M.Tech. in Mechatronics

Preface

Mechatronics is an exciting interdisciplinary field of engineering, based on mechanical and electrical engineering, control engineering as well as signal and data processing. Mechatronic systems sense their environment through multiple sensors, process the sensor signals and act back on the world by actuators. They can be found in almost all technological fields. Examples are current automobiles, airplanes, locomotives and train sets, smart home devices as there are washing machines or automated industrial production lines or agricultural robotic applications like ecological weed management or even wind power plant maintenance devices from the green energy sector.

Very typical for mechatronic systems is a high degree of integration of the different system components. The strong linkage between mechanical and electrical parts requires a new integrated design philosophy. It is no longer possible to develop the mechanical and electrical subsystems independently. Mechatronic system design simultaneously considers the mechanical, electrical and all other physical domains involved.

If you are a creative engineer interested in learning about the latest technology in this multidisciplinary field, have a closer look at the Mechatronics Master‘s degree programme offered by Dept. of Electronics and Communication Engineering, Amrita Vishwa Vidyapeetham, Amritapuri Campus.

Programme Outcomes (POs)

PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	An ability to demonstrate a degree of mastery over the area as per the specialization of the program.

Programme Specific Outcomes (POs)

PSO1	An ability to use modern tools for engineering design problems, analyze the performance and optimize the systems-level approaches in robotics and mechatronics.
PSO2	To investigate research problems in robotics and mechatronics and provide solutions using modern tools.

Curriculum

SEMESTER 1

Course Code	Course Title	L T P	Credits
25MT601	Introduction to Mechatronics Engineering	3 0 1	4
25MT602	AI in Robotics and Mechatronics	3 0 1	4
25MT603	Robot Design and Analysis	3 0 0	3
25MT604	Theory and Design of Control Systems	3 0 0	3
25MT681	Sensors and Actuators Lab	0 0 4	2
25MT682	Mechatronics System Simulation and Hardware Lab	0 0 4	2
22ADM501	Glimpses of Indian Culture		P/F
23HU601	Career Competency I	0 0 3	P/F
25AVP501	Mastery Over Mind	1 0 2	2
	Total Credits		**20**

SEMESTER 2

Course Code	Course Title	L T P	Credits
25MT611	Mechatronics System Design	3 0 1	4
25MT612	Embedded Systems for Robotics	3 0 0	3
	Elective I	3 0 0	3
	Elective II	3 0 0	3
	Elective III	3 0 0	3
25MT683	Mechatronics Programming and Hardware Lab	0 0 4	2
25MT684	Computer Vision and ML Lab	0 0 4	2
25RM601	Research Methodology	2 0 0	2
23HU611	Career Competency II	0 0 3	1
25MT698	Industry Internship	0 0 3	1
	Total Credits		**24**

SEMESTER 3

Course Code	Course Title	L T P	Credits
25MT798	Dissertation- Phase I		10

SEMESTER 4

Course Code	Course Title	L T P	Credits
25MT799	Dissertation- Phase II		15

Total Credits for M.Tech Program: 69

Electives List

MTech in Mechatronics			
Course Code	**Title**	**L T P**	**Credits**
25MT.1	Industry 4.0 Technologies	3 0 0	3
25MT632	Electronic System Level Design	3 0 0	3
25MT633	Semiconductor device modelling	3 0 0	3
25MT634	Emerging Architectures for Machine Learning	3 0 0	3
25MT635	Data Structures and Algorithms	3 0 0	3
25MT636	Embedded Real Time Systems	3 0 0	3
25MT637	FPGA Based System Design	3 0 0	3
25MT638	Process Control and Instrumentation	3 0 0	3
25MT639	Advanced Process Control	3 0 0	3
25MT640	Digital Image Processing	3 0 0	3
25MT641	Kinematics and Dynamics of Robots	3 0 0	3
25MT642	Machine Learning and Algorithm Design	3 0 0	3
25MT643	Unmanned Aerial Vehicles	3 0 0	3
25MT644	Advanced AI for Robotics	3 0 0	3
25MT645	Computational Intelligence	3 0 0	3
25MT646	Medical Robotics	3 0 0	3
25MT647	Embedded Systems For Automotive Applications	3 0 0	3
25MT648	Embedded Systems in Biomedical Applications	3 0 0	3
25MT649	Design For IoT And Cloud Computing	3 0 0	3
25MT650	Micro Electromechanical Systems (MEMS)	3 0 0	3
25MT651	Soft Robotics	3 0 0	3
25MT652	Real Time Operating Systems	3 0 0	3
25MT653	Computer Vision	3 0 0	3
25MT654	Natural Language Processing	3 0 0	3
25MT655	Sensor Networks	3 0 0	3
25MT656	Power Electronics	3 0 0	3
25MT657	Advanced Topics in Intelligent Systems II	3 0 0	3

Department of Electronics and Communication Engineering
Curriculum 2025
M.Tech Mechatronics

25MT601 Introduction to Mechatronics Engineering LTPC-3-0-1-4

Learning Objectives

LO1. To understand mathematical concepts used in LTI systems.

LO2. To impart knowledge in control theory concepts like system stability and performance.

LO3. To provide insight in design and implementation of digital logic circuit systems.

LO4. To develop the ability to analyze MOSFET-based electronic circuits

Course Outcomes

CO1: Analyze LTI systems using state-space models, transformations, and canonical forms.

CO2: Analyze and evaluate the stability of dynamical systems and stability techniques in linearization and integral control.

CO3: Design and analyze combinational and sequential digital logic circuits, including Mealy and Moore machines.

CO4: Design and analyze analog MOSFET amplifier circuits using small-signal models and biasing methods.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	2	-
CO2	3	-	2	3	-
CO3	2	2	3	3	2
CO4	2	2	3	2	1

Unit I

Similarity transformations, diagonal form and Jordan form, functions of a square matrix, Lyapunov equation, quadratic form and positive/negative definiteness; Singular value decomposition, norms of matrices, solution of LTI state equations; Input-output stability of LTI systems, internal stability, Lyapunov theorem; Controllability, observability, canonical decomposition, minimal realizations and coprime fractions, state feedback and state estimators.

Unit II

Qualitative behavior near equilibrium points, limit cycles, existence of periodic orbits, Lyapunov stability; Input output stability, *L* stability, *L*2 gain; Feedback system: The small gain theorem; Passivity, memoryless functions, state models, feedback systems: passivity theorem, absolute stability, circle criterion, Popov criterion; Feedback control: Stabilization via linearization, integral control, integral control via linearization.

Unit III

Combinational circuit building blocks - arithmetic circuits, Multiplexers - Decoders – Encoders; Sequential circuit building blocks – Flip-flops, Counters, Synchronous sequential circuits - Basic design steps - State assignment problem – Design of Mealy and Moore state models.

Unit IV

MOSFET Biasing and configurations – Review of MOSFETs, basic amplifier configurations, MOSFET at dc, biasing, Load line analysis; MOSFET amplifier- Small-signal analysis, Single-stage amplifier, Common Source, Common Gate, Source Follower.

Textbook

1. Mechatronics: Electromechanics and Control Mechanics (Denny K. Miu)
2. Stephen Brown, Zvonko Vranesic, ―Fundamentals of Digital logic with Verilog Design‖, Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.
3. S. Sedra, K. C. Smith and A. N. Chandorkar, ―Microelectronic Circuits -Theory and Applications‖, Seventh Edition, Oxford University Press, 2017.

References:

1. Chen, Linear system theory and design, third edition, Oxford, 1999.
2. Khalil, Nonlinear systems, third edition, Prentice Hall, 2002.
3. Franklin, Feedback control of dynamic systems, Prentice Hall, 2006.
4. M Morris Mano and Michael D Ciletti, Digital Design with Introduction to the Verilog HDL, Pearson Education, Fifth Edition, Fifth Edition, Fifth Edition, Fifth Edition, 2015
5. Robert L Boylestad and Louis Nashelsky, ―Electronic Devices and Circuit Theory‖, Eleventh Edition, Pearson India Education Services Pvt. Ltd.,

25MT602 AI in Robotics and Mechatronics LTPC- 3-0-1-4

Learning Objectives

LO1. Gain foundational knowledge in linear algebra, probability, and statistics for AI algorithms.

LO2. Learn and apply supervised, unsupervised, and neural network-based learning techniques to solve robotics problems.

LO3. Understand AI applications in vision, language processing, and real-time robotic perception and decision-making.

LO4. Explore reinforcement learning, cognitive robotics, and design for intelligent robotic systems.

