

## M-Tech Biomedical Engineering & Artificial Intelligence

### CURRICULUM

#### Semester - 1

| Type | Course Code | Course Name                                          | L T P | Credits   |
|------|-------------|------------------------------------------------------|-------|-----------|
| FC   | 25MA607     | Mathematics for Data Science                         | 3 0 0 | 3         |
| FC   | 25BI681     | Advanced Computer Programming                        | 0 0 2 | 1         |
| SC   | 25BI601     | Human Physiology                                     | 2 0 0 | 2         |
| SC   | 25BI602     | Embedded Design for Smart Systems                    | 3 0 2 | 4         |
| SC   | 25BI603     | Biomedical Electronics and Circuits                  | 2 0 2 | 3         |
| SC   | 25BI604     | Biomedical Instrumentation: Measurement and Analysis | 2 0 2 | 3         |
| SC   | 25BI605     | Bio electromagnetics                                 | 2 0 0 | 2         |
| HU   | 25AVP501    | Mastery over Mind                                    | 1 0 2 | 2         |
| HU   | 22ADM501    | Glimpses of Indian Culture                           |       | P/F       |
| HU   | 23HU601     | Career Competency I                                  | 0 0 3 | P/F       |
|      |             | Total Credits                                        |       | <b>20</b> |

#### Semester – 2

| Type | Course Code | Course Name                            | L T P | Credits   |
|------|-------------|----------------------------------------|-------|-----------|
| FC   | 25BI611     | Internet of Medical Things             | 2 0 0 | 2         |
| SC   | 25BI612     | Applied Machine learning               | 3 0 2 | 4         |
| SC   | 25BI613     | Biomedical Signal Processing           | 2 0 2 | 3         |
| SC   | 25BI614     | Biomedical Image Processing            | 2 0 2 | 3         |
| SC   | 25RM608     | Research Methodology                   | 2 0 0 | 2         |
| SC   | 25BI615     | Biosensors for Smart Health Monitoring | 2 0 2 | 3         |
| E    |             | Elective 1                             | 2 0 2 | 3         |
| P    | 25BI690*    | Live-in-Labs-I - Participatory Design  | 0 0 2 | 1         |
| HU   | 23HU611     | Career Competency II                   | 0 0 3 | 1         |
|      | 25BI698     | Industrial Internship                  | 0 0 2 | 1         |
|      |             | <b>Total Credits</b>                   |       | <b>23</b> |

**Semester – 3**

| Type | Course Code | Course Name                                              | L T P | Credits   |
|------|-------------|----------------------------------------------------------|-------|-----------|
| E    |             | Elective 2                                               | 2 0 2 | 3         |
| P    | 25BI798     | Dissertation- Phase I                                    |       | 10        |
| P    | 25BI790*    | Live-in-Labs II- Lab-to-Field: People Centred Innovation | 0 0 2 | 1         |
|      |             | <b>Total Credits</b>                                     |       | <b>14</b> |

**Semester – 4**

| Type | Course Code | Course Name            | L T P | Credits   |
|------|-------------|------------------------|-------|-----------|
| P    | 25BI799     | Dissertation- Phase II |       | 15        |
|      |             | <b>Total Credits</b>   |       | <b>15</b> |

**Total Course Credits: 72****ELECTIVES**

| Type               | Course Code | Course Name                                | L T P | Credits |
|--------------------|-------------|--------------------------------------------|-------|---------|
| <b>ELECTIVE-I</b>  |             |                                            |       |         |
| E                  | 25BI631     | Flexible electronics for Smart Systems     | 2 0 2 | 3       |
| E                  | 25BI632     | Medical Robotics                           | 2 0 2 | 3       |
| E                  | 25BI633     | Multivariate Time-Series Analysis          | 2 0 2 | 3       |
| E                  | 25BI634     | Speech and Audio processing                | 2 0 2 | 3       |
| <b>ELECTIVE-II</b> |             |                                            |       |         |
| E                  | 25BI731     | Deep Learning in Healthcare                | 2 0 2 | 3       |
| E                  | 25BI732     | Computer Vision and immersive technologies | 2 0 2 | 3       |
| E                  | 25BI733     | Wearable Biomedical Systems                | 3 0 0 | 3       |
| E                  | 25BI734     | BioMEMS                                    | 3 0 0 | 3       |
| E                  | 25BI735     | Virtual Instrumentation                    | 3 0 0 | 3       |
| E                  | 25BI736     | Bio-Inspired Computing                     | 3 0 0 | 3       |
| E                  | 25BI737     | Mobile Computing                           | 2 0 2 | 3       |
| E                  | 25BI738     | Brain-computer interfacing                 | 2 0 2 | 3       |

## SYLLABUS

|         |                              |         |
|---------|------------------------------|---------|
| 25MA607 | Mathematics for Data Science | 3-0-0-3 |
|---------|------------------------------|---------|

### New Course

#### Learning Objectives

LO1: Understand and apply core concepts of linear algebra such as vectors, matrices, eigenvalues/eigenvectors, and linear transformations for solving computational problems.

LO2: Develop a foundational understanding of probability theory, including random variables and probability distributions, to model uncertainty in engineering and data-driven systems.

#### Course Outcomes

CO1: Apply fundamental concepts from linear algebra and probability to represent and solve data-centric problems relevant to biomedical engineering and artificial intelligence.

CO2: Model and analyze real-world biomedical or AI-related scenarios mathematically, interpreting data to derive insights and propose scientifically sound solutions.

#### Course Contents

Mathematical Foundations - Linear Algebra- Vectors, Matrices, Eigenvalues, Eigenvectors, singular value decomposition, dimensionality reduction, Principal component analysis, linear transformations. Probability and Statistics: Random Variables, Probability Distributions, Distribution functions and properties, Discrete and Continuous, Statistical Inference – Estimation and Hypothesis Testing.

Applied Case Studies & Mathematical Modeling: Data-Driven Problem Solving, Framing real-world biomedical and AI problems mathematically, Building and analyzing mathematical models, Applying linear algebra and probability concepts to interpret data.

Project-Based Learning: Team and individual mini-projects based on industry-inspired or biomedical use-cases.

#### Textbooks

1. Data Mining Concepts and Techniques by Jiawei Han and Micheline Kamber
2. An Introduction to Probability and Statistics by Rohatgi and Saleh.
3. Business Analytics: Data Analysis and Decision Making by Christian Albright and Wayne Winston

New CourseLearning Objectives

LO1: Understand and apply core Python programming concepts

LO2: Develop foundational skills in data analysis and visualization

Course Outcomes

CO1: Develop problem-solving skills. Modularize a complex task and formulate a program structure with defined subtasks

CO2: Apply fundamental programming constructs such as logical flow control, loops, functions

CO3: Apply python specific data structures and concepts of object-oriented programming

CO4: Create programs with python modules, packages and libraries

Course Contents

Introduction to Python, variables, data types, objects and object oriented programming, classes, inheritance, lists and indices, loops, conditional statements, functions, script files, loading and using modules

Numpy arrays , Data analysis using pandas, plotting using Matplotlib, programming with spatial data

Skills acquired : Basics of python programming

Textbooks

1. Downey, A. (2015). Think Python. " O&#39;Reilly Media, Inc.".
2. McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. O&#39;Reilly Media, Inc.
3. <https://www.earthdatascience.org/courses/intro-to-earth-data-science/>
4. Lutz, M. (2013). Learning python: Powerful object-oriented programming. " O&#39;Reilly Media.

Learning Objectives

LO1 Develop a foundational understanding of human physiological systems and their relevance to drug action and delivery.

LO2 Understand the principles of pharmacology and explore various drug delivery mechanisms, including emerging technologies and regulatory considerations.

Course Outcomes

CO1 Ability to explain the structure and function of major human physiological systems and their role in maintaining homeostasis.

CO2 Ability to Analyze drug-receptor interactions, pharmacokinetics, and pharmacodynamics in the context of therapeutic drug design.

CO3 Ability to compare and evaluate conventional, controlled, and advanced drug delivery systems, including nanoparticle and stimuli-responsive approaches, along with associated regulatory challenges.

Course Contents

Cell Physiology - Introduction to cell organelles - Bioelectric potentials – Homeostasis – Transport mechanisms. Neuro muscular system - Bone types. Nervous system - Sensory nervous system - Motor nervous system - Brain structure and its functions. Blood and lymph -Functions of blood - Blood groups.

Circulatory system - physiology of the heart - Conducting system of the heart - Arterial and venous blood pressure. Gastrointestinal system - Gastric secretion - Pancreatic secretion - Renal physiology - Structure of kidney - Respiratory system - Mechanism of breathing - Regulation of respiration - Transport of gases - Hypoxia - Endocrinology - Endocrine glands -Hormones and their functions.

Textbooks

1. Physiology, 5th Edition, Linda S. Costanzo, Saunders-Elsevier 2009.
2. Marieb E and Hoehn K, Human Anatomy & Physiology, Tenth Edition, Benjamin Cummings, 2014.
3. Guyton A C and Hall J E, Textbook of Medical Physiology, Thirteenth Edition, Elsevier Saunders, 2015.

Syllabus revisionLearning Objectives

LO1 To introduce design concepts of embedded systems.

LO2 To provide insights on embedded C programming for configuring microcontroller and peripherals

LO3 To enable development of embedded system models

Course Outcomes

CO1 Ability to identify the features of STM32F microcontroller

CO02: Ability to apply embedded C programming skills for configuring STM32F peripherals

CO03: Ability to analyze external peripheral interfacing with a microcontroller

CO04: Ability to design and develop embedded systems using STM32F microcontroller

Course Contents

Unit.1: Introduction to Embedded Systems - Introduction to ARM - Advanced RISC Features – Specifications of Automotive Grade Controllers with examples - Core Data path - Register Organization – System Architecture - Memory Organization - Low Power Modes - Power Control Registers - Backup Registers - Programming STM32F.

Unit.2: STM32F Peripherals: Embedded C Programming - General Purpose Input Output - UART - ADC - DAC- Timers - Interrupts and Exceptions - PWM - SPI.

