
| CO1 | Explain UNIX commands, various types of network protocols and architecture of biological databases |
| CO2 | Demonstrate and interpret the biological string matching by dot matrix and dynamic program algorithms |
| CO3 | Apply, solve, interpret and analyze the heuristics based pairwise sequence analysis of macromolecules through various algorithms |
| CO4 | Apply, solve, interpret and analyze the heuristics based multiple sequence analysis of macromolecules through various algorithms |
| CO5 | Construct, interpret and assess the different molecular phylogenetic tree prediction and gene prediction algorithms |

**TEXT BOOKS:**


1. Bergeron, Bryan P. *Bioinformatics computing*. 2nd Edition, Prentice Hall Professional, ISBN: 0-13-100825-0, 2003.
2. Attwood, Teresa K., and David J. Parry-Smith. *Introduction to bioinformatics*. 1st Edition, Prentice Hall, ISBN: 13: 9780582327887, 2003.


**REFERENCES:**


1. Rastogi, S. C., Parag Rastogi, and Namita Mendiratta. *Bioinformatics Methods And Applications:Genomics Proteomics And Drug Discovery*. 4thEdition, PHI Learning Pvt. Ltd.,ISBN: 978-81-203-4785-4, 2013.
2. Mount, David W., and David W. Mount. *Bioinformatics: sequence and genome analysis*. 2nd Edition, , Cold Spring Harbor Lab (CHSL) press, USA, ISBN: 0-87969-687-7", 2004.
3. Gusfield, Dan. *Algorithms on strings, trees and sequences: computer science and computationalbiology*. Cambridge university press,11thPrint" (2008), Online publication (2010).(1997), BookDOI: http://dx.doi.org/10.1017/CBO9780511574931.


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| Programme | Course Code | Name of the Course | L | T | P | C |
|---|---|---|---|---|---|---|
| B.E. | 16BM6305 | BIOMEDICAL WASTE MANAGEMENT | 3 | 0 | 0 | 3 |

**Course Objective**

1. Understand hazard control
2. Understand the hazardous materials used in hospital and its impact on health
3. Understand various waste disposal procedures and management.
4. Learn safety of hospital
5. Understand infection control, prevention and patient safety

| Unit | Description | Instructional Hours |
|---|---|---|
| I | **HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS**<br>Healthcare Hazard Control : Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers' Compensation, Orientation, Education, and Training. | 9 |
| II | **HOSPITALWASTE MANAGEMENT**<br>Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal | 9 |
| III | **HAZARDOUS MATERIALS**<br>Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection. | 9 |
| IV | **FACILITY SAFETY**<br>Facility Safety : Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating, and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety. | 9 |

| | | |
|---|---|---|
| V | **INFECTION CONTROL, PREVENTION AND PATIENT SAFETY**<br>Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety. | 9 |
| | **Total Instructional Hours** | **45** |

**Course Outcome**

CO1: Analyse various hazards, accidents and its control
CO2: Design waste disposal procedures for different biowastes
CO3: Categorise different biowastes based on its properties
CO4: Design different safety facility in hospitals
CO5: Propose various regulations and safety norms

**TEXT BOOKS:**

1. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014).
2. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012).

**REFERENCES:**

1. R.C.Goyal, —Hospital Administration and Human Resource Management‖, PHI – Fourth Edition, 2006
2. J. Landrum, —Medical Waste Management and disposal‖, Elsevier, 1991

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**DEPARTMENT OF BIOMEDICAL ENGINEERING**

**ACADEMIC YEAR 2020-2021**

**REGULATION 2019**

**CO'S, PO'S & PSO'S MAPPING**

**Semester – I**

**Course Code & Name:19HE1101& Technical English**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 2 | - | 1 | 2 | 1 | 2 | 3 | 1 | 3 | 3 | 2 | 1 |
| **CO2** | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 1 | 2 | 2 | 3 | **2** |
| **CO3** | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 1 | 2 | 2 | 2 | 1 |
| **CO4** | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 3 | 3 | 1 |
| **CO5** | - | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 1 |
| **Avg** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 2 | 2 | **1** |

**Course Code & Name:19MA1103 & Calculus and Differential Equations**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 3 | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |
| **Avg** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 2 | **1** |

**Course Code & Name:19PH1151&Applied Physics**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 1 | 1 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 1 | 1 | 2 | - | - | - | - | - | - | 1 | 3 | 3 | 1 |
| **CO3** | 3 | 2 | 1 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 3 | 1 |
| **CO4** | 3 | 2 | 3 | 2 | 3 | 1 | - | - | - | - | - | 1 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 3 | 2 | 2 | 2 | - | - | - | - | - | 1 | 2 | 3 | 1 |
| **Avg** | 3 | 2 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | 2 | 2 | **1** |