Course Outcomes

CO1: Apply mathematical, statistical, and supervised learning methods to analyze data and build classification/regression models for robotic applications.

CO2: Design and train neural networks for perception, motion control, and decision-making in robotic systems.

CO3: Implement computer vision, natural language processing, and clustering algorithms for real-time perception and environment understanding in robotics.

CO4: Apply reinforcement learning and cognitive robotics principles to robotic learning and planning, while addressing ethical and safety issues.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	-
CO2	3	-	2	3	-
CO3	3	-	3	2	-
CO4	2	2	3	3	2

Unit I

Mathematical Concepts Review- Linear Algebra, Probability & Statistics Fundamentals. Descriptive Data Analysis - Central Tendency, Dispersion, Visualization. Supervised Learning Basics - k-NN, Naive Bayes, Decision Trees, Ensemble Methods. Regression Techniques - Ordinary Least Squares. Classifier Performance Metrics - Precision, Recall, F1 Score.

Unit II

Artificial Neurons, Perceptron, Multi-Layer Perceptron (MLP), Backpropagation Algorithm, Hyperparameter Tuning, Sensor Data Processing and Real-Time Perception, Motion Planning and Control Computer Vision: Object Detection, Scene Understanding NLP in Robotics: Voice-Controlled Systems Cluster Analysis: K-Means, DBSCAN

Unit III

Reinforcement Learning - Policy Learning, Reward Modeling. Cognitive Robotics - Reasoning and Planning in Uncertain Environments. AI in Manufacturing - Predictive Maintenance, Smart Automation. Human-Robot Interaction (HRI) - Safety, Usability. Ethics & Safety in AI Robotics - Bias, Transparency, Responsible Design

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Unit IV

Sensors & Actuators - Classification, Operation Principles, Calibration. Conventional Sensors - Thermocouples, Inductive, Capacitive, Piezoelectric, Encoders. Basic Actuators - Electromechanical, Electrical Machines. Fuzzy Set Theory - Fuzzy vs. Crisp Sets, Operations. Fuzzy Logic & Control: Mamdani and Sugeno Models, Applications in Robotics

Textbooks:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson. Robin R. Murphy, Introduction to AI Robotics, MIT Press
2. S.J. Russell and P. Norvig. Artificial Intelligence: A Modern Approach (3rd edition), Prentice-Hall, 2010.
3. G.J.Klir & Bo Yuan, “Fuzzy Sets and Fuzzy Logic Theory and Applications”, Prentice Hall of India, 2009
4. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Second Edition, O'Reilly Media, 2019.

Reference

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Second Edition, O'Reilly Media, 2019.
2. Earl Gose, Richard Johnsonbaugh, Steve Jost, Pattern Recognition and Image Analysis, Pearson Education India, 2015.
3. Clarence W. de Silva (2015) Sensors and Actuators: Engineering System Instrumentation, Second EditionAndrzej M Pawlak (2006) Sensors and Actuators in Mechatronics: Design and Applications
4. Timothy S.Ross, “Fuzzy Logic with engineering applications”, Weily India Pvt. Ltd., 2011.
5. Rao V.B and Rao H.V., “C++, Neural Networks and Fuzzy Logic”, BPB Publications

25MT603 **Robot Design and Analysis** **LTPC-3-0-0-3**

Learning Objectives

LO1. To understand the design process, from ideation to mechanical review of robotic systems.
LO2. To Learn kinematic and dynamic analysis of robotic mechanisms.
LO3. To explore various prototyping techniques and their relevance to robotic design.
LO4. To understand material selection, manufacturing process planning, and cost-performance analysis in robot development.

Course Outcomes

CO1: Apply structured product design and development of robotic systems, including mechanical design and modelling.
CO2: Model and analyze the kinematics and dynamics of robotic mechanisms to support design decisions.
CO3: Evaluate prototyping techniques and plan effective physical prototypes of robotic systems.
CO4: Analyze materials, manufacturing processes, and design-for-manufacture principles for robot fabrication with attention to cost and reliability.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	-	2	2	-
CO2	3	-	2	3	-
CO3	2	2	2	3	1
CO4	3	2	2	3	2

Unit I:

Introduction to product design and development; Design process and its Phases, Mechanical Design Review; Fundamentals of 3D modelling; Basic manufacturing processes; Various Robot Design

Unit II

Mechanical design review; Basic concepts of kinematics and dynamics; Modelling and analysis of robotics systems; Prototype basics – principles of prototyping – planning for prototypes.

Unit III

Material selection for Robot manufacturing - Economics - Cost Vs Performance - Weighted property Index - Value Analysis - Role of Processing and Design - Classification of Manufacturing Process - Design for Manufacture - Design for Assembly - Design for castings, Forging, Metal Forming, Machining and Welding - Residual stress - Fatigue, Fracture and Failure.

Textbooks:

1. Karl t. Ulrich and Steven d Eppinger "Product Design and Development ", McGraw Hill, Edition 2000.
2. Robotics: Designing the Mechanisms for Automated Machinery, Academic Press, 1999

References

1. Planchard, D. C. and Planchard, M. P., (2012). Engineering design with SolidWorks 2012: A step-by-step project-based approach utilizing 3D solid modelling, Schroff Development Corporation, Mission, Kansas. ISBN 978-1-58503-697-4.
2. Service Robots and Robotics: Design and Application, Marco Ceccarelli (University ofCassino, Italy). 2012

25MT604 Theory and Design of Control Systems LTPC-3-0-0-3

Learning Objectives

LO1: To learn to model physical systems using transfer function and state-space representations and analyze time and frequency-domain responses.

LO2: To understand various stability analysis techniques and control system characteristics such as robustness, controllability, and observability.

LO3: To apply frequency-domain and state-space methods for control system design with performance specifications.

LO4: To explore advanced control design techniques such as pole placement, observer design, and optimal control using LQR.

Course Outcomes

CO1: Develop mathematical models of physical systems using transfer functions and state-space methods and analyze their time/frequency response.

CO2: Analyze the stability, sensitivity, and robustness of control systems using frequency-domain tools and state-space concepts.

CO3: Assess system properties such as controllability, observability, and detectability using canonical transformations.

CO4: Design control systems using pole placement, observer design, and optimal control (LQR) methods in both time and frequency domains.

CO-PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	-	2	2	-
CO 2	3	-	2	3	-
CO 3	3	-	3	2	-
CO 4	2	2	2	3	2

Unit I

Modeling: transfer function and state-space representations of differential governing equations; time and frequency-domain system response.

Unit II

Analysis: stability of linear and nonlinear systems; nominal sensitivity functions; Nyquist stability criterion; stability margins; sensitivity, robustness, and the robust stability theorem; design specifications and characterization of constraints; effect of open-loop integrators, poles and zeros; frequency-domain design limitations; eigenvalue and eigenvectors; Jordan canonical form; controllability and observability and detectability; canonical decomposition.

Unit III

Design: Pole placement techniques in both the frequency domain and via state feedback;full state and reduced-order observer design; output feedback design; transfer function interpretations of output feedback design; introduction to the linear quadratic regulator.

Textbook

1. Feedback Systems: An Introduction for Scientists and Engineers, Karl Johan Astrom and Richard M. Murray

References:

1. Multivariable Feedback Control: Analysis and Design, Sigurd Skogestad and Ian Postlethwaite, Wiley, 2nd Ed., 2005.

2. K. Ogata, Modern Control Engineering, 5th edition, PHI, 2012.

25MT611 Mechatronics Systems Design LTPC-3-0-1-4

Learning Objectives

LO1: Understand the integrated approach to designing mechatronic systems involving mechanical structure, electronics, and control logic.

LO2: Learn the functioning and application of electro-hydraulic and electro-pneumatic actuators in mechatronic systems.

LO3: Gain familiarity with data acquisition systems, I/O interfacing, and real-time software implementation.

LO4: Analyze real-world mechatronic system case studies to understand sensor calibration, control design, and practical system integration.

Course Outcomes

CO1: Apply integrated design principles to develop mechatronic systems considering mechanical, control, ergonomic, and safety aspects.

CO2: Analyze and select appropriate electro-hydraulic, electro-pneumatic actuators, and rotary drives for motion control applications.

CO3: Interface and configure real-time data acquisition systems, including I/O cards, sensors, and application software.

CO4: Evaluate and interpret real-world mechatronic system behavior using case studies in automotive, manufacturing, and structural applications.