Unit.3: External Peripheral Interfacing: LCD - Keypad - Motor - Servo Motor - EEPROM - Seven Segment Interfacing - Sensor Interfacing. Case Studies: ADAS system for Body Electronics and Infotainment applications (Selection of micro controller for Automotive as lab experiment)

List of experiments for Embedded Programming Lab

1. Toggle Green LED (LD2) on Nucleo64 board at 1 Hz, using BSRR & SWITCH
2. USART / UART Transmit & Receive
3. Interrupt handling – GPIO, UART
4. Toggle user LED at 5 Hz using the 'SysTick' Counter
5. Toggle the LED at 1 Hz using TIM2
6. Generating Waveform Output Using Compare Mode
7. Using ADC to convert an input channel
8. Using 32-bit TIM2 for PWM Output
9. Transmit / Receive via CAN

Textbooks

1. Shujen Chen, Eshragh Ghaemi, Muhammad Ali Mazidi, STM32 Arm Programming for Embedded Systems, Microdigitaled, 2019.
2. Donald Norris, Programming with STM32: Getting Started with the Nucleo Board and C/C++, McGraw-Hill Education, 2018.
3. STM32F446xx advanced Arm®-based 32-bit MCUs, Reference Manual, 2020

New NameLearning Objectives

LO1 To understand the fundamental principles of electronics.

LO2 To design, test and analyse biomedical circuits and signals.

Course Outcomes

CO1 Apply knowledge of engineering and science to understand the principle of biomedical electronic circuits.

CO2 Understand how to measure and fine-tune circuit performance to solve problems in the areas of biomedical signals.

Course Contents

Basics of circuits and systems – Network theorems and laws – Diodes – transistors – amplifier circuits – filter circuits – Op-amps – Active filters – signal conditioning and processing circuits - peak detectors, rectifiers, comparators, timers, multivibrator. Analog circuits for processing medical data.

Laboratory module will involve hands-on hardware experiments on

1. Network theorems, voltage, and current division.
2. Diode circuits
3. Passive filters
4. Transistor amplifiers
5. Active filters
6. Signal conditioning circuits
7. Medical signal acquisition circuits

Recommended Tools: NI-Multisim software for simulations, Digilent Analog Discovery kits and Waveforms software for hands-on circuit implementation.

Textbooks

1. Microelectronic Circuits by Sedra Smith, 5<sup>th</sup> edition, 2004
2. Electric Circuits, Nilsson, J.W. and Riedel, S.A., 9<sup>th</sup> edition, 2011

|                |                                                             |                |
|----------------|-------------------------------------------------------------|----------------|
| <b>25BI604</b> | <b>Biomedical Instrumentation: Measurement and Analysis</b> | <b>2-0-2-3</b> |
|----------------|-------------------------------------------------------------|----------------|

### New Name and Credit Change

### Learning Objectives

LO1 To familiarize with major signal and image acquisition modalities in healthcare.

LO2 To understand instrumentation and signal characteristics associated with each modality.

### Course Outcomes

CO1 To get familiarized with

1. Biomedical signal acquisition modalities like ECG, EEG, EMG,
2. Biomedical imaging modalities like x-ray, MRI, CT and
3. Surgical and other analytic equipment.

CO2 Ability to read and interpret data from diverse modalities.

### Course Contents

Introduction to biomedical instruments and data – purpose – types – data characteristics – data acquisition and analysis.

Biomedical signals and their measurements – Biopotentials - Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyography (EMG), Photoplethysmography (PPG).

Medical images and their measurements - X-ray, Magnetic Resonance Imaging (MRI), Computed Tomography (CT), PET, and SPECT, Ultrasonography.

Surgical Instruments, ENT, and Ophthalmic Instruments. Medical equipment safety.

The course will include a hospital field visit.

### Textbooks

1. Ananthi, S. A, “Textbook of medical instruments”, New Age International, 2005.
2. Webster, J. G. (ed.), “Medical instrumentation: application and design”, Fourth edition, John Wiley & Sons, Hoboken
3. J.J.Carr&J.M.Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia.

|                |                            |                |
|----------------|----------------------------|----------------|
| <b>25BI605</b> | <b>Bioelectromagnetics</b> | <b>2-0-0-2</b> |
|----------------|----------------------------|----------------|

### New Course

### Learning Objectives

LO1: Understand the fundamental physics of electromagnetic fields and wave propagation.

LO2: Analyze how EM fields interact with biological tissues at cellular and tissue levels.

LO3: Examine diagnostic and therapeutic medical technologies that utilize electromagnetic fields.

LO4: Evaluate safety guidelines and simulate biological responses to EM exposure.

### Course Outcomes

CO1: Apply Maxwell’s equations to biological scenarios and human tissue models.

CO2: Assess the dielectric behavior of biological tissues across frequency bands.

CO3: Analyze biomedical devices based on electromagnetic interactions

CO4: Understating of bioelectromagnetic fields and sources

## CO5: Understanding the electromagnetic exposure and safety standards

### Course Contents

Foundations of Bioelectromagnetics, Maxwell's equations and wave equations, Electromagnetic spectrum relevant to biology, Boundary conditions and wave reflection/refraction in tissues, Energy absorption, Electromagnetic behavior as a function of size and wavelength.

Electromagnetic Behaviour, Low-frequency approximations, Electrical and Magnetic Fields induced in objects, E Field patterns for electrode configurations, Measurement of low-frequency electric and magnetic fields

Plane wave propagation in biological media, Waves in lossless media, Wave reflection and refraction, Waves in lossy media, Transmission lines and waveguides, Resonant systems, Antennas, Ray propagation effects, Total internal reflection and fiber optic waveguides, Propagation of laser beams, Scattering from particles, Photon interactions with tissues, Measurement of high-frequency electric and magnetic fields (light)

Bioelectromagnetic dosimetry, Polarization, Electrical properties of the human body, Thermal and non-thermal effects, Human models, Energy absorption (SAR), Numerical methods for bioelectromagnetic simulation

Electromagnetic guidelines and Regulations: Exposure and Safety Standards, Specific Absorption Rate (SAR), EMF exposure guidelines (IEEE, ICNIRP, WHO)

Electromagnetics in medicine, Hyperthermia for cancer therapy, Wireless body area networks (WBANs), Nanotechnology.

### Textbooks

1. Plonsey & Malmivuo, Bioelectromagnetism, Oxford University Press, 1995.
2. C. Furse, D.A Christensen, C.H. Durney, and J. Nagel, "Basic Introduction to Bioelectromagnetics," CRC Press 3rd Ed, 2018.

|                |                                   |                |
|----------------|-----------------------------------|----------------|
| <b>25BI611</b> | <b>Internet of Medical Things</b> | <b>2-0-0-2</b> |
|----------------|-----------------------------------|----------------|

### Learning Objectives

LO1 To understand the concepts of Internet of Things.

LO2 To provide exposure to the routing protocols used in medical IoT devices.

LO3 To comprehend on applications of IoT in the field of healthcare.

### Course Outcomes

CO1 Ability to understand the basic architecture of an IoT device.

CO2 Ability to apply big data analytics in Medical IoT devices.

CO3 Ability to analyse mobility in location based IoT systems.

CO4 Ability to evaluate the performance of IoT applications in healthcare.

### Course contents

Introduction to IoT - Physical design of IoT - Logical design of IoT - IoT enabling technologies - IoT levels and deployment templates - Cloud computing - Deployment models - Service models - Service management - Cloud security - Communication protocols - CoAP – MQTT. IoT in Healthcare - Challenges in current healthcare systems - IoT healthcare services - Big data in IoT - Architecture of apache flume and spark - Wireless Body Area Networks (WBAN) Routing Protocols - Medium access control - Issues of WBAN.

Case Studies - Wearable sensor network for remote health monitoring - IoT based location aware smart healthcare framework - Analysis of recovery of mobility through inertial navigation techniques and virtual reality - Control and remote monitoring of muscle activity and simulation in the rehabilitation process. Azure, AWS.

### Textbooks

1. Valentina Emilia Balas and Souvik Pal, Healthcare Paradigms in the Internet of Things Ecosystem, Academic Press, 2021.
2. Arsheep Bahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, 2015.
3. Rajkumar Buyya and Amir Vahid Dastjerdi, Internet of Things Principles and Paradigms, Elsevier Inc, 2016.

|                |                                 |                |
|----------------|---------------------------------|----------------|
| <b>25BI612</b> | <b>Applied Machine Learning</b> | <b>3-0-2-4</b> |
|----------------|---------------------------------|----------------|

### Learning Outcomes

LO1 To introduce different machine learning paradigms.

LO2 To provide understanding of machine learning algorithms to be used on a given dataset for regression/classification problems.

### Course Outcomes

CO1 Ability to conduct data analysis and data visualization.

CO2 Apply the complete ML pipeline in real-world dataset - Analyse datasets, decide pre-processing steps, visualize data, apply ML models, and infer the meaning based on different performance metrics.

### Course contents

Introduction to machine learning and machine learning applications. Data featurization, vectorization, linear algebra, and matrix representations. Supervised learning - linear regression, polynomial regression, logistic regression, Decision Trees, Support Vector Machine and ANN. Regularization, tuning, overfitting, underfitting. Unsupervised learning: Clustering, dimensionality reduction (PCA). Deep Neural networks: multilayer perceptron, transfer learning, edge models. ML model evaluation metrics. Generative AI - LLMs. MLOps - introduction to converting ML models from test bench to production (saving, loading, using trained models).

### Textbooks

1. An Introduction to Statistical Learning by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani (2022)
2. Géron, Aurélien. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O&#39; Reilly Media, 2019.

Credit ChangeLearning Objectives

LO1 To introduce characteristics of biomedical signals.

LO2 To provide understanding of artifact removal in biomedical signals.

LO3 To enhance knowledge in event detection and waveform analysis of biomedical signals.

LO4 To provide insight on pattern classification in biomedical signals.

Course Outcomes

CO1 Ability to understand concepts of signal processing.

CO2 Ability to apply algorithms for signal processing.

CO3 Ability to analyse biomedical signals and systems.

CO4 Ability to evaluate biomedical signal processing systems.