**Course Code & Name:19CY1151&Chemistry for Engineers**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | 2 | 1 | 1 | - | - | - | - | 1 | 1 | 1 | 2 |
| **CO2** | 3 | 2 | 2 | - | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 |
| **CO3** | 3 | 2 | 2 | - | 2 | 1 | 1 | - | - | - | - | 1 | 1 | - | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | 2 |
| **CO5** | 3 | 2 | 2 | - | 2 | 1 | - | - | - | - | - | 1 | 1 | 1 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Avg** | 3 | 2 | 2 | 2 | 2 | 1 | 1 | - | - | - | - | 1 | 1 | 1 | 2 |

**Course Code & Name:19CS1151&Python Programming and Practices**

| **PO& PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | - | 2 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |
| **CO2** | 2 | 3 | 3 | - | 2 | - | - | - | 2 | - | - | 2 | 2 | 2 | 1 |
| **CO3** | 2 | 3 | 3 | - | 2 | - | - | - | 2 | - | - | 2 | 2 | 2 | 1 |
| **CO4** | 2 | 3 | 3 | - | 2 | - | - | - | 2 | - | - | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 3 | 3 | - | 2 | - | - | - | 2 | - | - | 2 | 2 | 2 | 1 |
| **Avg** | 2 | 3 | 3 | - | 2 | - | - | - | 2 | - | - | 2 | 2 | 2 | 1 |

**Course Code & Name:19EE1155&Basics of Electrical Engineering**

| **PO& PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| **CO2** | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| **CO3** | - | 3 | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| **CO4** | - | - | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - | 1 |
| **CO5** | - | - | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - | 1 |
| **Avg** | **-** | **2** | **1** | **-** | **1** | - | - | - | - | **-** | **-** | **-** | **1** | **-** | **1** |

**SEMESTER II**

**Course Code & Name: 19HE2101 & Business English for Engineers**

| **PO& PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 3 | - | 3 | 1 | - | 2 |
| **CO2** | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | - | 2 | - | 1 | 1 |
| **CO3** | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 1 | 3 | 1 | - | 1 |
| **CO4** | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 1 | 2 |
| **CO5** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 3 | 1 | 1 | 1 |
| **Avg** | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 3 | 1 | 1 | **1** |

**Course Code & Name:19MA2102 &Complex Variables And Transform Calculus**

| **PO& PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 2 | 3 | - | - | - | - | - | - | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 1 | 2 | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 1 | 2 |
| **Avg** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 2 | **1** |

**Course Code & Name:**19PH2151&MaterialScience

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 1 | 1 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 1 | 1 | 2 | - | - | - | - | - | - | 1 | 2 | 2 | 1 |
| **CO3** | 3 | 2 | 1 | 2 | 2 | - | - | - | - | - | - | 1 | 2 | 3 | 2 |
| **CO4** | 3 | 3 | 1 | 2 | 2 | 1 | - | - | - | - | - | 1 | 2 | 2 | 1 |
| **CO5** | 3 | 2 | 2 | 3 | 2 | 1 | 2 | - | - | - | - | 1 | 2 | 3 | 2 |
| **Avg** | 3 | 2 | 1 | 2 | 2 | 1 | 2 | - | - | - | - | 1 | 2 | 2 | 1 |

**Course Code & Name:19CY2151 Environmental Studies**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | - | - | - | - | 2 | 3 | 3 | 2 | - | - | 2 | - | - | 1 |
| **CO2** | 2 | - | - | - | - | 2 | 3 | 3 | 2 | - | - | 2 | - | - | 2 |
| **CO3** | 2 | 1 | 1 | - | - | 2 | 3 | 3 | 2 | - | - | 2 | - | - | 1 |
| **CO4** | 2 | 1 | 2 | - | - | 2 | 3 | 3 | 2 | - | - | 2 | - | - | 1 |
| **CO5** | 2 | 1 | 2 | - | - | 2 | 3 | 3 | 2 | - | - | 2 | - | - | 2 |
| **Avg** | 2 | 1 | 2 | - | - | 1 | 2 | 3 | 2 | - | - | 2 | - | - | 1 |

**Course Code & Name:19CS2152 Essentials of C&C++Programming**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | - |  | 3 | - | - | 1 | 1 | - | 2 | 2 | 3 | 3 | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | - | - | 1 | 1 | - | 2 | 2 | 2 | 3 | 1 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | - | - | 1 | 1 | - | 2 | 2 | 2 | 3 | 2 |
| **CO4** | 3 | 3 | - | 2 | 3 | - | - | 1 | 1 | - | 2 | 2 | 2 | 3 | 1 |
| **CO5** | 3 | - | 2 | 2 | 3 | - | - | 1 | 1 | - | 2 | 2 | 2 | 3 | 2 |
| **Avg** | 3 | 3 | 2 | 2 | 3 | - | - | 1 | 1 |  | 2 | 2 | 2 | 3 | 1 |