CO-PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	-	3	3	2
CO 2	3	-	2	3	-
CO 3	2	-	3	2	-
CO 4	3	2	2	3	2

Unit I

Mechatronic systems – Integrated design issue in mechatronic – mechatronic key element, mechatronics approach – control program control – adaptive control and distributed system Design process – Type of design – Integrated product design – Mechanism, load condition design and flexibility – structures – man machine interface, industrial design and ergonomics, information transfer, safety.

Unit II

Control devices – Electrohydraulic control devices, electro pneumatic proportional controls – Rotational drives – Pneumatic motors: continuous and limited rotation – Hydraulic motor: continuous and limited rotation – Motion convertors, fixed ratio, invariant motion profile, variators.

Unit III

Real time interface – Introduction, Elements of a data acquisition and Control system, overview of I/O process, installation of I/O card and software – Installation of the application software – over framing.

Unit IV:

Case studies on data acquisition – Testing of transportation bridge surface materials – Transducer calibration system for Automotive application – strain gauge weighing system –

solenoid force – Displacement calibration system – Rotary optical encoder – controlling temperature of a hot/cold reservoir – sensors for condition monitoring – mechatronic control in automated manufacturing.

Textbooks

1. Bolton (2015), "Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering", Pearson Education Limited, ISBN - 9781292076683.
2. Devdas Shetty, Richard A. Kolkm (2010), "Mechatronics System Design", CengageLearning, ISBN - 9781439061992.

Reference Books

1. Brian Morriss (1994), "Automated Manufacturing Systems – Actuators Controls, Sensors and Robotics", McGraw-Hill Inc., ISBN - 9780028023311.
2. Bradley, D. Dawson, N.C. Burd and A.J. Loader (1993), "Mechatronics: Electronics inproducts and Processes", CRC Press, ISBN – 9780748757428.

25MT612 Embedded Systems for Robotics LTPC-3-0-0-3

Learning Objectives

LO1: To understand the role of embedded controllers, actuators, and sensors in robotic systems, including modern control techniques and ROS.

LO2: To learn the mechanical and kinematic design principles of mobile robots such as differential drive, omni-drive, balancing and walking robots**.**

LO3: To explore embedded control strategies like PID, velocity, and position control for real-time robotic applications.

LO4: To understand key concepts of localization, path planning, and map generation in autonomous mobile robots.

Course Outcomes

CO1: Explain embedded system architectures and their integration with robotic systems using sensors, actuators, and control strategies.

CO2: Design mobile robot drive mechanisms and analyze drive kinematics.

CO3: Implement control techniques (PID, velocity, position) in embedded platforms for robotic motion control.

CO4: Apply embedded techniques for localization, maze navigation, and map generation in mobile robotics.

CO-PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	-	3	2	-
CO 2	2	-	2	3	-
CO 3	2	-	3	2	2
CO 4	2	2	3	3	2

Unit I

Robots and Embedded Systems-Robots and Controllers: Mobile Robots-Embedded Controllers-Interfaces-Operating System, Robot operating system (ROS), Sensors, Actuators in Robots - Control - On-Off Control, PID Control, Velocity Control and Position Control, Recent Trends in Robotics

Unit II

Mobile Robot Design: Driving Robots- Single Wheel Drive- Differential Drive- Tracked

Robots- Synchro-Drive- Ackermann Steering- Drive- Kinematics, Omni-Directional Robots, Balancing Robots, Walking Robots, Walking Robots, Walking Robots, Walking Robots

Unit III

Mobile Robots, Concepts of Localization, and path planning, Maze Exploration, Map Generation

Textbook(s)

Thomas Bräunl, "Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems", Third Edition, Springer-Verlag Berlin Heidelberg, 2008.

Reference(s)

1. R.K.Mittal and I.J.Nagrath, ―Robotics and Control‖, Tata McGraw-Hill Publishing Company Ltd., New
Delhi, 2003.
2. John J. Craig, Introduction to Robotics: Mechanics and Control, Fourth Edition, Pearson, 2018.
3. Anis Koubaa, ―Robot Operating System (ROS) The Complete Reference‖, First Volume, Springer, 2016.
4. K.S. Fu, R.C. Gonzalez and C.S.G. Lee, ―Robotics: Control, Sensing, Vision, and Intelligence‖, McGraw-Hill, New York, 1987.

25MT631 Industry 4.0 Technologies LTPC-3-0-0-3

Learning Objectives

LO1: To understand the concepts of human machine interaction
LO2: To understand the connectivity solutions
LO3: To understand design principles of Industry 4.0.

Course Outcomes

CO1: To understand the concepts of digital printing systems
CO2: To familiarize PLC programming
CO3: Ability to connect robots with various communication systems
CO4: To Evaluate4the opportunities and the challenges of Industry 4.0 cyber security.

CO-PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	-	-	-	-	-
CO 2	-	-	2	2	2
CO 3	2	2	3	2	2
CO 4	3	3	3	3	3

Unit I

Human-machine interaction - Augmented-reality systems - Transferring digital instructions to the physical world - Advanced robotics and 3-D printing - Autonomous activities - Lean Manufacturing - Human-machine interaction - Touch interfaces, virtual reality and augmented-reality systems

Unit II

Advanced robotics - 3-D printing - Cloud Computing and Concept of "Equipment-As-a-Service," EAAS - Connectivity Solutions: Bluetooth, BLE, Bluetooth 5.0, ZigBee, ZigBee 3.0, Z- Wave, 6LowPAN, RFID, WiFi, Mobile/Cellular, SATCOM, PLC, PLC Programming

(Ladder LogicProgramming) - Proactive/Predictive Maintenance and Continuous Monitoring

Unit III

Cyber-physical systems (CPS) in the industry 4.0 vision - Cyber-physical systems key characteristics - Industry 4.0 building blocks - The (Industrial) Internet of Things - Industry 4.0 principles: horizontal and vertical integration; Principles of Big Data, Data Mining, Data Organization and Data Warehousing - Data security in Industry 4.0

Textbook

1. Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, Apress, 2017

References

1. The Fourth Industrial Revolution by Klaus Schwab
2. Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0 by Ibrahim Garbie

25MT632 Electronic System Level Design LTPC-3-0-0-3

Learning Objectives

LO1 To introduce design and verification at system level.
LO2 To introduce open-source language-based design and debug.
LO3 To provide basics of Transaction Level Modelling and High-Level Synthesis.
LO4 To introduce portable test and stimulus standards.

Course Outcomes

CO1 Ability to understand Electronic System level Design and Verification.
CO2 Ability to apply system level design methodologies using open-source languages.
CO3 Ability to analyse virtual prototyping and its advantages.
CO4 Ability to evaluate the transaction level models built using SystemC.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	3	-	2
CO2	-	-	3	3	3
CO3	-	-	3	3	2
CO4	-	-	3	3	3

Unit I

Introduction to Electronic System Level Design– Hybrid Design – ESLD Flows andMethodologies – Architecture Exploration–Hardware-software Partitioning.

Unit II

Models for ESL Design– Open-Source Languages–SpecC–ArchC and SystemC for ESLD–Transaction Level Modelling Building Platform Models in SystemC.

Unit III

High Level Synthesis– ESL Verification – Virtual Platform and Virtual Prototyping– Debugging SystemC Platform Models –SystemC Based Power Evaluation – SystemCStandards and Accellera Initiatives ESLD – Project Based Practice design

References

1. Sandro Rigo, Rodolfo Azevedo and Luizsantos, Electronic System Level Design – AnOpen-Source Approach, Springer, 2011.

25MT633 Semiconductor Device Modeling LTPC-3-0-0-3

Learning Objectives

LO1 To review the basic MOSFET structures and characteristics.
LO2 To impart knowledge on MOS models in simulation.
LO3 To introduce FINFETs and other multi-gate transistors.
LO4 To provide practical knowledge on design tools for device modelling.

Course Outcomes

CO1 Ability to understand the MOSFET structure evolution, types and working principle and multi gate transistors.
CO2 Ability to apply the knowledge to model devices using simulation.
CO3 Ability to analyse the device behaviour and characteristics of MOS using simulation.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	3	3	3
CO2	-	-	3	3	3
CO3	-	-	3	2	3
CO4	-	-	-	-	-

Unit I

Introduction to MOSFET – Output and Transfer Characteristics – MOS Capacitor —Long, short channel MOSFETS – Non-Ideal Effects – MOSFET Scaling – Threshold voltage– Smallsignal model – Large Signal model – MOSFET parasitic capacitances.