Course contents

Brief introduction to biomedical signals - Challenges in biomedical signal acquisition and analysis - Need for Computer Aided Diagnosis (CAD)

Sampling and reconstruction - Types of noise - Random noise - Structured noise - Physiological interference - Linear time-invariant filters - Time domain filters - Synchronized averaging - Moving average filters - Derivative based filters.

Transform domain analysis of signals and systems - Discrete Fourier Transform (DFT) and its properties - Pole-zero plot - Time-frequency analysis - Short-Time Fourier Transform (STFT) - Wavelet Transform

Filter design - Butterworth filters - Notch and comb filters - Event detection - Analysis of waveshape and waveform complexity - Morphological analysis - Envelope extraction and analysis - Feature extraction - Receiver operating characteristics - Case studies - Removal of artifacts - QRS Detection and classification of ectopic beats in ECG signals - Detection of epileptic seizures in EEG signals - Study of muscular contraction using parametric analysis of EMG signals.

Laboratory module will involve hands-on experiments on

1. Digital signal processing - Basic operations
2. Time domain filtering
3. Discrete Fourier Transform (DFT)
4. Frequency domain filtering
5. Artifact removal in bio-signals
6. Waveform analysis and feature extraction from bio-signals
7. Pattern classification in bio-signals

Recommended Tools: MATLAB, Python

Textbooks

1. Rangayyan, Rangaraj M, Biomedical signal analysis, John Wiley & Sons, 2015
2. Subasi, Abdulhamit. Biomedical signal analysis and its usage in healthcare in Biomedical Engineering and its Applications in Healthcare, pp. 423-452. Springer, 2019.
3. Devasahayam, S.R., Signals and systems in biomedical engineering: signal processing and physiological systems modeling. Springer Science & Business Media, 2014.
4. Haykin, Simon, and Barry Van Veen, Signals and systems, John Wiley & Sons, 2007

5. John G.Proakis and DimitusG.Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", Third Edition, Prentice Hall of India, 2002.
6. Subasi, A., Practical guide for biomedical signals analysis using machine learning techniques: A MATLAB based approach. Academic Press, 2019.
7. Blinowska, Katarzyn J., and Jaroslaw Zygierecz. Practical biomedical signal analysis using MATLAB. CRC Press, 2011.

**25RM608**

**Research Methodology**

**2 0 0 2**

### Learning Objectives

LO1 To enable defining and formulating research approaches towards obtaining solutions to practical problems.

LO2 To facilitate development of scientific oral and written communication skills.

LO3 To comprehend the concepts behind adhering to scientific ethics and values.

### Course Outcomes

CO1 Ability to understand some basic concepts of research and its methodologies.

CO2 Ability to define and apply appropriate parameters and research problems.

CO3 Ability to develop skills to draft research papers.

CO4 Ability to analyse and comprehend the ethical practices in conducting research and dissemination of results in different forms.

### Course contents

Meaning of research - Types of research - Research process - Problem definition - Objectives of research - Research questions - Research design - Approaches to research - Quantitative vs. qualitative approach - Understanding theory - Building and validating theoretical models - Exploratory vs. confirmatory research - Experimental vs theoretical Research - Importance of reasoning in research.

Problem formulation - Conducting literature review - Referencing - Information sources - Information retrieval - Role of libraries in information retrieval - Tools for identifying literatures - Indexing and abstracting services - Citation indexes.

Experimental research - Cause effect relationship - Development of hypothesis -Measurement systems analysis - Error propagation - Validity of experiments - Statistical design of experiments - Field experiments - Data/Variable types & classification - Data collection - Numerical and graphical data analysis - Sampling - Observation - Surveys -Inferential statistics and interpretation of result.

Preparation of dissertation and research papers - Tables and illustrations - Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript - References, citation, and listing system of documents. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work

Intellectual property: To give an idea about IPR, registration, patents-copyrights, and its enforcement.

Medical Ethics: Moral, Legal, Social, Religious and Cultural Contexts, Information and Consent, Truthfulness, Voluntariness, Patient Data Confidentiality, End-of-Life Ethics, Case Studies, Regulatory Compliance.

### Textbooks

1. Bordens, K. S. and Abbott, B. B., Research Design and Methods - A Process Approach, 8th Edition, McGraw-Hill, 2011.
2. C. R. Kothari, Research Methodology - Methods and Techniques, 2nd Edition, New Age International Publishers.
3. Davis, M., Davis K., and Dunagan M., Scientific Papers and Presentations, 3rd Edition, Elsevier Inc.
4. Michael P. Marder, Research Methods for Science, Cambridge University Press, 2011.
5. T. Ramappa, Intellectual Property Rights Under WTO, S. Chand, 2008.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age. Aspen Law & Business; 6th Edition July 2012.
7. Tony Greenfield and Sue Greener., Research Methods for Postgraduates, 3rd Edition, John Wiley & Sons Ltd., 2016.
8. Gopalakrishnan B, Khaute M, Bhat B S, Bhat S, Sastry S R, Kaur K, Menon M, Kamath A, Saha M, Sadhya M, Reflections on Medical Law and Ethics in India, First Edition, Eastern Law House, 2016.

|                |                                              |             |
|----------------|----------------------------------------------|-------------|
| <b>25BI615</b> | <b>Biosensor for Smart Health Monitoring</b> | <b>2023</b> |
|----------------|----------------------------------------------|-------------|

### New Course

#### Learning Objectives

- LO1: Compare and evaluate different types of biosensors (electrochemical, optical, microwave) based on their working principles, sensitivity, and application areas.
- LO2: Design and simulate microwave biosensor structures (e.g., resonators, antennas, metamaterials) using electromagnetic simulation tools, considering biological material properties.
- LO3: Analyze and interpret experimental results from fabricated biosensors using network analyzers, and assess their performance in terms of sensitivity, selectivity, and SAR.

### Course Outcomes

- CO1: To impart foundational knowledge of biosensors with an emphasis on the unique characteristics and advantages of microwave-based biosensing techniques.
- CO2: To develop an understanding of microwave engineering concepts relevant to biosensor design, including wave propagation in biological tissues and planar transmission structures.
- CO3: To provide hands-on experience in the design, simulation, and testing of microwave biosensors for biomedical applications using modern tools and fabrication techniques.

### Course contents

Fundamentals of Biosensors - Introduction to biosensors: Types and classifications, Principle of biosensing, Comparison of electrochemical, optical, and microwave biosensors, Application domains.

Microwave Engineering Basics - Microwave theory and transmission line fundamentals, S-parameters and network analysis, Wave propagation in biological tissues, Planar structures: microstrip, CPW, and slotline. Dielectric properties of biological materials.

Bio-Interface and Sensing Mechanisms - Biomolecule immobilization techniques, Surface functionalization and biorecognition layers, Interaction of electromagnetic fields with biological matter, Specific absorption rate (SAR), Characteristics of biosensors - Sensitivity, selectivity, and limit of detection (LOD).

Microwave Sensor Structures - Resonant sensors: split-ring resonators, stub resonators, antennas, Non-resonant sensors: transmission/reflection-based sensors, Metamaterial-based biosensors.

Lab:

- Sensor design and parameter optimization using electromagnetic simulators
- Modeling tissue phantoms and biological layers
- Thermal effects and SAR analysis
- PCB fabrication for microwave devices
- Sensor testing using network analyser

### Textbooks

1. D. M. Pozar, Microwave Engineering, 4th ed., Hoboken, NJ, USA: Wiley, 2011.
2. Martín, Ferran, et al. Planar microwave sensors. John Wiley & Sons, 2022.
3. D. M. Pozar, Microwave and RF Design of Wireless Systems, Hoboken, NJ, USA: Wiley, 2000.
4. Rasooly A and Herold K E (Eds), Biosensors and Biodetection: Methods and Protocols, Volume 503: Optical-Based Detectors, Springer-Verlag, 2009.

|         |                             |      |
|---------|-----------------------------|------|
| 25BI614 | Biomedical Image Processing | 2023 |
|---------|-----------------------------|------|

### Learning Objectives

LO1 To familiarize with major signal and image acquisition modalities in healthcare.

LO2 To understand instrumentation and signal characteristics associated with each modality.

### Course Outcomes

CO1 To get familiarized with (a) biomedical signal acquisition modalities like ECG, EEG, EMG, (2) biomedical imaging modalities like x-ray, MRI, CT and (3) surgical and other analytic equipment.

CO3 Ability to read and interpret data from diverse modalities.

### Course Contents

Imaging Modalities: Brief survey of major modalities for medical imaging: Ultrasound, X-ray, CT, MRI, PET, and SPECT.

Objectives of biomedical image analysis - Computer aided diagnosis, Removal of artifacts - Image Enhancement - Gray level transforms - Histogram transformation.

Spatial domain filters - Frequency domain filters - Morphological image processing - Binary morphological operations and properties - Morphological algorithms - Medical Image Segmentation, Thresholding - Region growing - Region splitting and merging - Edge detection. Analysis of shape and texture - Representation of shapes and contours - Shape factors - Models for generation of texture - Statistical analysis of texture - Fractal analysis - Fourier domain analysis of texture - Applications - Contrast enhancement of mammograms - Detection of calcifications by region growing - Shape and texture analysis of tumours. Reconstruction Techniques, Classification and Clustering, Examples of Image Classification for Diagnostic/Assistive Technologies, Case studies.

Image processing practical exercises:

1. Basic operations on images
2. Image enhancement using point operations.
3. Image enhancement using spatial domain filters.
4. Histogram processing of images.
5. Image enhancement using frequency domain filters.
6. Denoising of medical images.
7. Medical image segmentation using edge and region-based methods.
8. Extraction of shape and texture features from a medical image.
9. Design of pattern classification system for biomedical images.
10. Performance metrics in bioimages.

Recommended Tools MATLAB, Python

#### Textbooks

1. Suetens, P. Fundamentals of Medical Imaging, Cambridge University Press
2. Dougherty, G, Digital Image Processing for Medical Applications, Cambridge University Press
3. Prince, J. & Links, J. Medical Imaging Signals and Systems, Prentice Hall
4. Bankman, Isaac., Handbook of Medical Imaging: Processing and Analysis, Academic Press
4. Yoo, Terry S. Insight into Images: Principles and Practice for Segmentation, Registration and Image Analysis, CRC Press
5. Sethian, J.A., Level-set Methods, Cambridge University Press, 2000

## ELECTIVES

|         |                                        |      |
|---------|----------------------------------------|------|
| 25BI631 | Flexible Electronics for Smart Systems | 2023 |
|---------|----------------------------------------|------|

### New Course

### Learning Objectives

LO1: Understand and explain the structural foundations of flexible materials used in biomedical devices.