**Course Code & Name:19ME2154 Engineering Graphics**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 2 | 1 | 1 | 1 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 3 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | - | - | - |  | - | - | 3 | 3 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 3 | 1 | 1 | 1 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 3 | 2 | 2 | 2 |
| **Avg** | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 3 | 2 | 2 | 1 |

**Course Code & Name:19ME2001 Engineering Practices**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | 3 | - | 3 | - | 1 | - | 1 | - | - | - | 1 | 2 | 1 |
| **CO2** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| **CO3** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| **CO4** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| **CO5** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| **Avg** | 3 | - | 3 | - | 3 | - | - | - | 1 | - | - | - | 1 | 2 | 1 |

**Semester – III**

**Course Code & Name: 19MA3102 Fourier Analysis and Transforms**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 1 | 2 |
| **Avg** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |

**Course Code & Name:19BM3201 Electron Devices and Circuits**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 2 | 1 |
| **CO2** | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | 1 |
| **CO3** | 3 | 2 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| **CO4** | 2 | - | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| **CO5** | 2 | - | | | - | - | - | - | - | - | - | - | - | 3 | 1 |
| **Avg** | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | 0 | 2 | 1 |

**Course Code & Name:19BM3202 Medical Biochemistry**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 | 2 |
| **CO2** | 3 | - | 2 | | - | 2 | - | - | - | - | - | - | 3 | 2 | 1 |
| **CO3** | - | 1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| **CO4** | 3 | - | 2 | | - | - | - | - | - | - | - | 2 | - | 3 | 1 |
| **CO5** | 1 | 3 | 3 | 3 | - | - | - | - | - | - | - | 2 | - | 3 | 2 |
| **Avg** | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |

**Course Code & Name: 19BM3203 Human Anatomy and physiology**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 2 |
| **CO2** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 1 | 1 |
| **CO3** | 1 | 1 | - | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| **CO4** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 1 | 1 |
| **CO5** | 1 | 1 | - | 1 | - | - | - | - | - | - | - | 2 | 2 | 1 | 2 |
| **Avg** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |

**Course Code & Name:19BM3251 Digital Electronics**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 2 | - | 1 | - | 2 | - | 2 | 2 | - | 2 | 1 |
| **CO2** | 2 | 2 | 2 | 2 | 2 | - | - | - | - | 2 | 2 | 2 | - | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 2 | 2 | - | 2 | 2 | 2 | - | 2 | 2 | - | 2 | 1 |
| **CO4** | 2 | 2 | 2 | 2 | 2 | - | 2 | 2 | - | 2 | 2 | - | - | 2 | 1 |
| **CO5** | 2 | - | 2 | 1 | 2 | - | - | - | - | - | 2 | 1 | - | 1 | 2 |
| **Avg** | 2 | 2 | 2 | 2 | 2 | 0 | 1 | 1 | 1 | 1 | 2 | 1 | 0 | 2 | 1 |

**Course Code & Name:19BM3001 Electron Devices and Circuits Laboratory**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | 2 | - | - | - | - | - | 3 | - | - | - | - | 2 | 2 |
| **CO2** | 2 | 2 | 3 | - | - | - | - | - | 3 | - | - | - | - | 2 | 1 |
| **CO3** | 3 | - | - | - | - | - | - | - | 3 | - | - | - | - | 2 | 1 |
| **CO4** | 3 | - | - | - | - | - | - | - | 3 | - | - | - | - | 3 | 1 |
| **CO5** | 3 | - | - | - | - | - | - | - | 3 | - | - | - | 1 | | 1 |
| **Avg** | 3 | 0 | 1 | - | - | - | - | - | 3 | - | - | - | 1 | 2 | 1 |

**Course Code & Name:19BM3002 Biochemistry Laboratory**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 | 1 |
| **CO2** | 3 | - | 2 | - | - | 2 | - | - | - | - | - | - | 3 | 2 | 1 |
| **CO3** | - | 1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 |
| **CO4** | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | - | 3 | 1 |
| **CO5** | 1 | 3 | 3 | 3 | - | - | - | - | - | - | - | 2 | - | 3 | 1 |
| **Avg** | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |

**Semester – IV**

**Course Code & Name:19BM4201 Linear Integrated Circuits**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| **CO2** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 1 | 1 |
| **CO3** | 1 | 1 | 2 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| **CO4** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 1 | 1 |
| **CO5** | 1 | 1 | 2 | 1 | - | - | - | - | - | - | - | 2 | 2 | 1 | 2 |
| **Avg** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |

**Course Code & Name:19BM4202 Bio MEMS and Nanotechnology**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |
| **CO2** | 2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | 3 | 1 |
| **CO5** | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 3 | 1 |
| **Avg** | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |

**Course Code & Name:19BM4203 Pathology and Microbiology**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 2 | - | - | - | - | - | - | - | 1 | 1 | 1 | 2 | 2 |
| **CO2** | 1 | 1 | 2 | 3 | | 1 | - | - | - | - | | 1 | 1 | 1 | 1 |
| **CO3** | 1 | 3 | 3 | - | - | - | - | - | 3 | 1 | 2 | 2 | 3 | 2 | 1 |
| **CO4** | 1 | 1 | 2 | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 1 |
| **CO5** | 1 | 3 | 3 | 3 | | 2 | - | - | 3 | 1 | 2 | 2 | 3 | 3 | 1 |
| **Avg** | 1 | 2 | 2 | 1 | | 1 | - | - | 1 | 0 | 1 | 1 | 2 | 2 | 1 |

**Course Code & Name:19MA4152 Statistics and Numerical Methods**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 1 | 2 | - | - | - | - | - | - | 2 | 3 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | 3 | 2 | 2 | 1 |
| **CO3** | 3 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |
| **Avg** | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |

**Course Code & Name:19BM4251 Sensors and Measurement**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | - | - | - | - | - | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| **CO2** | 3 | - | - | - | - | - | - | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| **CO3** | 3 | - | - | - | - | - | - | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| **CO4** | 3 | - | - | - | - | - | - | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| **CO5** | 3 | - | - | - | - | - | - | 1 | 1 | 1 | | 1 | | | 1 |
| **Avg** | 3 | 0 | - | - | - | - | - | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |

**Course Code & Name: 19BM4001 Integrated Circuits lab**

| PO& PSO | PO1 | PO2 | PO 3 | PO 4 | PO 5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | - | - | - | - | - | 3 | - | - | 2 | | 3 | 1 |
| **CO2** | 2 | - | 2 | - | - | - | - | - | 3 | - | - | 2 | | 3 | 1 |
| **CO3** | 3 | - | 3 | 2 | - | - | - | - | 3 | - | - | - | - | 3 | 1 |
| **CO4** | 3 | - | - | - | 2 | - | - | - | 3 | - | - | - | - | 2 | 1 |
| **CO5** | 3 | - | - | 2 | - | - | - | - | 3 | - | - | 2 | 1 | 3 | 1 |
| **Avg** | 3 | 0 | 1 | 1 | 0 | - | - | - | 3 | - | - | 1 | 0 | 3 | 1 |

**Course Code & Name: 19BM4002 Human Physiology Laboratory**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | - | - | - | - | - | 3 | - | - | 2 | - | 3 | 1 |
| **CO2** | 2 | - | 2 | - | - | - | - | - | 3 | - | - | 2 | - | 3 | 1 |
| **CO3** | 3 | - | 3 | 2 | - | - | - | - | 3 | - | - | - | - | 3 | 1 |
| **CO4** | 3 | - | - | - | 2 | - | - | - | 3 | - | - | - | - | 2 | 1 |
| **CO5** | 3 | | | 2 | | - | - | - | 3 | - | - | 2 | 3 | 3 | 1 |
| **Avg** | 3 | 0 | 1 | 1 | 0 | - | - | - | 3 | - | - | 1 | 1 | 3 | 1 |

**<u>Semester – V</u>**

**Course Code & Name: 16BM5201 Biocontrol systems**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | | 1 |
| **CO2** | 3 | 2 | - | 2 | - | - | - | - | - | - | - | - | 2 | 3 | 1 |
| **CO3** | 2 | 3 | - | 3 | - | - | - | - | - | - | - | - | 2 | 3 | 1 |
| **CO4** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 |
| **CO5** | 3 | - | - | | - | - | - | - | - | - | - | - | - | - | 1 |
| **Avg** | 2 | 2 | - | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 |

**Course Code & Name: 16BM5202 BIOMEMS and Nanotechnology**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO2** | 2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | 3 | 1 |
| **CO5** | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 3 | 1 |
| **Avg** | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |

**Course Code & Name: 16BM5203 Hospital Engineering**

| **PO& PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| **CO2** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 1 | 1 |
| **CO3** | 1 | 1 | - | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| **CO4** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 1 | 1 |
| **CO5** | 1 | 1 | - | 1 | - | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| **Avg** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 1 | 1 | 1 |

**Course Code & Name: 16BM5204 Biomedical Instrumentation**

| **PO& PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO 11** | **PO 12** | **PSO1** | **PS 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 | 1 | 1 |
| **CO2** | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 | 1 | 2 |
| **CO3** | 1 | 1 | 1 | 1 | - | 1 | - | - | - | - | - | - | 2 | 2 | 1 |
| **CO4** | 0 | 0 | 1 | 1 | - | 1 | - | - | - | - | - | - | 2 | 2 | 1 |
| **CO5** | 0 | 0 | - | - | - | - | - | - | - | - | - | - | 2 | 1 | 1 |
| **Avg** | 1 | 1 | 0 | 0 | - | 0 | - | - | - | - | - | - | 2 | 1 | 1 |