Unit II

SPICE Models for semiconductor Devices –MOSFET Level1, Level2 and level 3 models – BSIMmodel– Model parameters– Models for semiconductor contacts and hetero junctions – Charge control models –Second order effects –Velocity Saturation and universal models– FINFETs –SOI MOSFETS: single gate to multi gate -Multigate MOSFET Technology – Physics of multigate MOS– Mobility in multigate MOSFET

Unit III

Radiation Effects in Single gate and Multi gate FETs – Single event effects - Multigate MOSFET Circuit Design - Digital, Analog circuit design - Double gate MOSFET- Drain current model - Scale length - Fabrication Requirements – Challenges – SoC Design-Technology Aspects

References

1. B.G Streetman and S.K Banerjee, Solid State Electronic Devices, Seventh Edition, PrenticeHall India,2010
2. D.A.Neamen, Semiconductor Physics and Devices: Basic Principle, Third Edition,McGraw –Hill International,2003.
3. J. P. Collinge, FinFETs and Other Multi-Gate Transistors, Springer, 2008
4. Y.Taur and T.H. Ning, Fundamentals of Modern VLSI Devices, Second Edition,Cambridge University Press,2009.

25MT634 Emerging Architectures for Machine Learning LTPC-3-0-0-3

Learning Objectives

LO1 To introduce new paradigms in computing.

LO2 To familiarize various aspects and issues in implementation of machine learning systems.
LO3 To impart background on application of FPGAs and unconventional computing platforms for machine learning.
LO4 To provide exposure to using state of the art computing tools.

Course Outcomes
CO1 Ability to understand high performance machine learning architectures.
CO2 Ability to apply computing paradigms for machine intelligence problems.
CO3 Ability to suggest solutions and platforms for dataflow intensive problems.
CO4 Ability to evaluate the use of diverse technologies to design efficient applications.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	3	3	2
CO2	-	-	3	3	2
CO3	-	-	3	3	2
CO4	-	-	3	3	2

Unit I
Accelerated Computing – GPUs – Overview of GPU Architectures – CUDA – OpenCL – Case Studies IoT and Cloud Architectures – Use Cases – VLSI Design Challenges for IoT–Power – Area and Security – Intel Dashboard Framework.

Unit II
Overview of Cloud Computing – Introduction to Hadoop Framework – Case Study – FPGA Architectures for Neural Networks and Bioinformatics – Review of Neural Networks and Deep Learning.

Unit III
Data Precision and Implementation Issues – Case Studies of Regression Implementation – FPGA and Reconfigurable Architectures for Bioinformatics – Database Search – Sequencing and Alignment.

References

1. David B. Kirk, Wen-Mei W. Hwu, Programming Massively Parallel Processors: AHands-on Approach, Second Edition, Morgan Kauffman, 2016.
2. Bertil Schmidt, Bioinformatics: High Performance Parallel Computer Architectures, CRC Press, 2011

25MT635 Data Structures and Algorithms LTPC-3-0-0-3

Learning Objectives
LO1 To introduce the linear and non-linear data structures and explore its applications.
LO2 To provide representation using graph data structure.
LO3 To impart knowledge of basic sorting and searching algorithm.
LO4 To instil the concept of designing efficient algorithms using data structures.

Course Outcomes
CO1 Ability to understand linear and non-linear data structures.
CO2 Ability to apply appropriate data structures to solve computational problems.
CO3 Ability to analyse the algorithms and its complexity.
CO4 Ability to design and employ algorithms using relevant data structures in real-time applications.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	3	-	2
CO2	-	-	3	-	3
CO3	-	-	3	2	3
CO4	-	-	3	3	3

Unit I

Algorithm Analysis - Methodologies for Analyzing Algorithms - Asymptotic Notation - Recurrence Relations – Data Structures - Linear Data Structures - Stacks – Queues - Linked-Lists - Vectors -Trees -Binary Search Trees - AVL trees - Red-Black trees - B-trees - Hash-Tables -Dictionaries - Associative Arrays - Database Indexing – Caches – Sets.

Unit II

Searching and Sorting -Insertion and Selection Sort - Quick sort - Merge sort - Heap sort - Bucket Sort and Radix Sort - Comparison of sorting algorithms and lower bounds on sorting - Fundamental Techniques - The Greedy Method - Divide and Conquer.

Unit III

Dynamic Programming - Graph Algorithms - Breadth-first search - Depth-first search - Topological sort - strongly connected components - Minimum Spanning Trees - Single-Source Shortest Paths - All-Pairs Shortest Paths - Maximum Flow - Network Flow and Matching - Flows and Cuts

References

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, MIT Press, 2009.
2. Robert Sedgewick and Kevin Wayne, "Algorithms", Fourth Edition, Addison Wesley, 2011.
3. Kurt Mehlhorn and Peter Sanders, "Data Structures and Algorithms: The Basic Toolbox", Springer, 2008.
4. John V. Guttag, "Introduction to Computation and Programming using Python", MIT Press, second edition, 2016

25MT636 Embedded Real Time Systems LTPC-3-0-0-3

Learning Objectives

LO1 Understand Microcontroller fundamentals: ARM ASM programming and basic of C, IO Interfacing:

LO2 To familiarize with forward and inverse kinematics of robotics

LO3 To understand digital signal processing, high speed interfacing, file system management, interfacing robotic Components.

Course Outcomes

CO1 Apply Design and Development Process: Architecture, Micro architecture.

CO2 Apply Development Tools: Block Diagrams, Flow Charts, Call Graphs, Dataflow Graphs, Finite State Machines.

CO3 Apply Software: Structs, Stacks and Recursion.

CO4 Analyse prototypes of actual embedded systems.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	-	-

CO2	-	-	2	3	2
CO3	2	-	2	3	2
CO4	2	3	2	3	3

This course looks at components, interfaces and methodologies for building systems. Specific topics include microcontrollers, design, verification, hardware/software synchronization, interfacing devices to the computer, timing diagrams, real-time operating systems, data collection and processing, motor control, analog filters, digital filters, and real time signal processing. Topics include Computer Architecture review, Design of I/O Interfaces, Software Design, Real Time Operating Systems, Multitasking (preemptive scheduling, resource sharing and priority determination), Digital Signal Processing, High Speed Interfacing, File system management, Interfacing Robotic Components, High- Speed Networks, Robotic Systems.

Textbooks/References:

1. Jonathan Valvano, “Embedded Systems: Real-Time Operating Systems for Arm Cortex M Microcontrollers”, CreateSpace Publishing, 2012.
2. Joseph Yiu, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors",Third Edition, Newnes, 2013.
3. Martin, "The Designer's Guide to the Cortex-M Processor Family: A Tutorial approach", First Edition, Newnes, 2009.

25MT637 FPGA Based System Design LTPC-3-0-0-3

Learning Objectives

LO1 To introduce the internal architecture of programmable logic with focus on FPGA.
LO2 To provide knowledge in FPGA design flow at the architectural and system design.
LO3 To impart a good background in block-based design using standard system level tools.

Course Outcomes

CO1 Ability to understand the structure of the fabric of programmable logic.
CO2 Ability to apply techniques for logic designing using field programmable devices.
CO3 Ability to analyse and comprehend FPGA design flow and related design, synthesis and timing issues.
CO4 Ability to evaluate system level architectures by integrating IP cores including softcore and hardcore processors.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	3	-	-
CO2	-	-	3	-	-
CO3	-	-	3	2	-
CO4	-	-	3	2	2

Unit I

Programmable logic devices - PROM- PAL – PLA- CPLD - Gate arrays -MPGA - FPGA- Programming technologies - EPROM-EEPROM-FLASH-SRAM- FPGA fabric- Configurable logicblock – LUT – Slice - SliceM - programmable interconnects - Input output blocks – keeper circuit – Xilinx 7 series architecture.

Unit II

FPGA Design flow and abstraction levels – Verilog design for synthesis-one hot encoding-Memory blocks- Block memory generator (BRAM/BROM)- single port memory- dual port memory- FIFO-distributed RAM-synthesis pitfalls-latch inference-static timing analysis-speed performance-timing constraints-clock management -clock buffers-clock tree routing

Unit III

Introduction to SoC design –Hard macros – multipliers –DSP block-hard core processors-interface circuits-– configuration chain – JTAG interface - Zynq7000

References

1. Amano, Hideharu, Principles and Structures of FPGAs, First Edition, Springer, 2018.
2. Readler, Blaine C., Verilog by example: a concise introduction for FPGA design. FullArc Press, 2011.
3. Zainalabedin Navabi, Embedded Core Design with FPGAs, First Edition, McGraw Hill,2008
4. Xilinx Inc, Vivado Design Suite User Guide, 2021

25MT638 Process Control and Instrumentation LTPC-3-0-0-3

Learning Objectives

LO1 Understand Process Modelling hierarchies, theoretical and empirical models.
LO2 To familiarize with PID control systems and instrumentation.
LO3 Analyse Programmable logic controllers and SCADA in process automation.