LO2: Interpret device performance in terms of physical principles like piezoresistivity, bioimpedance, and capacitive sensing.

LO3: Design and simulate flexible circuits for healthcare monitoring.

LO4: Evaluate integration strategies for sensors, actuators, and readout circuits in biomedical systems.

LO5: Analyze case studies and critically assess emerging flexible biomedical technologies.

### Course Outcomes

CO1: Understand the principles and materials of flexible electronics.

CO2: To provide hands-on experience in the design, simulation, and testing of flexible devices in biomedical context

CO3: Analyze clinical applications, challenges, and emerging trends in flexible electronics.

### Course contents

**Unit 1: Introduction to Flexible Electronics** Overview of flexible and stretchable electronics - Advantages and constraints in biomedical settings - Biocompatibility and mechanical requirements with key application areas: wearables, implants, e-skin, bio-patches. Materials for Flexible Biomedical Devices - Conductive polymers (e.g., PEDOT:PSS), organic semiconductors - Inorganic thin films on flexible substrates - Substrates: PDMS, PET, PI, hydrogels - Bioresorbable and biodegradable materials

**Unit 2: Device Modeling and Fabrication Techniques** Fundamentals of field-effect transistors (FETs), strain sensors, and capacitive sensors - Bioelectric signal acquisition: ECG, EMG, EEG - Simulation tools: Multiphysics based ANSYS, TCAD, COMSOL. Fabrication Techniques - Printing technologies: inkjet, screen, aerosol jet - Transfer printing, roll-to-roll fabrication - Microfluidic integration and encapsulation - Cleanroom protocols and wearable-grade fabrication.

**Unit 3: Interface Electronics, Signal Processing and System Integration** Low-power amplifiers, ADCs for bio signals - Filtering, artifact rejection, and signal conditioning - Wireless communication: NFC, BLE, inductive coupling. System Integration and Powering - Flexible batteries, energy harvesting (triboelectric, piezoelectric) - System-on-foil concepts - Embedded microcontrollers for biomedical applications

**Unit 4: Applications and Case studies** Smart bandages, wearable ECG/EEG, sweat sensors, electronic tattoos - Neural interfaces and implantable devices - Recent research papers and product teardowns.

### **Laboratory Work:**

- Simulation and fabrication of flexible sensors (e.g., resistive, capacitive)
- Characterization of flexible substrates and electrodes
- Bio-signal acquisition with a flexible patch and data analysis
- Integration project: Design of a flexible wearable health monitor

### Textbooks

1. *Flexible and Stretchable Electronics* by Takao Someya (Wiley)
2. *Bioelectronics: Principles and Applications* by Mark Meyyappan

3. *Wearable Bioelectronics* O. Parlak, A. Salleo, A. Turner, 2020 Elsevier Ltd.
4. *Flexible Electronics: from Materials to Devices*, Guozhen Shen, Zhiyong Fan, 2016 World Scientific Publishing Co. Pte. Ltd.
5. *Flexible Electronics: Materials and Applications (Electronic Materials: Science & Technology)*, W. S. Wong and A. Salleo, 2010 Springer
6. *Materials Science and Engineering: An Introduction 8th*, W. D. Callister, D. G. Rethwisch, 2010, Wiley.
7. Selected journal articles from *Advanced Materials*, *IEEE TBME*, *ACS Applied Materials & Interfaces*, etc.

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|----------------|---------------------------------------------------|----------------|
| <b>25BI732</b> | <b>Computer Vision and Immersive Technologies</b> | <b>2 0 2 3</b> |
|----------------|---------------------------------------------------|----------------|

### New Course

### Learning Objectives

LO1: Demonstrate understanding of key computer vision techniques and explain their relevance in immersive technologies.

LO2: Design and develop basic interactive AR/MR experiences using industry-standard platforms such as Unity, Vuforia, ARCore, or MRTK.

### Course Outcomes

CO1. Understand the fundamentals of computer vision and its role in immersive systems.

CO2. Apply image processing and vision-based tracking methods.

CO3. Analyse the core principles and technologies behind AR, VR, and MR.

CO4. Build basic AR/MR applications using industry tools and platforms.

### Course contents

#### Unit 1: Foundations of Computer Vision

Image representation, color spaces (RGB, grayscale), image filtering, edge detection, feature detection (Harris, SIFT, ORB), feature descriptors and matching, geometric transformations, homography, optical flow, and motion estimation.

#### Unit 2: 3D Vision and Camera Pose Estimation

Stereo vision, depth estimation, structure from motion, epipolar geometry, camera calibration, projection matrices, Perspective-n-Point (PnP) problem, pose estimation, and introduction to SLAM.

#### Unit 3: Immersive Technologies: AR, VR, and MR

AR systems and classifications (marker-based, markerless), tracking and registration, AR toolkits (ARToolkit, Vuforia), rendering and interaction; VR and MR concepts, hardware components, spatial mapping, ARCore, ARKit, MRTK, and immersive interaction design.

### Textbooks

1. Szeliski, Richard. *Computer vision: algorithms and applications*. Springer Nature, 2022.
2. Howse, Joseph, and Joe Minichino. *Learning OpenCV 4 Computer Vision with Python 3: Get to grips with tools, techniques, and algorithms for computer vision and machine learning*. Packt Publishing Ltd, 2020.
3. Schmalstieg, Dieter, and Tobias Hollerer. *Augmented reality: principles and practice*. Addison-Wesley Professional, 2016.
4. Craig, Alan B. "Understanding augmented reality: Concepts and applications." (2013)

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|----------------|-------------------------|----------------|
| <b>25BI632</b> | <b>Medical Robotics</b> | <b>2 0 2 3</b> |
|----------------|-------------------------|----------------|

### Learning Objectives

- LO1 To impart basic understanding of robotics.  
 LO2 To enable understanding the design and control concepts of medical robots.  
 LO3 To comprehend on the application of robotics in the field of healthcare.

### Course Outcomes

- CO1 Ability to understand different types of Robotic Systems  
 CO2 Ability to apply the concepts of robotics for surgery.  
 CO3 Ability to analyse the positioning and orientation of medical robots.  
 CO4 Ability to design the kinematics model for a specified robotic system.

### Course contents

Introduction to robots - Robots as mechanical devices - Classification of robotic manipulators - Robotic systems - Accuracy and repeatability - Wrists and end-effectors - Mathematical modelling of robots - Symbolic representation of robots - The configuration space - The state space - The workspace common kinematic arrangements of manipulators - Forward kinematics - Inverse kinematics - Velocity kinematics.  
 Medical robots - Robots for navigation - Movement replication - Robots for imaging - Rehabilitation and prosthetics - Describing spatial positioned orientation - Standardizing kinematic analysis - Computing joint angles - Quaternions - Robot kinematics -Three-joint robot - Six-joint robot.  
 Application of medical robots - The learning curve of robot - Assisted laparoscopic surgery - Haptic feedback in robotic heart surgery - Robotic applications in neurosurgery - Miniature robotic guidance for spine surgery.

### Textbooks

1. Achim Schweikard and Floris Ernst, Medical Robotics, Springer, 2015.
2. VanjaBozovic, Medical Robotics, Springer, 2008.
3. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, John Wiley & Sons, 2005.

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|----------------|------------------------------------------|----------------|
| <b>25BI633</b> | <b>Multivariate Time-Series Analysis</b> | <b>2 0 2 3</b> |
|----------------|------------------------------------------|----------------|

### Name and Credit Change

### Learning Objectives

- LO1 To provide basic concepts of multivariate signals.  
 LO2 To impart knowledge on statistical analysis of multivariate time series data.  
 LO3 To introduce time and spectral domain approaches for analysing multivariate biomedical data.

### Course Outcomes

CO1 Ability to understand the basics of multivariate signal processing.  
 CO2 Ability to apply statistical analysis for multivariate time series data.  
 CO3 Ability to analyse multi-domain features of Biomedical signals.  
 CO4 Ability to evaluate performance of multivariate signal processing algorithms.

### Course contents

Concept of random variables - Stochastic processes - Relations among random variables - correlation, multiple correlation, and partial correlation - Univariate and multivariate Gaussian distributions - Univariate Time Series - Time domain approach - Frequency domain approach. Time series models - AR Models, ARMA Models - Multivariate Time Series - Time domain approach and spectral domain approach - Assessing relations among time series in the spectral domain - Data based estimation versus model based estimation - Principal Component Analysis (PCA) - Signal decorrelation - Independent Component Analysis (ICA).  
 Data compression of EEG and ECG signals - EMG Source signal separation techniques - EEG signal separation and Pattern Classification - Correlation of Biomedical signals - Evaluating causal relations in biomedical systems - Case studies - ICA based analysis on neurological disorders using EEG - Deep learning-based arrhythmia classification using EEG.

### Textbooks

1. William W. S. Wei, Multivariate Time Series Analysis and Applications, Wiley, 2019.
2. Katarzyn Blinowska, Jaroslaw Zygierecz, Practical Biomedical Signal Analysis Using MATLAB -Multiple channels (multivariate) signal, CRC press, 2011.
3. Johnson, Applied Multivariate Statistical Analysis, PHI publisher, 2012.
4. Jocelyn Chanussot, Jocelyn Chanussot, Kacem Chehdi, Multivariate Image processing, Wile Publication, 2009.

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|----------------|------------------------------------|----------------|
| <b>25BI634</b> | <b>Speech and Audio Processing</b> | <b>2 0 2 3</b> |
|----------------|------------------------------------|----------------|

### Learning Objectives

LO1 To introduce the concepts of signal processing with application to speech processing.  
 LO2 To provide insights on feature extraction for speech coding, synthesis, and recognition.  
 LO3 To enable understanding of deep learning applications to speech processing and health care.