**Course Code & Name: 16BM5205 Microprocessors and Microcontrollers**

| **PO& PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | - | - | - | - | - | - | - | - | - | - | 3 | - | 1 |
| **CO2** | 1 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 3 | 1 |
| **CO3** | 3 | - | 3 | - | 2 | - | - | - | - | - | - | - | - | 3 | 1 |
| **CO4** | 2 | - | 3 | - | 3 | - | - | - | - | - | - | - | - | 2 | 1 |
| **CO5** | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| **Avg** | 2 | 1 | 1 | | 1 | - | - | - | - | - | - | - | 2 | 2 | 1 |

**Course Code & Name: 16BM5001 Microprocessors and Microcontrollers Lab**

| **PO& PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | - | - | - | - | - | 3 | - | - | 2 | - | 3 | 1 |
| **CO2** | 2 | - | 2 | - | - | - | - | - | 3 | - | - | 2 | - | 3 | 2 |
| **CO3** | 3 | - | 3 | 2 | - | - | - | - | 3 | - | - | - | - | 3 | 1 |
| **CO4** | 3 | - | - | | 2 | - | - | - | 3 | - | - | - | - | 2 | 2 |
| **CO5** | 3 | - | - | 2 | - | - | - | - | 3 | - | - | 2 | 3 | 3 | 1 |
| **Avg** | 3 | 0 | 1 | 1 | 0 | - | - | | 3 | - | - | 1 | 1 | 3 | 1 |

**Course Code & Name: 16BM5002 Biomedical Instrumentation Lab**

| **PO& PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | - | - | - | - | - | 3 | - | - | 2 | - | 3 | 1 |
| **CO2** | 2 | - | 2 | - | - | - | | - | 3 | - | - | 2 | - | 3 | 1 |
| **CO3** | 3 | - | 3 | 2 | - | - | - | - | 3 | - | - | - | - | 3 | 1 |
| **CO4** | 3 | - | - | - | 2 | - | - | - | 3 | - | - | - | - | 2 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 3 | | | 2 | - | - | - | - | 3 | - | - | 2 | 3 | 3 | 1 |
| Avg | 3 | 0 | 1 | 1 | 0 | - | - | - | 3 | - | - | 1 | 1 | 3 | 1 |

## SEMESTER VI

**Course Code & Name: 16BM6201 Biosignal Processing**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 1 | 1 | 2 | - | - | - | - | - | - | - | 1 | 1 | 1 | 2 |
| CO2 | - | 1 | 1 | 2 | 3 | - | 1 | - | - | - | - | - | 1 | 1 | 1 |
| CO3 | - | 1 | 3 | 3 | - | - | - | - | - | 3 | 1 | 2 | 2 | 3 | 2 |
| CO4 | - | 1 | 1 | 2 | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| CO5 | - | 1 | 3 | 3 | 3 | - | 2 | - | - | 3 | 1 | 2 | 2 | 3 | 3 |
| Avg | - | 1 | 2 | 2 | 1 | - | 1 | - | - | 1 | 0 | 1 | 1 | 2 | 2 |

**Course Code & Name: 16BM6202 Diagnostic and Therapeutic Equipment-I**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 | 1 |
| CO2 | 3 | - | 2 | - | - | 2 | - | - | - | - | - | - | 3 | 2 | 1 |
| CO3 | - | 1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| CO4 | 3 | | 2 | - | - | - | - | - | - | - | - | 2 | - | 3 | 1 |
| CO5 | 1 | 3 | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| Avg | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |

**Course Code & Name: 16BM6203 Radiological Equipment**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 | 1 |
| CO2 | 3 | - | 2 | - | - | 2 | - | - | - | - | - | - | 3 | 2 | 1 |
| CO3 | - | 1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| CO4 | 3 | | 2 | - | - | - | - | - | - | - | - | 2 | - | 3 | 1 |
| CO5 | 1 | 3 | 3 | 3 | - | - | - | - | - | - | | 2 | - | 3 | 1 |
| Avg | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | - | 1 | 3 | 1 |

**Course Code & Name: 16BM6204 Biomechanics**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 | 1 |
| CO2 | 3 | - | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 | 1 |
| CO3 | - | 1 | 2 | 2 | - | 2 | - | - | - | - | - | - | - | 3 | 1 |
| CO4 | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | - | 3 | 1 |
| CO5 | 1 | 3 | 3 | 3 | - | - | - | - | - | - | - | 2 | - | 3 | 1 |
| Avg | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |

**Course Code & Name: 16BM6001 Biosignal Processing Laboratory**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 1 | 1 | 2 | - | - | - | - | - | - | - | 1 | 1 | 1 | 2 |
| CO2 | - | 1 | 1 | 2 | 3 | - | 1 | - | - | - | - | - | 1 | 1 | 1 |
| CO3 | - | 1 | 3 | 3 | - | - | - | - | - | 3 | 1 | 2 | 2 | 3 | 2 |
| CO4 | - | 1 | 1 | 2 | - | - | - | - | - | - | - | - | 1 | 1 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO5** | - | 1 | 3 | 3 | 3 | - | 2 | - | - | 3 | 1 | 2 | 2 | 3 | 3 |
| **Avg** | - | 1 | 2 | 2 | 1 | - | 1 | - | - | 1 | 0 | 1 | 1 | 2 | 2 |

**Course Code & Name: 16BM6002 Diagnostic and Therapeutic Equipment Laboratory**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | 2 | - | - | - | - | 3 | - | - | 2 | 3 | 3 | 1 |
| **CO2** | 2 | - | 2 | - | 2 | - | - | - | 3 | - | - | 2 | | 3 | 1 |
| **AVG** | 3 | 1 | 1 | 1 | 1 | - | - | - | 3 | - | - | 2 | 2 | 3 | 1 |

**PROFESSIONAL ELECTIVE I**

**Course Code & Name: 16BM5301 Analog and Digital Communication**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | - | - | 3 | 2 | 2 | 1 | - | 2 | 2 | 1 | 1 |
| **CO2** | 2 | 2 | 2 | 1 | - | - | 3 | 2 | - | 1 | - | 2 | 2 | 1 | 1 |
| **CO3** | 2 | 2 | 3 | 1 | - | - | 3 | 2 | 2 | 1 | - | 2 | 2 | 1 | 2 |
| **CO4** | 2 | 2 | 2 | 1 | - | - | 3 | 2 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 2 | 2 | 1 | - | - | 3 | 2 | - | 1 | - | 2 | 2 | 1 | 1 |
| **Avg** | 2 | 2 | 2 | 1 | - | - | 3 | 3 | 1 | 1 | - | 2 | 2 | 1 | 1 |

**Course Code & Name: 16BM5302 Biomaterials**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 2 | 1 |
| **CO2** | 3 | - | 2 | - | - | 2 | - | - | - | - | - | - | 3 | 2 | 1 |
| **CO3** | - | 1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 |
| **CO4** | 3 | - | 2 | | - | - | - | - | - | - | - | 2 | - | 3 | 1 |
| **CO5** | 1 | 3 | 3 | 3 | - | - | - | - | - | - | - | 2 | - | 3 | 1 |
| **Avg** | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |

**Course Code & Name: 16BM5303 Total Quality Management**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| **CO2** | - | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | 1 |
| **CO3** | - | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | 1 |
| **CO4** | - | - | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - | 1 |
| **CO5** | - | - | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - | 1 |
| **Avg** | - | 2 | 1 | - | 1 | - | - | - | - | - | - | - | 1 | - | 1 |

**Course Code & Name: 16BM5304 Human Rights**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | 1 | 1 | - | - | - | - | 1 | - | - | - | - | - | 1 |
| **CO2** | - | 2 | 1 | 2 | - | - | - | - | 1 | 2 | - | - | - | - | 1 |
| **CO3** | - | 2 | 1 | 1 | - | - | - | - | 1 | - | - | 2 | - | - | 1 |
| **CO4** | - | 2 | 1 | 1 | - | - | - | - | 1 | - | - | 2 | - | - | 1 |
| **CO5** | - | 2 | 1 | 2 | - | - | - | - | 1 | - | - | 2 | - | - | 1 |
| **Avg** | - | 2 | 1 | 2 | - | - | - | - | 1 | 0 | - | 2 | - | - | 1 |

**Course Code & Name: 16BM5305 Intellectual Property Rights**

| PO& | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO | PO | PO | | | PSO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| PSO | | | | | | | | | | 10 | 11 | 12 | PSO 1 | PSO 2 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | 1 | 1 | - | - | - | - | 1 | - | - | - | - | - | 1 |
| CO2 | - | 2 | 1 | 2 | - | - | - | - | 1 | 2 | - | - | - | - | 1 |
| CO3 | - | 2 | 1 | 1 | - | - | - | - | 1 | - | - | 2 | - | - | 1 |
| CO4 | - | 2 | 1 | 1 | - | - | - | - | 1 | - | - | 2 | - | - | 1 |
| CO5 | - | 2 | 1 | 2 | - | - | - | - | 1 | - | - | 2 | - | - | 1 |
| Avg | - | 2 | 1 | 2 | - | - | - | - | 1 | 0 | - | 2 | - | - | 1 |

**PROFESSIONAL ELECTIVE II**

**Course Code & Name: 16BM6301 Nano Technology and Applications**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |
| CO2 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| CO3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| CO4 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | 3 | 1 |
| CO5 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 3 | 1 |
| Avg | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |

**Course Code & Name: 16BM6302 Embedded Systems in Medical Devices**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | - | 1 | 1 | - | - | - | 3 | - | 3 | - | - | - | - | 1 |
| CO2 | 2 | - | 3 | - | - | - | - | 3 | - | 1 | - | 1 | - | - | 1 |
| CO3 | 2 | - | 3 | - | - | - | - | 3 | - | 1 | - | 1 | - | - | 1 |
| CO4 | 2 | - | 3 | - | - | - | - | 3 | - | 1 | - | - | - | - | 1 |
| CO5 | - | - | 3 | - | - | - | - | 1 | - | 1 | - | - | - | - | 1 |
| Avg | 2 | - | 3 | 0 | - | - | - | 3 | - | 1 | - | 1 | - | - | 1 |

**Course Code & Name: 16BM6303 Biophotonics**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | 1 | 1 | - | 2 | 2 | 3 | - | - | - | - | 1 |
| CO2 | - | - | - | - | 2 | 2 | - | 2 | 2 | 3 | - | - | - | 2 | 1 |
| CO3 | - | - | - | - | 1 | 1 | - | 2 | 2 | 3 | - | - | - | - | 1 |
| CO4 | - | - | - | - | 1 | 1 | - | 2 | 2 | 3 | - | - | - | 2 | 1 |
| CO5 | - | - | - | - | - | - | - | 2 | 2 | 3 | - | - | - | - | 1 |
| Avg | - | - | - | - | 1 | 1 | - | 2 | 2 | 3 | - | - | - | 1 | 1 |

**Course Code & Name: 16BM6304 Bioinformatics**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 1 | - | 2 | - | - | - | - | 1 | - | 1 | - | 3 | - | 1 |
| CO2 | - | 1 | - | 3 | - | 1 | - | - | 2 | - | 2 | - | 3 | - | 1 |
| CO3 | - | - | - | 3 | - | - | - | - | 3 | - | 1 | - | 3 | - | 1 |
| CO4 | - | 1 | - | 3 | - | 1 | - | - | 2 | - | - | - | 3 | - | 1 |
| CO5 | - | 1 | - | 3 | - | - | - | - | - | - | - | - | 1 | - | 1 |
| Avg | - | 1 | - | 3 | - | 0 | - | - | 2 | - | 1 | - | 3 | - | 1 |

**Course Code & Name: 16BM6305 Biomedical Waste Management**

| PO& PSO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | - | - | - | - | - | - | 3 | - | - | - | - | 1 |
| CO2 | 1 | 2 | 3 | - | - | - | - | - | - | 1 | - | 1 | - | - | 1 |
| CO3 | 1 | 2 | 3 | - | - | - | - | - | - | 1 | - | 1 | - | - | 1 |
| CO4 | 2 | 1 | 3 | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| CO5 | 1 | 1 | 3 | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Avg | 1 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | - | - | 1 |

## Mapping of Course Outcome and Programme Outcome:

| Year | Sem | Course code & Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | I | 19HE1101 Technical English | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 2 | 2 | **1** |
| | | 19MA1103 Calculus and Differential Equations | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 2 | **1** |
| | | 19PH1151 Applied Physics | 3 | 2 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | 2 | 2 | **1** |
| | | 19CY1151 Chemistry for Engineers | 3 | 2 | 2 | 2 | 2 | 1 | 1 | - | - | - | - | 1 | 1 | 1 | 2 |
| | | 19CS1151 Python Programming and Practices | 2 | 3 | 3 | - | 2 | - | - | - | 2 | - | - | 2 | 2 | 2 | 1 |
| | | 19EE1155 Basics of Electrical Engineering | - | 2 | 1 | - | 1 | - | - | - | - | - | - | - | 1 | - | **1** |
| | II | 19HE2101 Business English for Engineers | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 3 | 1 | 1 | **1** |
| | | 19MA2102 Complex Variables And Transform Calculus | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 2 | **1** |
| | | 19PH2151 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | - | - | - | - | 1 | 2 | 2 | 1 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Material Science | | | | | | | | | | | | | | | |
| | | 19CY2151 Environmental Studies | 2 | 1 | 2 | - | - | 1 | 2 | 3 | 2 | - | - | 2 | - | - | 1 |
| | | 19CS2152 Essentials of C&C++ Programming | 3 | 3 | 2 | 2 | 3 | - | - | 1 | 1 | | 2 | 2 | 2 | 3 | 1 |
| | | 19ME2154 Engineering Graphics | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 3 | 2 | 2 | 1 |
| II | III | 19MA3102 Fourier Analysis and Transforms | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| | | 19BM3201 Electron Devices and Circuits | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | 0 | 2 | 1 |
| | | 19BM3202 Medical Biochemistry | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |
| | | 19BM3203 Human Anatomy and physiology | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| | | 19BM3251 Digital Electronics | 2 | 2 | 2 | 2 | 2 | 0 | 1 | 1 | 1 | 1 | 2 | 1 | 0 | 2 | 1 |
| | | 19BM3001 Electron Devices and Circuits Laboratory | 3 | 0 | 1 | - | - | - | - | - | 3 | - | - | - | 1 | 2 | 1 |
| | | 19BM3002 Biochemistry Laboratory | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |
| | IV | 19BM4201 Linear Integrated Circuits | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 1 |
| | | 19BM4202 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |

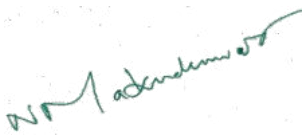
| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bio MEMS and Nanotechnology | | | | | | | | | | | | | | |
| | | 19BM4203 Pathology and Microbiology | 1 | 2 | 2 | 1 | | 1 | - | - | 1 | 0 | 1 | 1 | 2 | 2 | 1 |
| | | 19MA4152 Statistics and Numerical Methods | 3 | 3 | 3 | 2 | 2 | | | | | | | 2 | 2 | 2 | 1 |
| | | 19BM4251 Sensors and Measurement | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 2 | 2 | 2 | 1 |
| | | 19BM4001 Integrated Circuits lab | 3 | 0 | 1 | 1 | 0 | - | - | - | 3 | - | - | 1 | 0 | 3 | 1 |
| | | 19BM4002 Human Physiology Laboratory | 3 | 0 | 1 | 1 | 0 | - | - | - | 3 | - | - | 1 | 1 | 3 | 1 |

**Regulation 2016**

| Year | Sem | Course code & Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| III | V | 16BM5201 Biocontrol systems | 2 | 2 | - | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| | | 16BM5202 BIOMEMS and Nanotechnology | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |
| | | 16BM5203 Hospital Engineering | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 1 | 1 | 1 |
| | | 16BM5204 Biomedical Instrumentation | 1 | 1 | 0 | 0 | - | 0 | - | - | - | - | - | - | 2 | 1 | 1 |
| | | 16BM5205 Microprocessors and | 2 | 1 | 1 | | 1 | - | - | - | - | - | - | - | 2 | 2 | 1 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Microcontrollers | | | | | | | | | | | | | | | |
| | | 16BM5001 Microprocessors and Microcontrollers Laboratory | 3 | 0 | 1 | 1 | 0 | - | - | | 3 | - | - | 1 | 1 | 3 | 1 |
| | | 16BM5002 Biomedical Instrumentation Laboratory | 3 | 2 | - | - | - | - | - | - | 3 | - | - | 2 | - | 3 | 1 |
| | VI | 16BM6201 Biosignal Processing | - | 1 | 2 | 2 | 1 | - | 1 | - | - | 1 | 0 | 1 | 1 | 2 | 2 |
| | | 16BM6202 Diagnostic and Therapeutic Equipment-I | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |
| | | 16BM6203 Radiological Equipment | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | - | 1 | 3 | 1 |
| | | 16BM6204 Biomechanics | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |
| | | 16BM6001 Biosignal Processing Laboratory | - | 1 | 2 | 2 | 1 | - | 1 | - | - | 1 | 0 | 1 | 1 | 2 | 2 |
| | | 16BM6002 Diagnostic and Therapeutic Equipment Laboratory | 3 | 1 | 1 | 1 | 1 | - | - | - | 3 | - | - | 2 | 2 | 3 | 1 |
| | | 16BM6801 Mini Project | - | - | - | - | - | - | - | - | 3 | - | 3 | - | - | - | 1 |
| | PE1 | 16BM5301 BioMEMS And Nanotechnology | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |
| | | 16BM5302 Biomaterials | 2 | 1 | 2 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | 3 | 1 |
| | | 16BM5303 Total Quality Management | - | 2 | 1 | - | 1 | - | - | - | - | - | - | - | 1 | - | 1 |
| | | 16BM5304 Human Rights | - | 2 | 1 | 2 | - | - | - | - | 1 | 0 | - | 2 | - | - | 1 |
| | | 16BM5305 Intelligent Property Rights | - | 2 | 1 | 2 | - | - | - | - | 1 | 0 | - | 2 | - | - | 1 |
| | PE2 | 16BM6301 Nano Technology and | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | 1 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Applications | | | | | | | | | | | | | | | |
| | | 16BM6302 Embedded Systems in Medical Devices | 2 | - | 3 | 0 | - | - | - | 3 | - | 1 | - | 1 | - | - | 1 |
| | | 16BM6303 Biophotonics | - | - | - | - | 1 | 1 | - | 2 | 2 | 3 | - | - | - | 1 | 1 |
| | | 16BM6304 Bioinformatics | - | 1 | - | 3 | - | 0 | - | - | 2 | - | 1 | - | 3 | - | 1 |
| | | 16BM6305 Biomedical Waste Management | 1 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | - | - | 1 |



**CHAIRMAN-BOS** **DEAN ACADEMICS**