Course Outcomes

CO1 Apply Feedback & feed forward control, cascade control, selective control loops, ratio control, feed forward and ratio control, multi-loop and multivariable control.
CO2 Apply: PID design, tuning, trouble shooting, tuning of multiloop PID control systems.
CO3 Analyse Decoupling control, Instrumentation for process monitoring and preparation of P&I diagrams.
CO4 Analyse Statistical process control, supervisory control, direct digital control, distributed control, PC based automation.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	-	-
CO2	-	-	2	3	2
CO3	2	2	2	3	2
CO4	3	3	3	3	3

Process Modeling: Hierarchies. Theoretical models: transfer function, state space models, and time series models. Development of empirical models from process data- chemical reactor modeling. Feedback & feed forward control, cascade control, selective control loops, ratio control, feed forward and ratio control. Multi-loop and multivariable control: process interactions, singular value analysis. PID design, tuning, trouble shooting, tuning of multiloop PID control systems. Decoupling control: strategies for reducing control loop interactions. Instrumentation for process monitoring: codes and standards, preparation of P&I diagrams. Model predictive control. Statistical process control, supervisory control, direct digital control, distributed control, PC based automation. Programmable logic controllers: organization, programming aspects, ladder programming, final control elements. SCADA in process automation. Case studies.

Textbooks/ References:

1. Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar and Francis J. Doyle "ProcessDynamics and Control", John Wiley and Sons, 2010.
2. Ernest O. Doebelin, "Measurement Systems Application and Design", McGraw Hill International Editions, 2006.
3. Johnson D Curtis, "Process Control Instrumentation Technology", Prentice Hall India, 2013.
4. Bob Connel, "Process Instrumentation Applications Manual", McGraw Hill, 1996.

25MT639 Advanced Process Control LTPC-3-0-0-3

Learning Objectives

LO1 Understand Process Dynamic Modelling and analysis
LO2 To familiarize with Process control such as cascade. Ration and feedback/forward.
LO3 Analyse fuzzy logic controllers.

Course Outcomes

CO1 Apply Feedback & feed forward control, cascade control, selective control loops, ratio control, feed forward and ratio control, multi-loop, and multivariable control.
CO2 Apply: PID design, tuning, trouble shooting, tuning of multiloop PID control systems.
CO3 Analyse internal model controller.
CO4 To design fuzzy based neural network controller.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	-	-
CO2	-	-	2	3	2
CO3	-	2	3	3	2
CO4	2	3	3	3	3

Introduction: Review of basics of Process Control, Control objective and benefits, Control system elements. Mathematical modeling and dynamic performance analysis process for control: Basic Concepts in modeling, models from fundamental laws, empirical model identification, dynamic performance analysis of first order, second order, multi-capacity processes, Effect of Zeros and time delay. Multivariable Process control: Cascade control, Ratio control, feedback-feed forward control, override control, selective control, modeling of multivariable process, Design of Multivariable controllers. Model Based control: Feedback-feed forward, delay compensation, Internal Model controller (IMC): Concept, IMC design Procedure. MPC: General Principles, Model forms, DMC, SISO unconstrained DMC Problem, controller tuning. Statistical Process Control (SPC): Concept, Design procedure.
Mini project: Design of Fuzzy-Logic based controller, Design of Neural Network based controller.

Textbooks/References:

1. Thomas E. Marlin, "Process Control", McGraw-Hill International Edition.
2. Jose A. Romagnoli and Ahmet Palazoglu, "Introduction to Process Control", CRC Taylor and Francis Group.
3. Statistical Process Control –ISA.
4. B.G. Liptak, "Handbook of Instrumentation - Process Control".
5. Les A. Kane, “Handbook of Advanced Process Control Systems and Instrumentation” Springer.

25MT640 **Digital Image Processing** **LTPC-3-0-0-3**

Learning Objectives

LO1 To introduce the concepts of foundation in 2-D signal processing

LO2 To provide insights on image enhancement techniques in spatial and frequency domain.

LO3 To impart knowledge on the concept of image segmentation.

Course Outcomes

CO1 Ability to analyse images in the frequency domain using various transforms.

CO2 Ability to evaluate the techniques for image enhancement and image restoration.

CO3 Ability to interpret image segmentation and representation techniques

CO4 Construct simulations in MATLAB to study digital image processing.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	-	-
CO2	-	-	2	3	2
CO3	-	-	2	3	2
CO4	-	-	2	3	3

Two-Dimensional Signals and Systems: Two-dimensional convolution, 2D Discrete-Space Fourier Transform, Inverse 2-D Fourier Transform, Fourier Transform of 2-D or Spatial Convolution, Symmetry properties of Fourier Transform, Continuous-Space Fourier Transform. Sampling in two dimensions: Sampling theorem, Change in Sample rate, Down sampling, Ideal decimation, Up sampling, Ideal interpolation. Continuous Image characterization: Psychophysical vision properties, Photometry, Colorimetry. Fundamentals of Digital Image Processing: Image acquisition - Various modalities, Image sampling and quantization, mathematical representation, Image reconstruction based on interpolation. Gray level transformation, Histogram processing, Arithmetic and logic operations. Transformand filtering: Intensity transformation and spatial filtering, filtering in frequency domain, Image restoration and reconstruction, Binary image morphology. Smoothing and sharpening filters, Line detection, Edge detection, Zero crossings of the second derivative. DFT, smoothing in frequency domain filtering, Sharpening in frequency domain filtering.

Degradation model, noise models, restoration in spatial domain, restoration in frequency domain. Estimation of degradation function, inverse filtering, Wiener filtering, constrained least square filtering. Color Image Processing: Color Models, the RGB Color Model, the CMYand CMYK Color Models, the HSI Color Model, Pseudo color image processing, Basics of FullColor Image Processing, Smoothing and Sharpening, Image Segmentation Based on Color. Image Segmentation-Point, Line, and Edge Detection, Thresholding-Types Boundary based and Region-Based Segmentation. Representation of Boundary Descriptors, Regional Descriptors- Texture descriptors. MATLAB applications.

Textbooks/References:

1. John W Woods, "Multidimensional Signal, Image and Video Processing and Coding", Academic Press, 2006.
2. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2009.
3. William K. Pratt, “Digital Image Processing”, John Wiley, New York, 2007.
   Kenneth R. Castleman, "Digital Image Processing", Prentice Hall, 1996.
4. Gonzalez, Woods and Eddins, "Digital Image Processing using MATLAB", PrenticeHall, 2004.

25MT641 Kinematics and Dynamics of Robots LTPC-3-0-0-3

Learning Objectives

LO1 To Understand various robot classifications, specifications, and applications.
LO2 To familiarize with forward and inverse kinematics of robotics
LO3 To develop a dynamic robot system.

Course Outcomes

CO1 Apply coordinate transformations to map position and orientation coordinates from end effector to robot base.
CO2 Apply forward and inverse kinematics to manipulate objects by robots.
CO3 Analyse forward and inverse dynamics to manipulate objects by robots.
CO4 Construct simulations in Bioanalyzer/MATLAB to verify kinematics and dynamics of robots.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-
CO2	1	2	2	2	1
CO3	3	2	2	2	2
CO4	3	3	3	3	3

Robot types, trends, applications, classification - Anatomy and Architecture of Manipulators – Mobile Robots – Advanced Robots - Holonomic and Non-holonomic Robots - transformations – Quaternions - Robot Kinematics: Forward and Inverse - Manipulator Jacobian - Force relations – Multi-body Dynamics: Forward and Inverse – Lagrange-Euler Dynamic Model – Recursive Newton-Euler Formulation - Trajectory planning in Joint space and Cartesian space – MATLAB/Robo Analyzer Simulations of Kinematic and Dynamic models.