### Course Outcomes

CO1 Ability to understand concepts of Speech signal processing.  
 CO2 Ability to apply the concepts of signal processing to feature extraction of speech/audio signals.  
 CO3 Ability to analyse and process speech data for speech coding, synthesis, and recognition.  
 CO4 Ability to evaluate speech/audio processing techniques in healthcare applications.

### Course contents

Introduction to signal processing - FIR and IIR filters - DFT - FFT - Speech analysis overview - Modelling of speech production - Speech perception and models - Feature extraction for speech processing - Auditory system as a filter bank - Linear predictive coding - Spectrum - Cepstrum - Mel-frequency cepstral coefficients. Introduction to music synthesis - Music signal analysis - Source separation -Speech recognition - Synthesis and coding - Introduction to deep

neural networks - Applications of deep learning techniques to speech processing - Applications of speech and audio processing in healthcare - Case studies - Dysarthria – Aphasia. Analysis of speech/audio - Experiment with speech analysis and synthesis - Experiment with deep learning techniques for speech recognition - Analyse the speech signals of controls with dysarthria and aphasia.

### Textbooks

1. B. Gold, N. Morgan, D. Ellis, Speech, and Audio Signal Processing: Processing and Perception of Speech and Music, Wiley, 2011.
2. Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, Spoken Language Processing: A guide to theory, algorithm and system development, Prentice Hall Inc., 2001.
3. U Kamath, J Liu, J Whitaker, Deep Learning for NLP and speech recognition, Springer, 2019.

|         |                             |      |
|---------|-----------------------------|------|
| 25BI731 | Deep Learning in Healthcare | 2023 |
|---------|-----------------------------|------|

### New Course

#### Learning Objectives

LO1 To provide basic introduction to deep learning and its role in biomedicine and healthcare.

LO2 To introduce different concepts, methods, and potential intelligent systems in medicine.

#### Course Outcomes

CO1 Ability to understand decision support systems.

CO2 Ability to apply neural networks and deep neural networks for healthcare problems.

CO3 Ability to apply time-series forecasting for healthcare applications.

### Course contents

Introduction to Deep Learning in Healthcare, covering diagnostic, prognostic, and personalized medicine applications with real-world case studies; Biomedical Data Types and Challenges, focusing on imaging, signals, text, and omics data along with issues like annotation, bias, and class imbalance; Tools and Frameworks for Implementation, introducing Python, PyTorch/TensorFlow, MONAI, and MedPy; CNNs for Medical Image Classification, including transfer learning and fine-tuning; Tumor Detection and Grading, with hands-on case studies using MRI/CT; Semantic Segmentation in Radiology, exploring U-Net and organ-specific tasks; 3D Medical Image Analysis, focusing on volumetric data and 3D architectures; Image Registration and Localization, covering alignment and landmark detection; Time-Series Signal Processing, centered on ECG, EEG, and wearable sensor data; RNNs and LSTMs for Biomedical Signals, including arrhythmia detection; Sleep Stage Classification using EEG, highlighting models like DeepSleepNet; Multimodal Biosignal Fusion, integrating multiple physiological signals for diagnosis; Clinical NLP and Predictive Modeling, including BERT and transformer-based approaches for EHR analysis; Explainable AI in Healthcare, introducing GradCAM, SHAP, and LIME for model interpretability; and Project-Based Learning, with hands-on demos such as retinal image analysis, biosignal-based stress/seizure detection, and a clinical triage assistant.

### Textbooks

1. Begg, Rezaul, Daniel TH Lai, and Marimuthu Palaniswami, computational intelligence in biomedical engineering. CRC Press, 2007.

2. Hudson, Donna L., and Maurice E. Cohen. Neural networks and artificial intelligence for biomedical engineering, Institute of Electrical and Electronics Engineers, 2000.
3. Agah, Arvin, Introduction to medical applications of artificial intelligence, Medical Applications of Artificial Intelligence, CRC Press, 2013. 18-25.

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|----------------|------------------------------------|----------------|
| <b>25BI733</b> | <b>Wearable Biomedical Systems</b> | <b>3 0 0 3</b> |
|----------------|------------------------------------|----------------|

### Learning Objectives

- LO1 To introduce the fundamentals of wearable sensor technology.  
 LO2 To impart knowledge on electronics in wearable system design.  
 LO3 To enable knowledge development on principles of energy harvesting.  
 LO4 To provide insight to assistive technologies in wearable system.

### Course Outcomes

- CO1 Ability to understand the basics of wearable sensor system design.  
 CO2 Ability to apply the IC technologies for bio sensing.  
 CO3 Ability to analyse the energy and power consumption requirements in system design.  
 CO4 Ability to evaluate the multi parameter measurements from wearable sensors.

### Course contents

Introduction to Wearable sensors - Attributes of wearables - Meta-wearable - Challenges and opportunities - Future of wearables - Social interpretation of Aesthetics - Case study - Google glass - Wearable haptics - Need for wearable haptic devices - Categories of wearable haptic and tactile display - Wearable Sensors - Chemical and Biochemical sensors - System design - Challenges in chemical biochemical sensing – Applications.

Flexible Electronics and Energy Harvesting Systems - Thin-film transistors - Low-power Integrated Circuit design for biopotential sensing - Analog circuit design techniques.

Lowpower design for ADCs - Digital circuit design techniques - Architectural design for low power biopotential acquisition - Practical considerations - Energy harvesting from human body - Temperature gradient - Foot motion - Wireless energy transmission - Energy harvesting from light and RF energy - Energy and power consumption issues - Future considerations  
 Monitoring Physical and Physiological Parameters - Wearable sensors for physiological signal measurement - Physical measurement - cardiovascular diseases – Neurological diseases - Gastrointestinal diseases - Wearable and non-invasive assistive technologies - Assistive devices for individuals with severe paralysis - Wearable tongue drive system - Dual-mode tongue drive system.

### Textbooks

1. Edward Sazonov, Michael R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Academic Press, USA, 2014.
2. Tom Bruno, Wearable Technology: Smart Watches to Google Glass for Libraries, Rowman & Littlefield Publishers, Lanham, Maryland, 2015.
3. Raymond Tong, Wearable Technology in Medicine and Health Care, Academic Press, USA, 2018.
4. Haider Raad, The Wearable Technology Handbook, United Scholars Publication, USA, 2017.

### Learning Objectives

LO1 To introduce the basics of MEMS.

LO2 To provide understanding fabrication of BioMEMS.

LO3 To impart knowledge on biomedical applications of MEMS.

### Course Outcomes

CO1 Ability to understand the operation of micro devices, micro systems, and their application.

CO2 Ability to design the micro devices, micro systems using the MEMS fabrication process.

CO3 Ability to analyse the optic MEMS applications in bioengineering.

CO4 Ability to evaluate the performance of MEMS in diagnostic applications.

### Course contents

History of BioMEMS - overview of the different types of MEMS and microsystems, Smart systems and 3D architectures. Current state of the art and trends at the academic and industrial levels. Micropatterning of substrates and cells - Microfluidics - Molecular biology on a Chip - Cell-based chips for biotechnology - BioMEMS for cell biology - Tissue microengineering MEMS for biomedical sensing and diagnostic applications - MEMS for in vivo sensing - MEMS and Electrical Impedance Spectroscopy (EIS) for non-invasive measurement of cells - MEMS ultrasonic transducers for biomedical applications - BioMEMS for drug delivery applications - BioMEMS for drug delivery applications - Applications of MEMS technologies for minimally invasive medical procedures - Smart microgrippers for bioMEMS applications. Optical bio-sensing applications - Colorimetric detection - Fluorescence detection - Luminescence detection - Bioluminescence detection - Chemiluminescence detection - Bio chemiluminescence detection - Electrochemiluminescence detection.

### Textbooks

1. Albert Folch, Introduction to BioMEMS, CRC Press, 2013.
2. Shekhar Bhansali and Abhay Vasudev, MEMS for Biomedical Applications, Woodhead Publishing Limited, 2012.
3. Samira Hosseini, Michelle Alejandra Espinosa-Hernandez, Ricardo Garcia-Ramirez, Ana Sofia Cerda-Kipper, Sofia Reveles-Huizar, Luis Acosta-Soto, BioMEMS - Biosensing Applications, Springer, 2021.

Learning Objectives

- LO1 To provide knowledge of virtual instrumentation.  
LO2 To enable understanding of virtual signal processing tools.  
LO3 To introduce biomedical applications of virtual instrumentation.

Course Outcomes

- CO1 Ability to understand programming concepts for virtual instrumentation.  
CO2 Ability to analyse bio-signal processing algorithms using virtual instrumentation.  
CO3 Ability to develop virtual codes for biomedical applications.

Course contents

Introduction to virtual instrumentation - Loops and structures - Arrays and clusters - Graphs and charts File and string handling - Basics of data acquisition - Common communication buses using DAQ assistant - Real world DAQ and issues - Network and distributed systems.  
Data handling techniques - Signal acquisition and sampling theorem - Effect of undersampling - Convolution - Designing an FIR and IIR filters - FFT analysis of periodic and aperiodic signals - Designing of low pass filter - High pass filter - Bandpass filter - Band reject filter - Notch filter and Comb filter.  
Processing of ECG, EMG and EOG signals - Adaptive signal processing - Data compression techniques - AZTEC - TP - CORTES and KL transform.

Textbooks

1. Sanjay Gupta and Joseph John, Virtual Instrumentation Using Labview, Tata McGraw Hill Education Private Limited, 2010.
2. Behzad Ehsani, Data Acquisition using LabVIEW, Packt Publishing, 2016.
3. Kunal Mitra, Stephanie Miller, Short Pulse Laser Systems for Biomedical Applications, Springer Briefs in Applied Sciences and Technology, 2017.
4. Leon Goldman, The Biomedical Laser Technology and Clinical Applications, Springer Verlag, 1981.

Learning Objectives

- LO1 To introduce concepts of Bio-inspired Computing and its applications.  
LO2 To provide insight on Artificial Neural Networks.  
LO3 To introduce Fuzzy logic and Fuzzy Systems.  
LO4 To provide knowledge on optimization algorithms.

Course Outcomes

- CO1 Ability to understand the principles of bio-inspired algorithms.

CO2 Ability to apply bio-inspired techniques for pattern recognition and optimization tasks.  
CO3 Ability to analyse problems in medical applications using bio-inspired approaches.  
CO4 Ability to evaluate performance of optimization algorithms.

#### Course contents

Neural networks - Artificial neurons - Activation functions - Learning rules - Supervised and Unsupervised Learning - Single layer and multilayer perceptron - Kohonen's self-organizing networks - Hopfield networks. Fuzzy systems - Fuzzy sets and relations - Membership functions - Rule base reduction methods - Decision making with fuzzy information - Fuzzy classification and pattern recognition - Neuro-fuzzy systems. Introduction to genetic algorithms - Parent selection - Crossover - Mutation - Genetic Programming - Particle Swarm Optimization - Ant colony optimization - Artificial immune systems - Case Studies - Fuzzy region growing for segmentation of calcifications in mammograms - Classification of normal and ectopic beats using neural networks - Image registration using hybrid bio-inspired approaches.

#### Textbooks

1. Fausett, Laurene V. Fundamentals of neural networks: architectures, algorithms and applications, Pearson Education India, 2006.
2. Ross, Timothy J. Fuzzy logic with engineering applications. Vol. 2. New York: Wiley, 2004.
3. Goldberg, David E. Genetic algorithms, Pearson Education India, 2006.

|         |                  |      |
|---------|------------------|------|
| 25BI737 | Mobile Computing | 2023 |
|---------|------------------|------|

#### Learning Objectives

LO1 To introduce different mobile application and development platforms  
LO2 To provide an overview of the use of portable devices and wireless communication technologies to enable access to digital resources and services from anywhere.

#### Course Outcomes

CO1 Ability to comprehend the technical modules of mobile devices, operating systems and applications.  
CO2 Introduction to Android platform and the design of user interface for mobile applications  
CO3 Introduction to working with database and security systems.  
CO4 Overview is Security systems and permissions in mobile computing.

#### Course contents

History of mobile devices, mobile operating systems and mobile application frameworks, Modern mobile operating systems, and their architecture. Overview of mobile application development languages: C and Java. Introduction to Android platform: virtual machine, development tools, Java packages, emulators, services, Structure, and lifecycle of an application for Android system. User interface design for mobile applications: Graphical User

Interface - preparing containers and components, management of component layout, event handling; Introduction to integration and working with database. Overview of security and permissions, Bluetooth communication, deployment of application.

### Textbooks

2. Bill Phillips, Chris Stewart, Brian Hardy, and Kristin Marsicano, Android Programming: The Big Nerd Ranch Guide, 2017.
3. Rajiv Ramnath, Roger Crows, and Paolo Sivilotti, Android SDK 3 for Dummies, Wiley.
4. Asoke K. Talukder, Roopa R. Yavagal, Mobile Computing: Technology, Applications, and Service Creation, 2007.
5. Burnette E., Hello, Android: Introducing Google's Mobile Development Platform, 2010.
6. Steele J, The Android Developer's Cookbook: Building Applications with the Android SDK, 2010.
7. Chris Griffith, Mobile App Development with Ionic: Cross-Platform Apps with Ionic, Angular & Cordova, 2017.
8. Joshua Morony, Building Mobile Apps with Ionic & Angular [eBook].

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|----------------|-----------------------------------|----------------|
| <b>25BI738</b> | <b>Brain Computer Interfacing</b> | <b>2 0 2 3</b> |
|----------------|-----------------------------------|----------------|

### Learning Objectives

- LO1 To introduce the concepts of Brain Computer Interfacing (BCI).  
LO2 To impart knowledge about the data acquisition methods used in BCI.  
LO3 To enhance the understanding on BCI signal Processing and parameter extraction.  
LO4 To enable the knowledge on classification of cognitive task from BCI parameters.

### Course Outcomes

- CO1 Ability to understand the basic concepts of EEG and BCI.  
CO2 Ability to apply signal processing techniques in BCI.  
CO3 Ability to analyse human cognition using BCI parameters.  
CO4 Ability to evaluate machine learning methods in BCI applications.

### Course contents

Brain activation patterns - Spikes - Oscillatory potential - Event-Related Potentials (ERP) -Mu rhythms - Stimulus related potentials - Visual evoked potentials and auditory evoked potentials – Potentials related to cognitive tasks - Brain computer interface types - Invasive -Non-invasive - Brain signal for BCI signal - EEG - MEG - fNIRS – fMRI. BCI signal processing - Spatial - Temporal - Spatio-temporal filters - Spike sorting - Time and frequency domain analysis - Wavelet analysis - Principal Component Analysis (PCA) -Independent Component Analysis (ICA) - Artifacts reduction - Feature Extraction - Phase synchronization and coherence - ERP Analysis in BCI. Interfacing Brain and Machine - BCI system monitoring hardware - Machine Learning for feature classification - BCI application - Neuro prosthetic devices - Cursor and robotic control using multi electrode array implant - Visual cognitive BCI - Emotion detection.

### Textbooks

1. Ella Hassianien, A &Azar.A.T, Brain-Computer Interfaces Current Trends and Applications, Springer, 2015.

2. Rajesh.P, N.Rao, Brain-Computer Interfacing: An Introduction, Cambridge University Press, First edition, 2013.
3. Jonathan Wolpaw, Elizabeth Winter Wolpaw, Brain Computer Interfaces Principles and practice, Oxford University Press, USA, Edition 1, January 2012.
4. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction, Springer, 2010

25AVP501

MASTERY OVER MIND

1-0-2-2

## PG SYLLABUS

### COURSE OBJECTIVES

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organize university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction introduces immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony. With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for Life along with Education for Living" and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

### COURSE OUTCOME

| After successful completion of the course, students will be able to: |                                                                                                           |
|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| S.No.                                                                | Course Outcomes                                                                                           |
| 1.                                                                   | Understand the scientific benefits of meditation. (CO1)                                                   |
| 2.                                                                   | Explain the science behind meditation and its effects on physical and mental well-being (CO2).            |
| 3.                                                                   | Understand the meditation techniques to cultivate emotional intelligence and improve relationships (CO3). |
| 4.                                                                   | Learn and practice MAOM meditation in daily life (CO4).                                                   |
| 5.                                                                   | To apply the effect of meditation to compassion-driven action (CO5)                                       |

### Syllabus:

#### Scientific benefits of Meditation (CO1)

Scientific benefits of meditation, exploring its effects on physical and mental wellbeing.

Learn about the different types of meditation practices, the essential elements of meditation, and the empirical evidence supporting its benefits.

Video resource-Swami Atmanandamrita Puri

#### Science Behind Meditation (CO2)

A: A preliminary understanding of the Science of meditation. What can modern science tell us about this tradition-based method?

B: How meditation helps humanity according to what we know from scientific research

Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)

Reading 2: 'Science and Spirituality.' Chapter 85 in Amritam Gamaya (2022). Mata

Amritanandamayi Mission Trust.

### **Role of Meditation in Emotional intelligence (CO3)**

Learn how meditation practices can enhance self-awareness, self-regulation, motivation, empathy, and social skills, leading to improved relationships and decision-making. Improve communication, emotional intelligence, and interpersonal skills. Logical and analytical reasoning

### **Practicing MA OM Meditation in Daily Life (CO4)**

Guided Meditation Sessions following scripts provided (Level One to Level Five)

Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami Atmananda Puri)

Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

### **Meditation and Compassion-driven Action (CO5)**

Understand how meditation can help to motivate compassion-driven action.

Reading 1: Schindler, S., & Frieze, M. (2022). The relation of mindfulness and prosocial behavior: What do we (not) know? Current Opinion in Psychology, 44, 151-156.

Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

### **Textbooks / References:**

1. Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019
2. Swami Amritaswarupananda Puri, "The Color of Rainbow" published by MAM, Amritapuri.
3. Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019
4. R Nagarathna et al, "New Perspectives in Stress Management" Swami Vivekananda Yoga Prakashana publications, Jan 1986
5. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019
6. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018
7. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
8. Mata Amritanandamayi Devi "Compassion: The only way to Peace: Paris Speech", MA Center, April 2016.
9. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.
10. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

|                                             |
|---------------------------------------------|
| <b>GLIMPSES OF INDIAN CULTURE</b>           |
| <b>P/F</b>                                  |
| <b>22ADM501: GLIMPSES OF INDIAN CULTURE</b> |
| <b>A. Prerequisite: nil</b>                 |
| <b>B. Nature of Course: Theory</b>          |
| <b>C. Course Objectives:</b>                |

- The course "Glimpses of Indian Culture" aims to provide students with a comprehensive understanding of various aspects of Indian culture, with a focus on its spiritual, philosophical, and religious dimensions.
- Through an exploration of the chapters from the provided book, students will gain insights into the foundational principles, practices, and symbols that shape the diverse cultural landscape of India
- Aligned with the Indian Knowledge Systems (IKS) framework outlined in the National Education Policy, this course serves as an introduction to the vast reservoir of wisdom and knowledge rooted in Indian heritage.
- By engaging with the chapters in the book, students will develop a holistic appreciation for the rich tapestry of Indian culture, spanning from its philosophical underpinnings to its artistic expressions, rituals, and societal values.
- This course aims to cultivate cultural sensitivity, critical thinking, and a deeper understanding of the diverse spiritual and cultural traditions that have shaped India's identity over millennia.