Textbooks/References:

1. S K Saha, “Introduction to Robotics”, 2nd edition, McGraw Hill Education (India) Pvt.Ltd., 2014.
2. Robert J Schilling, “Fundamentals of Robotics, Analysis and Control”, Prentice Hall, 2007.
3. Reza N Jazar, “Theory of Applied Robotics: Kinematics, Dynamics and Control”, 2nd Ed. Springer, 2010.
4. Peter Corke, "Robotics, Vision, and Control: Fundamental Algorithms in MATLAB",Springer, 2013.
5. John J Craig, “Introduction to Robotics: Mechanics and Control”, Pearson, 2018.
6. K S Fu, et al, “Robotics: Control, Sensing, Vision and Intelligence”, Tata McGraw Hill, 2008.
7. Springer Handbook of Robotics, B Siciliano, O Khatib, editors, 2nd Ed., Springer, 2016.

25MT642 Machine Learning and Algorithm Design LTPC-3-0-0-3

Learning Objectives

LO1 To introduce the concepts and provide a mathematical foundation for developing machine learning models

LO2 To provide insights on the evaluation of machine learning models for various applications

LO3 To impart knowledge on algorithm design and its applications**.**

Course Outcomes

CO1 Ability to understand concepts of machine learning and algorithm design.

CO2 Ability to apply machine learning and algorithm design concepts for analysis of problems.

CO3 Ability to analyse and process datasets using machine learning techniques for extracting useful information

CO4 Ability to design and implement machine learning models for the given task.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	-	-
CO2	-	-	2	3	2
CO3	-	-	2	3	2
CO4	-	-	2	3	3

Unit I

Mathematical concepts review - Central tendency - Dispersion of data - Descriptive data summaries - k-nearest neighbor classifier - Bayes classifiers - Classifier performance measures

Unit II

Decision tree - Ensemble methods - Ordinary Least Squares - Artificial neurons - Perceptron - Multi Layer Perceptron and backpropagation -Hyperparameter tuning - Cluster analysis - Partitioning methods - Hierarchical methods -Density-based methods - Cluster evaluation **Unit III**

Graphs - Definitions and applications - Graph Connectivity - Graph Traversal - Testing Bipartiteness - Breadth-First Search - Directed graphs - Directed Acyclic Graphs -Topological ordering - Interval scheduling - Optimal caching - shortest paths - Minimum Spanning Tree - Clustering - Huffman Codes - Data Compression - Partitioning Problems - Graph Coloring

References

1. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques, Third Edition, Morgan Kaufmann Publishers (Elsevier), 2011.
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Second Edition, O'Reilly Media, 2019.
3. Earl Gose, Richard Johnsonbaugh, Steve Jost, Pattern Recognition and Image Analysis, Pearson Education India, 2015
4. Jon Kleinberg, Éva Tardos, Algorithm Design, Pearson, 2006

25MT643 Unmanned Aerial Vehicles LTPC-3-0-0-3

Learning Objectives

LO1: To understand the fundamentals, classification, and applications of UAV systems.
LO2: To explore the mechanics, dynamics, and mathematical modelling of UAV motion.
LO3: To learn ROS-based control strategies, motion planning, and trajectory generation.
LO4: To understand state estimation and visual navigation techniques (e.g., SLAM, VIO).

Course Outcomes

CO1: Classify UAVs and explain their functional and structural components.
CO2: Analyze the geometry, dynamics, and kinematics of UAVs including inertial modelling.
CO3: Design and simulate motion planning and control algorithms using ROS-based frameworks.
CO4: Apply sensing techniques and probabilistic filters for UAV state estimation.
CO5: Evaluate and implement visual SLAM and motion estimation algorithms for UAV navigation.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	-	-
CO2	3	-	-	-	2
CO3	3	2	2	3	2
CO4	3	2	2	3	3
CO5	3	2	3	2	3

Introduction to UAV - Types of UAV - Geometry and Mechanics of UAVs including transformations, angular velocity, principal moment of inertia, equations of motions, ROS based Control, Trajectories and Motion Planning, Sensing and Probabilistic State Estimation, Visual Motion Estimation, Visual SLAM, Architectures, UAV and AGV interoperable frameworks.

Textbooks/References:

1. Thrun, Sebastian, Wolfram Burgard, and Dieter Fox. Probabilistic Robotics. MITpress, 2005.
2. Carrillo, Luis Rodolfo García, et al. Quad rotorcraft control: vision-based hovering and navigation. Springer Science & Business Media, 2012.
3. Corke, Peter. Robotics, vision and control: fundamental algorithms in MATLAB®second, completely revised. Vol. 118. Springer, 2017.

25MT644 Advanced AI For Robotics LTPC-3-0-0-3

Learning Objectives

LO1: To understand AI-based search and planning algorithms for robotic problem solving.

LO2: To learn knowledge representation techniques and expert system design for intelligent robots.

LO3: To explore neural networks, fuzzy logic, and genetic algorithms in robotic applications.

LO4: To apply AI paradigms to real-time decision-making and control in robotic systems.

Course Outcomes

CO1: Implement and analyze graph-based and heuristic search algorithms for robotic path planning.

CO2: Represent knowledge using semantic networks, rules, frames, and ontologies for robotic reasoning.

CO3: Design expert systems for intelligent decision-making in robotic applications.

CO4: Apply neural networks and fuzzy logic to model learning, perception, and control in robotics.

CO5: Design and evaluate evolutionary algorithms such as genetic algorithms for robotic system optimization.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	2
CO2	3	-	2	2	2
CO3	3	2	2	3	2
CO4	3	2	2	3	3
CO5	3	1	3	2	3

Problem solving: Graph based search, Algorithms for searching, Heuristic search, Robot path planning. Knowledge representation: Descriptive representation, Procedural representation, Rule based representation, Semantic networks, Frames, Ontologies, Knowledge based systems. Expert systems. Artificial neural networks: Perceptron, Learning, Associative memories, Self -organized networks, Applications of neural networks in robotics. Fuzzy logic systems: Fuzzy logic, Fuzzy reasoning, Fuzzy logic-based techniques, Fuzzy relations, Fuzzy control, implementing fuzzy controllers, Fuzzy decision making. Genetic algorithms: Principles, Working, Design, Applications in robotics.

Textbooks/References:

1. Russell, S.J. and Norvig, P., "Artificial Intelligence – A Modern Approach", PrenticeHall, 2003.
2. Negnewitsky, M., "A Guide to Intelligent Systems", Addison-Wesley, 2005.
3. Inger, G.F., "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", Addison-Wesley, 2005.
4. Nilsson, N.J., "Artificial Intelligence: A New Synthesis", Morgan-Kaufmann, 1998.

25MT645 Computational Intelligence LTPC-3-0-0-3

Learning Objectives

LO1 To introduce the principles of Computational Intelligence technique.

LO2 To provide insights on the various CI paradigms

LO3 To impart knowledge to select a suitable CI principle to solve engineering or real-life problems.

Course Outcomes

CO1 Ability to understand concepts of basic principles of Computational Intelligence techniques.

CO2 Ability to Understand various neural network architectures

CO3 Ability to analyse and define various fuzzy systems

CO4 Ability to design and implement suitable CI principle to solve engineering or real life.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	-	-	1
CO2	3	1	2	-	2
CO3	3	2	2	-	2
CO4	3	3	3	-	3

Computational intelligence (CI): Adaptation, Self-organization and Evolution, Biological and artificial neuron, Neural Networks Concepts, Paradigms, Implementations, Evolutionary computing: Concepts, Paradigms, Implementation, Swarm Intelligence, Artificial Immune Systems, Fuzzy systems: Concepts, Paradigms, Implementation, Hybrid systems, CI application: case studies may include sensor networks, digital systems, control, forecasting and time-series predictions.

Textbooks/References:

1. R.C. Eberhart, “Computational Intelligence: Concept to Implementations”, Morgan Kaufmann Publishers, 2007.
2. A Konar, “Computational Intelligence: Principles, Techniques and Applications”, Springer Verlag, 2005.

25MT646 **Medical Robotics** **LTPC-3-0-0-3**

Learning Objectives

LO1 To understand how medical robots are used in computer integrated minimally invasive surgery

LO2 To understand the diverse applications of robotics in surgery

LO3 To understand the methodologies for design of medical robots

Course Outcomes

CO1 Ability to understand concepts of medical robot automation

CO2 Ability to evaluate the techniques for Robotically Assisted Minimally Invasive Surgery

CO3 Ability to analyse haptic feedback.