**D. Course Outcomes:** After successful completion of the course, Students will be able to:

| CO   | Course Outcomes                                                                                                                                                                                                                                                                                                 | Knowledge level<br>[Bloom's Taxonomy] |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| CO01 | <b>Recall key concepts and terms associated with Sanatana Dharma, scriptures, and core cultural elements of India.</b><br>Statement: Demonstrate the ability to remember essential terms, concepts, and principles discussed in the chapters on Sanatana Dharma, scriptures, and cultural aspects.              | Remembering                           |
| CO02 | <b>Explain the concepts of Īśvara, Guru Tattva, Avatara Tattva, and the Theory of Karma as foundational elements of Indian cultural philosophy.</b><br>Statement: Understand the profound meanings of Īśvara, Guru, Avatara, and Karma, elucidating their importance in shaping Indian cultural thought.        | Understanding                         |
| CO03 | <b>Apply the knowledge of Purusharthas, Sanyasa, and Yajna to analyze real-life ethical and spiritual scenarios.</b><br>Statement: Utilize insights from Purusharthas, Sanyasa, and Yajna to navigate ethical dilemmas and make informed decisions.                                                             | Applying                              |
| CO04 | <b>Analyze the symbolism in cultural practices, Nataraja iconography, and temple architecture.</b><br>Statement: Deconstruct the layers of symbolism in various cultural aspects, including Nataraja representation and temple architecture, unraveling their deep meanings.                                    | Analyzing                             |
| CO05 | <b>Evaluate the significance of temples as cradles of culture and explore alternative systems in India's cultural landscape.</b><br>Statement: Assess the role of temples in preserving cultural heritage and critically examine the diversity of cultural and spiritual systems in India.                      | Evaluating                            |
| CO06 | <b>Develop projects or presentations that highlight the essence of Sanatana Dharma, sadhana, and the cultural significance of symbols.</b><br>Statement: Create expressive projects that capture the essence of Sanatana Dharma, convey the practices of sadhana, and portray the cultural meanings of symbols. | Creating                              |

**POs Programme Outcomes**

**COs**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PO1: Engineering Knowledge</b><br><b>PO2: Problem Analysis</b><br><b>PO3: Design/Development of Solutions</b><br><b>PO4: Conduct Investigations of complex problems</b><br><b>PO5: Modern tools usage</b><br><b>PO6: Engineer and Society</b><br><b>PO7: Environment and Sustainability</b><br><b>PO8: Ethics</b><br><b>PO9: Individual &amp; Teamwork</b><br><b>PO10: Communication</b><br><b>PO11: Project management &amp; Finance</b><br><b>PO12: Lifelong learning</b> | <ul style="list-style-type: none"> <li>CO 1: Recall key concepts and terms associated with Sanatana Dharma, scriptures, and core cultural elements of India.</li> <li>CO 2: Explain the concepts of Īśvara, Guru Tattva, Avatara Tattva, and the Theory of Karma as foundational elements of Indian cultural philosophy</li> <li>CO 3: Apply the knowledge of Purusharthas, Sanyasa, and Yajna to analyze real-life ethical and spiritual scenarios.</li> <li>CO 4: Analyze the symbolism in cultural practices, Nataraja iconography, and temple architecture.</li> <li>CO 5: Evaluate the significance of temples as cradles of culture and explore alternative systems in India's cultural landscape.</li> <li>CO 6: Develop projects or presentations that highlight the essence of Sanatana Dharma, sadhana, and the cultural significance of symbols.</li> </ul> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

#### **B.Tech. EEE Programme Specific Outcome (PSO)**

##### **PSO1:**

Awareness of Future Technology: Develop solutions for future systems using smart technologies.

##### **PSO2:**

Research and Innovation: Identify engineering challenges, approach using cutting edge research tools and execute innovative solutions.

#### **E. CO-PO Mapping: [affinity<sup>#</sup>: 3 – high; 2- moderate; 1- slightly]**

| COs     | Program Outcomes [POs] |     |     |     |     |     |     |     |     |      |      |      | Program Specific Outcomes [PSOs]* |      |
|---------|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|-----------------------------------|------|
|         | PO1                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1                              | PSO2 |
| CO01    | -                      | -   | -   | -   | -   | -   | -   | 2   | -   | -    | -    | 3    | -                                 | -    |
| CO02    | -                      | -   | -   | -   | -   | 1   | -   | 2   | -   | -    | -    | 3    | -                                 | -    |
| CO03    | -                      | -   | -   | -   | -   | 3   | 3   | 3   | 2   | -    | -    | 2    | -                                 | -    |
| CO04    | -                      | -   | -   | -   | -   | 3   | -   | -   | -   | -    | -    | 3    | -                                 | -    |
| CO05    | -                      | -   | -   | -   | -   | 2   | 3   | -   | -   | -    | -    | 2    | -                                 | -    |
| CO06    | -                      | -   | -   | -   | -   | 2   | 2   | 2   | 2   | -    | -    | 3    | -                                 | -    |
| Total   |                        |     |     |     |     |     |     |     |     |      |      |      |                                   |      |
| Average |                        |     |     |     |     |     |     |     |     |      |      |      |                                   |      |

#### **F. SYLLABUS**

#### **GLIMPSES OF INDIAN CULTURE**

**[P/F]**

##### **Course Syllabus**

|                   |   |                                         |
|-------------------|---|-----------------------------------------|
| <b>Chapter 1</b>  | - | <b>What is Sanatana Dharma</b>          |
| <b>Chapter 2</b>  | - | <b>The Heritage of Scriptures</b>       |
| <b>Chapter 3</b>  | - | <b>The idea of Īśvara</b>               |
| <b>Chapter 4</b>  | - | <b>Guru Tattva and Avatara Tattva</b>   |
| <b>Chapter 5</b>  | - | <b>Theory of Karma</b>                  |
| <b>Chapter 6</b>  | - | <b>Purusharthas</b>                     |
| <b>Chapter 7</b>  | - | <b>Sanyasa</b>                          |
| <b>Chapter 8</b>  | - | <b>Yajna</b>                            |
| <b>Chapter 9</b>  | - | <b>Symbolism</b>                        |
| <b>Chapter 10</b> | - | <b>Understanding Nataraja</b>           |
| <b>Chapter 11</b> | - | <b>Temples: The Cradle of Culture</b>   |
| <b>Chapter 12</b> | - | <b>Other Heterodox Systems in India</b> |
| <b>Chapter 13</b> | - | <b>Sadhana</b>                          |

#### **GLIMPSES OF INDIAN CULTURE**

##### **Reference Books:**

*The Eternal Truth by Mata Amritanandamayi Devi*

*Temples: Centers for Spiritual Practice by Mata Amritanandamayi Devi*  
*All About Hinduism by Swami Sivananda*  
*Art of God Symbolism by Swami Chinmayananda*  
*Temples in India by Swami Sivananda*

**G. Evaluation Pattern: 60:40**

| Component    | Weightage | Remarks |
|--------------|-----------|---------|
| Internal     | 60        | -       |
| External     | 40        | -       |
| <b>TOTAL</b> | 100       |         |

**23HU601**

**Career Competency I**

**L-T-P-C: 0-0-3-P/F**

**Prerequisite:**

An open mind and the urge for self-development, basic English language skills and knowledge of high school level arithmetic.

**Course Objectives:**

- Help students transit from campus to corporate and enhance their soft skills
- Enable students to understand the importance of goal setting and time management skills
- Support them in developing their problem solving and reasoning skills
- Inspire students to enhance their diction, grammar and verbal reasoning skills

**Course Outcomes:**

**CO1: Soft Skills** - To develop positive mindset, communicate professionally, manage time effectively and set personal goals and achieve them.

**CO2: Soft Skills** - To make formal and informal presentations with self-confidence.

**CO3: Aptitude** - To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.

**CO4: Aptitude** - To analyze, understand and apply suitable techniques to solve questions on logical reasoning and data analysis.

**CO5: Verbal** - To infer the meaning of words and use them in the right context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.

**CO6: Verbal** - To identify the relationship between words using reasoning skills. To understand and analyze arguments and use inductive/deductive reasoning to arrive at conclusions and communicate ideas/perspectives convincingly.

**CO-PO Mapping**

| PO/CO | PO1 | PO2 | PO3 |
|-------|-----|-----|-----|
| CO1   | 2   | 1   | -   |
| CO2   | 2   | 1   | -   |
| CO3   | 2   | 1   | -   |
| CO4   | 2   | 1   | -   |
| CO5   | 1   | 2   | -   |
| CO6   | 2   | 2   | -   |

**Syllabus:**

**Soft Skills**

Introduction to ‘campus to corporate transition’:

Communication and listening skills: communication process, barriers to communication, verbal and non-verbal communications, elements of effective communication, listening skills, empathetic listening, role of perception in communication.

Assertiveness skills: the concept, assertiveness and self-esteem, advantages of being assertive, assertiveness and organizational effectiveness.

Self-perception and self-confidence: locus of control (internal v/s external), person perception, social perception, attribution theories-self presentation and impression management, the concept of self and self-confidence, how to develop self-confidence.

Goal setting: the concept, personal values and personal goals, goal setting theory, six areas of goal setting, process of goal setting: SMART goals, how to set personal goals

Time management: the value of time, setting goals/ planning and prioritizing, check the time killing habits, procrastination, tools for time management, rules for time management, strategies for effective time management

Presentation skills: the process of presentation, adult learning principles, preparation and planning, practice, delivery, effective use of voice and body language, effective use of audio visual aids, dos and don'ts of effective presentation

Public speaking-an art, language fluency, the domain expertise (Business GK, Current affairs), self-confidence, the audience, learning principles, body language, energy level and conviction, student presentations in teams of five with debriefing

### **Verbal**

**Vocabulary:** Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misspelt words, commonly confused words and wrong form of words in English.

**Grammar:** Train students to understand the nuances of English Grammar and thereby enable them to spot grammatical errors and punctuation errors in sentences.

**Reasoning:** Stress the importance of understanding the relationship between words through analogy questions and learn logical reasoning through syllogism questions. Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication.

**Oral Communication Skills:** Aid students in using the gift of the gab to improve their debating skills.

**Writing Skills:** Introduce formal written communication and keep the students informed about the etiquettes of email writing. Make students practise writing emails especially composing job application emails.

### **Aptitude**

**Numbers:** Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.

**Percentage:** Basics, Profit, Loss & Discount, and Simple & Compound Interest.

**Ratio, Proportion & Variation:** Basics, Alligations, Mixtures, and Partnership.

**Averages:** Basics, and Weighted Average.

**Time and Work:** Basics, Pipes & Cistern, and Work Equivalence.

**Time, Speed and Distance:** Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.

**Statistics:** Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

**Data Interpretation:** Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other forms of data representation.

**Equations:** Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.

**Logarithms, Inequalities and Modulus:** Basics

### **References**

#### **Soft Skills:**

Communication and listening skills:

- Andrew J DuRbin , “Applied Psychology: Individual and organizational effectiveness”, Pearson-Merril Prentice Hall, 2004
- Michael G Aamodt, “An Applied Approach, 6<sup>th</sup> edition”, Wadsworth Cengage Learning, 2010

Assertiveness skills:

- Robert Bolton, Dorothy Grover Bolton, “People Style at Work..and Beyond: Making Bad Relationships Good and Good”, Ridge Associates Inc., 2009
- John Hayes “Interpersonal skills at work”, Routledge, 2003
- Nord, W. R., Brief, A. P., Atieh, J. M., & Doherty, E. M., “Meanings of occupational work: A collection of essays (pp. 21- 64)”, Lexington, MA: Lexington Books, 1990

#### Self-perception and self-confidence:

- Mark J Martinko, “Attribution theory: an organizational perspective”, St. Lucie, 1995
- Miles Hewstone, “Attribution Theory: Social and Functional Extensions”, Blackwell, 1983

#### Time management:

- Stephen Covey, “The habits of highly effective people”, Free press Revised edition, 2004
- Kenneth H Blanchard , “The 25 Best Time Management Tools & Techniques: How to Get More Done Without Driving Yourself Crazy” , Peak Performance Press, 1<sup>st</sup> edition 2005
- Kenneth H. Blanchard and Spencer Johnson, “The One Minute Manager” , William Morrow, 1984

#### Verbal:

- Erica Meltzer, “The Ultimate Guide to SAT Grammar”
- Green, Sharon, and Ira K. Wolf, “Barron's New GRE”, Barron's Educational Series, 2011
- Jeff Kolby, Scott Thornburg & Kathleen Pierce, “Nova’s GRE Prep Course”
- Kaplan, “Kaplan New GRE Premier”, 2011-2012
- Kaplan’s GRE Comprehensive Programme
- Lewis Norman, “Word Power Made Easy”, Goyal Publishers, Reprint edition, 1 June 2011
- Manhattan Prep, “GRE Verbal Strategies Effective Strategies Practice from 99th Percentile Instructors”
- Pearson- “A Complete Manual for CAT”, 2013
- R.S. Aggarwal, “A Modern Approach to Verbal Reasoning”
- S. Upendran, “Know Your English”, Universities Press (India) Limited, 2015
- Sharon Weiner Green, Ira K. Wolf, “Barron's New GRE, 19th edition (Barron's GRE)”, 2019
- Wren & Martin, “English Grammar & Composition”
- [www.bbc.co.uk/learningenglish](http://www.bbc.co.uk/learningenglish)
- [www.cambridgeenglish.org](http://www.cambridgeenglish.org)
- [www.englishforeveryone.org](http://www.englishforeveryone.org)
- [www.merriam-webster.com](http://www.merriam-webster.com)

#### Aptitude:

- Arun Sharma, “How to Prepare for Quantitative Aptitude for the CAT Common Admission Test”, Tata Mc Graw Hills, 5th Edition , 2012
- Arun Sharma, “How to Prepare for Logical Reasoning for the CAT Common Admission Test”, Tata Mc Graw Hills, 2nd Edition, 2014
- Arun Sharma, “How to Prepare for Data Interpretation for the CAT Common Admission Test”, Tata Mc Graw Hills, 3rd Edition, 2015
- R.S. Aggarwal, “Quantitative Aptitude For Competitive Examinations”, S. Chand Publishing, 2015
- R.S. Aggarwal, “A Modern Approach To Verbal & Non-Verbal Reasoning”, S. Chand Publishing, Revised -2015
- Sarvesh Verma, “Quantitative Aptitude-Quantum CAT”, Arihant Publications, 2016
- [www.mbatious.com](http://www.mbatious.com)
- [www.campusgate.co.in](http://www.campusgate.co.in)
- [www.careerbless.com](http://www.careerbless.com)

#### **Evaluation Pattern**

| Assessment                                | Internal | External |
|-------------------------------------------|----------|----------|
| Continuous Assessment (CA)* – Soft Skills | 30       | -        |
| Continuous Assessment (CA)* – Aptitude    | 10       | 25       |
| Continuous Assessment (CA)* – Verbal      | 10       | 25       |

|                    |    |    |
|--------------------|----|----|
| Total              | 50 | 50 |
| <b>Pass / Fail</b> |    |    |

\*CA - Can be presentations, speaking activities and tests.

**23HU611**

**Career Competency II**

**L-T-P-C: 0-0-3-1**

**Pre-requisite:** Willingness to learn, team spirit, basic English language and communication skills and knowledge of high school level arithmetic.

**Course Objectives:**

- Help students to understand the importance of interpersonal skills and team work
- Prepare the students for effective group discussions and interviews participation.
- Help students to sharpen their problem solving and reasoning skills
- Empower students to communicate effectively by using the correct diction, grammar and verbal reasoning skills

**Course Outcomes:**

**CO1: Soft Skills** - To demonstrate good interpersonal skills, solve problems and effectively participate in group discussions.

**CO2: Soft Skills** - To write technical resume and perform effectively in interviews.

**CO3: Aptitude** - To identify, investigate and arrive at appropriate strategies to solve questions on arithmetic by managing time effectively.

**CO4: Aptitude** - To investigate, understand and use appropriate techniques to solve questions on logical reasoning and data analysis by managing time effectively.

**CO5: Verbal** - To be able to use diction that is more refined and appropriate and to be competent in knowledge of grammar to correct/improve sentences

**CO6: Verbal** - To be able to examine, interpret and investigate passages and to be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.

**CO-PO Mapping**

| PO/CO | PO1 | PO2 | PO3 |
|-------|-----|-----|-----|
| CO1   | 2   | 1   | -   |
| CO2   | 2   | 1   | -   |
| CO3   | 2   | 1   | -   |
| CO4   | 2   | 1   | -   |
| CO5   | 1   | 2   | -   |
| CO6   | 2   | 2   | -   |

**Syllabus**

**Soft Skills**

Interpersonal skill: ability to manage conflict, flexibility, empathetic listening, assertiveness, stress management, problem solving, understanding one's own interpersonal needs, role of effective team work in organizations

Group problem solving: the process, the challenges, the skills and knowledge required for the same.

Conflict management: the concept, its impact and importance in personal and professional lives, (activity to identify personal style of conflict management, developing insights that helps in future conflict management situations.)

Team building and working effectively in teams: the concept of groups (teams), different stages of group formation, process of team building, group dynamics, characteristics of effective team, role of leadership in team effectiveness. (Exercise to demonstrate the process of emergence of leadership in a group, debrief and reflection), group discussions.

Interview skills: what is the purpose of a job interview, types of job interviews, how to prepare for an interview, dos and don'ts of interview, One on one mock interview sessions with each student

## **Verbal**

**Vocabulary:** Help students understand the usage of words in different contexts. Stress the importance of using refined language through idioms and phrasal verbs.

**Grammar:** Enable students to identify poorly constructed sentences or incorrect sentences and improvise or correct them.

**Reasoning:** Facilitate the student to tap her/his reasoning skills through critical reasoning questions and logical ordering of sentences.

**Reading Comprehension:** Enlighten students on the different strategies involved in tackling reading comprehension questions.

**Public Speaking Skills:** Empower students to overcome glossophobia and speak effectively and confidently before an audience.

**Writing Skills:** Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.

## **Aptitude**

**Sequence and Series:** Basics, AP, GP, HP, and Special Series.

**Geometry:** 2D, 3D, Coordinate Geometry, and Heights & Distance.

**Permutations & Combinations:** Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

**Probability:** Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.

**Logical Reasoning I:** Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.

**Logical Reasoning II:** Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding & Decoding, Cryptarithmic Problems and Input - Output Reasoning.

**Data Sufficiency:** Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.

**Campus recruitment papers:** Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.

**Miscellaneous:** Interview Puzzles, Calculation Techniques and Time Management Strategies.

## **References**

### **Soft Skills**

#### **Team Building**

- Thomas L.Quick, "Successful team building", AMACOM Div American Mgmt Assn, 1992
- **Brian Cole Miller, "Quick Team-Building Activities for Busy Managers: 50 Exercises That Get Results in Just 15 Minutes", AMACOM; 1 edition, 2003.**
- **Patrick Lencioni, "The Five Dysfunctions of a Team: A Leadership Fable", Jossey-Bass, 1st Edition, 2002**

### **Verbal**

- "GMAT Official Guide" by the Graduate Management Admission Council, 2019
- Arun Sharma, "How to Prepare for Verbal Ability And Reading Comprehension For CAT"
- Joern Meissner, "Turbocharge Your GMAT Sentence Correction Study Guide", 2012
- Kaplan, "Kaplan GMAT 2012 & 13"
- Kaplan, "New GMAT Premier", Kaplan Publishing, U.K., 2013
- Manhattan Prep, "Critical Reasoning 6th Edition GMAT"
- Manhattan Prep, "Sentence Correction 6th Edition GMAT"
- Mike Barrett "SAT Prep Black Book The Most Effective SAT Strategies Ever Published"
- Mike Bryon, "Verbal Reasoning Test Workbook Unbeatable Practice for Verbal Ability, English Usage and Interpretation and Judgement Tests"
- [www.bristol.ac.uk/arts/skills/grammar/grammar\\_tutorial/page\\_55.htm](http://www.bristol.ac.uk/arts/skills/grammar/grammar_tutorial/page_55.htm)

- [www.campusgate.co.in](http://www.campusgate.co.in)

### **Aptitude**

- Arun Sharma, “How to Prepare for Quantitative Aptitude for the CAT Common Admission Test”, Tata Mc Graw Hills, 5th Edition, 2012
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- Sarvesh Verma, “Quantitative Aptitude-Quantum CAT” , Arihant Publications , 2016
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- [www.campusgate.co.in](http://www.campusgate.co.in)
- [www.careerbless.com](http://www.careerbless.com)

### **Evaluation Pattern**

| <b>Assessment</b>                         | <b>Internal</b> | <b>External</b> |
|-------------------------------------------|-----------------|-----------------|
| Continuous Assessment (CA)* – Soft Skills | 30              | -               |
| Continuous Assessment (CA)* – Aptitude    | 10              | 25              |
| Continuous Assessment (CA)* – Verbal      | 10              | 25              |
| Total                                     | 50              | 50              |

\*CA - Can be **presentations, speaking activities and tests.**