CO4 Ability to develop conceptual surgical robots for a given task

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	-
CO2	2	3	2	3	2
CO3	2	-	2	3	2
CO4	2	2	2	3	3

Introduction to Medical Robotics; Medical Robot (MR) History, MR Automation and Navigation Challenges; Robotically Assisted Minimally Invasive Surgery (MIS); MR Visual Servoing; MR-MIS Navigation and Deformation Tracking; Haptic Feedback in MIS; Learningand Perceptual Docking in MIS; Surgical Robotics (Laparoscopic and Endoscopic Manipulators); Oncology Robotics

Reading

1. http://www.springer.com/engineering/biomedical+engineering/book/978-1-4419-1125-4 Surgical Robotics: Systems Applications and Visions (by Rosen, Jacob, Hannaford, Blake, Satava, Richard M. (Eds.))
2. http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291478-596X (The International Journal of Medical Robotics and Computer Assisted Surgery)
3. http://medrobotics.ri.cmu.edu/node/128439 (Medical Robotics at CMU)
4. http://robotics.eecs.berkeley.edu/medical/ (Medical Robotics at UC Berkeley)
5. http://www.imperial.ac.uk/study/pg/courses/global-health-innovation/medical-robotics/ (MRes Curriculum at Imperial College)

25MT647 Embedded Systems for Automotive Applications LTPC-3-0-0-3

Learning Objectives

LO1 To understand basics of automotive systems
LO2 To understand the automotive sensors and actuators
LO3 To understand and develop automotive control architecture

Course Outcomes

CO1 Understand various automotive subsystems
CO2 Introduce Automotive sensors and actuators
CO3 Develop automotive control systems in embedded platform.
CO4 Understand various automotive communication protocols and software architecture

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	2
CO2	2	-	2	-	2
CO3	3	2	3	2	3
CO4	3	2	3	2	3

Automotive Fundamentals – Vehicle functional domains and requirements – Automotive Electrical subsystems- The systems approach to control and automotive instrumentation – Sensors and Actuators in various vehicle domains. Systems in Power Train Electronics: Engine Management Systems in Chassis control: ABS, ESP, TCS, Active Suspension Systems, Cruise Control and Adaptive Cruise control systems – Body Electronic systems – AutomotiveSafety systems HVAC – Electric Hybrid Vehicles and their configurations- Drive-by-wire systems – Autonomous and Connected Vehicles and their challenges-Introduction to Embedded Automotive Protocols: CAN, LIN, Flex-Ray, MOST-AUTOSAR standard and its applications - OSEK VDX Open Systems in Automotive Networks.

Textbooks/References:

1. William B. Ribbens, "Understanding Automotive Electronics – An Engineering Perspective", Eight Edition, Elsevier Inc., 2017.
2. Robert Bosch GmbH, "Bosch Automotive Electrics and Automotive Electronics - Systems and Components, Networking and Hybrid Drive", Fifth Edition, SpringerVieweg, 2007.
3. Najamuz Zaman, "Automotive Electronics Design Fundamentals", Springer, 2015.
4. V. A. W. Hillier and David R. Rogers, "Hillier's Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics", Fifth Edition, Nelson Thrones, 2007.
5. Tom Denton, "Automobile Electrical and Electronic Systems", Fifth edition, Routledge, 2017.

25MT648 Embedded Systems in Biomedical Applications LTPC-3-0-0-3

Learning Objectives

LO1 To Introduce Fundamentals of Biomedical signals & its acquisition
LO2 To understand the non-invasive measurements.
LO3 To understand the application of computing & network in health care system

Course Outcomes

CO1 Understand the basics of Bio Potentials and Physiological Signals.
CO2 Familiarise Patient Monitoring System using Embedded Systems
CO3 Study of Embedded Systems in Patient Assistive Devices.
CO4 Analyse the application of Embedded systems in surgical devices, medical imaging, clinical laboratory equipment etc.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	-
CO2	2	3	2	3	2
CO3	2	-	2	3	2
CO4	2	2	2	3	3

Overview of biomedical devices – Origin of bio potentials – bio potential electrodes – bio potential amplifiers, System Theory for Physiological Signals: Filters, Modeling – Embedded systems in patient monitoring: ECG, EEG, EMG, Blood pressure, respiration, pulse oximeters, diagnostic devices.

Non-invasive Diagnosis Using Sounds from Within the Body, Non-invasive Measurement of Blood Pressure, Measurement of Electrical Potentials and Magnetic Fields from the Body Surface and Plethysmography. Healthcare and the Wireless Sensor Network, Smart m- Health Sensing, m-Health and Mobile Communication Systems, Data Collection and Decision Making. m-Health Computing m-Health 2.0, Social Networks, Health Apps, Cloud and Big Health Data, m-Health and Global Healthcare and the Future of m-Health – case study.

Textbooks/References:

1. John G. webster, Amit J. Nimunkar, “Medical Instrumentation - Application and Design”, Fifth Edition, John Wiley and Sons, 2020.
2. Subhas Chandra Mukhopadhyay and Aime Lay-Ekuakille, “Advances in BiomedicalSensing, Measurements, Instrumentation and Systems”, Springer, 2010.
3. Aime Lay-Ekuakille and Subhas Chandra Mukhopadhyay, “Wearable and Autonomous Biomedical Devices and Systems for Smart Environment - Issues and Characterization”, Springer, 2010.
4. Robert B. Northrop, “Noninvasive Instrumentation and Measurement in Medical Diagnosis”, CRC Press, 2019.
5. Roberts. H. Istepanian and Bryan Woodward, “m-Health Fundamentals and Applications”, Wiley, 2017.

Learning Objectives

LO1 To gain basic knowledge on IoT framework
LO2 To familiarize with computing & system integration
LO3 To develop an IoT system

Course Outcomes

CO1 Understand the challenges and requirement of IoT framework.
CO2 Distinguish applications from ubiquitous computing, IoT and WoT.
CO3 Discuss the issues in system integration, debugging, testing, and analysing the system performance.
CO4 Design an IoT application.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	-
CO2	3	2	2	2	2
CO3	3	2	2	2	2
CO4	3	2	2	3	3

Embedded Systems: Rise of embedded systems and their transition to intelligent systems and to Internet of Things -RFIDs, NFC, Web of Things - Embedded Systems Design: power and energy consumption; hardware design elements, software platforms –OS and applications, code optimization, validation and robust code generation; system integration, debugging and test methodology; tools for coding, debugging, optimization, and documentation; measurement of system performance, Creating virtual prototypes - hardware software emulation. IoT Reference Architectures, Introduction to Node Red, Visual Prototyping with Arduino and connectivity to IoT platforms, Applications: Healthcareand home automation examples. Cloud Computing: Infrastructure as a Service (IaaS), Cloud Database, Cloud storage. Platform as a Service (PaaS) for Web Rapid Application Development (RAD), Distributed Storage, Distributed Computing frameworks. Connectivity to remote server database, data access-storage processing. Development of cloud servers and web applications.

Textbooks / References:

1. Barry, P., and Crowley, P., “Modern Embedded Computing”, Morgan Kaufmann, 2012.
2. Vijay Madisetti and Arshdeep Bahga, “Internet of Things: A Hands-on Approach”, Hardcover Import, 2014.
3. Thomas Erl, “Cloud Computing: Concepts, Technology & Architecture”, Prentice Hall, May 2013.
4. Michael J. Kavis, “Architecting the Cloud: Design Decisions for Cloud Computing Service
5. “Models (SaaS, PaaS, &IaaS)”, Wiley CIO Series, January 2014.
6. George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud”, O'Reilly, 2009.

Learning Objectives

LO1 To gain basic knowledge on overview of Microelectromechanical System and various Fabrication Techniques

LO2 To familiarize with the operation principles of selected MEMS Sensors and Actuators

LO3 To develop interdisciplinary skills towards higher learning and research

Course Outcomes

CO1 Able to understand the world of microelectromechanical devices and systems

CO2 Able to gain fundamental knowledge on material properties & fabrication technologies

CO3 Able to comprehend working principles of sensing and actuation.

CO4 Able to design micro devices, micro systems using the MEMS fabrication process

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	-
CO2	2	3	2	3	2
CO3	3	2	2	3	2
CO4	3	2	2	3	3

Unit I

Definition of MEMS. MEMS devices. Silicon as a MEMS material – mechanical properties ofsilicon. Mechanical components in MEMS. Design concepts of mechanical components. Working Principles of Microsystems. Engineering Science for Microsystems design and Fabrication. Scaling laws – Scaling in geometry, rigid body dynamics, electrostatic forces, electromagnetic forces, electricity-fluid mechanics and heat transfer.

Unit II

Materials for MEMS and Microsystems. Fabrication technologies – Photolithography – Ion implantation – diffusion – oxidation – CVD – Physical Vapor Deposition – Etching. Micro manufacturing – Bulk and surface micro machining – LIGA.

Unit III

Microsystems Design – Design considerations – Process design – Mechanical Design – CAD – Micro system packaging – Levels – Bonding – Interfaces – Assembly – Selection of Packaging Materials.

Textbook

1. Tai–Ran Hsu – ‘Mems & Microsystems Design and Manufacturing’ – John Wiley & Sons – 2008 – 2nd Edition References

References:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2006.
2. Gaberiel M.Rebiz, “RF MEMS Theory, Design and Technology”, John Wiley & Sons,2003

Learning Objectives

LO1: To understand the principles of soft actuation, sensing, and control mechanisms.

LO2: To model and simulate the behaviour of soft robotic systems, considering compliance and nonlinearity.

LO3: To explore the design, fabrication, and application of soft robots in wearable, service, and medical domains.

LO4: To evaluate new materials and architectural paradigms for next-generation soft robotics.

Course Outcomes

CO1: Explain the working principles of distributed actuators, shape memory alloys, and tactile sensors in soft robotics.

CO2: Analyze the modelling, dynamics, and control of soft and compliant robotic systems.

CO3: Simulate and evaluate soft robotic using behaviour-based and optimal control strategies.

CO4: Identify suitable smart materials for soft actuator and sensor integration.

CO5: Critically assess application-specific designs for safety, adaptability, and innovation potential.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	-	-
CO2	2	-	2	3	2
CO3	3	1	2	3	2
CO4	3	2	2	3	3
CO5	3	2	3	3	3

Unit I

New Concepts for Distributed Actuators and Their Control, Shape Memory Alloys as Flexible Actuators, Control and Feedback Control of Distributed Actuators, Musculoskeletal Robots and Wearable Devices on the Basis of Cable-driven Actuators, Capacitive Tactile Proximity Sensing

Unit II

Modeling, Simulation and Control, Perception of Deformable Objects and Compliant Manipulation for Service Robots, Soft Robot Control with a Behavior-Based Architecture, Optimal Exploitation of Soft-Robot Dynamics, Simulation Technology for Soft Robotics Applications, Mechanics and Thermodynamics of Biological Muscle – A Simple Model Approach

Unit III

Nanostructured Materials for Soft Robotics – Sensors and Actuators, Fibrous Materials and Textiles for Soft Robotics, Opportunities and Challenges for the Design of Inherently Safe Robots, Soft Hands for Reliable Grasping Strategies, Task-specific Design of Tubular Continuum Robots for Surgical Applications, Soft Robotics Research, Challenges, and Innovation Potential, Through Showcases

Textbook

1. Soft Robotics: Transferring Theory to Application, Alexander Verl, Alin Albu-Schäffer, Oliver Brock, Annika Raatz, Springer

25MT652 Real Time Operating Systems LTPC-3-0-0-3

Learning Objectives

LO1: To understand the fundamental concepts, models, and timing constraints of real-time

systems.

LO2: To explore scheduling algorithms and fault-tolerant mechanisms for real-time applications.

LO3: To study real-time communication strategies and inter-process communication methods.

LO4: To analyze the architecture and features of various Real-Time Operating Systems (RTOSs).

Course Outcomes

CO1: Explain the characteristics, timing models, and architecture of real-time systems.

CO2: Analyze and apply scheduling algorithms for real-time task management.

CO3: Address fault tolerance, resource sharing, and system robustness in real-time environments.

CO4: Evaluate real-time communication methods and their design trade-offs.

CO5: Compare different RTOS architectures and demonstrate inter-process communication and task management using POSIX or other RTOS environments.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	2	2
CO2	2	-	2	3	2
CO3	2	1	2	3	2
CO4	3	-	3	3	3
CO5	3	2	3	3	3

Unit I

Introduction: Real-time and real time system, applications, models of real-time systems (RTS), characteristics, safety and reliability, types, timing constraints, examples of RTSs.; Global Times: time and order, time measurement, dense time vs sparse time, internal clock synchronization, external clock synchronization; Real-time model: components and messages, component state, gateway component, linking interface specification, component integration.

Unit II

Temporal relations: real-time entities, observations (untimed, indirect, state and event), real-time images and objects, temporal accuracy, permanence and idempotency, determinism; Real-time task scheduling: types of real-time tasks, task scheduling, concepts and classification, algorithms – clock driven scheduling, hybrid schedulers, event driven scheduling, EDF scheduling, rate monotonic algorithm, multiprocessor task allocation, dynamic allocation of tasks. Resource sharing and Dependencies: resource sharing, priority inversion, basic concepts of faults, errors, failures, anomaly detection, fault tolerance, robustness.

Unit III

Real-time communication: requirements, design issues, communication model, flow control, event triggered communication, rate constrained communication, time-triggered communication; Real-time operating systems: features, inter-component communication, task management, time as data, inter-task interactions, Process I/O, error detection, Unix as a RTOS, POSIX, Contemporary RTOSs like PSOS, RT Linux et, benchmarking real time systems.

Textbook(s)

Kopetz H. Real-time Systems: Design Principles for Distributed Embedded Applications. Springer Science & Business Media; 2011 Apr 15.

Reference(s)

1. Rajib Mall. Real-Time Systems: Theory and Practice, Pearson, First Edition; 2006.

2. Laplante PA. Real-time Systems Design and Analysis: An Engineer's Handbook. Wiley-

IEEE Press; 1996 Nov 1.
3. Real-Time Systems - Course (nptel.ac.in)
4. Real Time Systems (iitpkd.ac.in)

25MT653 Computer Vision LTPC-3-0-0-3

Learning Objectives

LO1: To understand the mathematical and physical principles of image formation and projection geometry.
LO2: To apply feature detection, alignment, and motion estimation for image analysis.
LO3: To explore multi-view geometry and 3D reconstruction techniques from stereo vision.
LO4: To develop and evaluate algorithms for camera calibration, pose estimation, and visual scene understanding.

Course Outcomes

CO1: Explain the principles of camera models, image formation, and projective geometry.
CO2: Implement and compare feature detection and matching algorithms for visual correspondence.
CO3: Analyze motion in visual scenes using optical flow and structure-from-motion techniques.
CO4: Apply stereo and multi-view geometry to perform 3D scene reconstruction.
CO5: Evaluate calibration methods and pose estimation algorithms for real-world computer vision applications.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	2	2
CO2	2	2	2	2	2
CO3	3	1	2	3	2
CO4	3	-	3	3	2
CO5	3	2	3	3	3

Unit I

Image Formation: Geometric image formation, Photometric image formation - Camera Models and Calibration: Camera Projection Models – Orthographic, Affine, Perspective, Projective models. Projective Geometry, Transformation of 2D and 3D, Internal Parameters, Feature Detection and Matching – points and patches, edges, lines, Feature-Based Alignment - 2D, 3D feature based alignment, pose estimation, Image Stitching, Dense motion estimation – Optical flow - layered motion, parametric motion, Structure from Motion.

Unit II

Local Feature Detectors and Descriptors: Hessian corner detector, Harris Corner Detector, LOG detector, DOG detector, SIFT, PCA-SIFT, GLOH, SURF, HOG, Pyramidal HOG, PHOW-Calibration Methods: Linear, Direct, Indirect and Multiplane methods - Pose Estimation.

Unit III

Stereo and Multi-view Geometry: Epi-polar Geometry, Rectification and Issues related to Stereo, General Stereo with E Matrix Estimation, Stratification for 2 Cameras, Extensions to Multiple Cameras, Self-Calibration with Multiple Cameras, 3D reconstruction of cameras and structures, Three View Geometry.

Textbook(s)

1. Forsyth and Ponce, ―Computer Vision – A Modern Approach‖, Second Edition, Prentice Hall, 2011.
2. Richard Szeliski, ―Computer Vision: Algorithms and Applications‖, Springer, 2011.

Reference(s)

1. Olivier Faugeras, Three-Dimensional Computer Vision, MIT Press, 1993.
2. Emanuele Trucco and Alessandro Verri, ―Introductory Techniques for 3-D Computer Vision‖, Prentice Hall, 1998.

25MT654 Natural Language Processing LTPC-3-0-0-3

Learning Objectives

LO1: To understand fundamental concepts of computational linguistics and word representation.
LO2: To analyze and build statistical and rule-based NLP models.
LO3: To explore deep learning techniques and advanced architectures such as transformers for NLP tasks.
LO4: To apply NLP techniques in real-world applications such as machine translation, sentiment analysis, and question answering.

Course Outcomes

CO1: Apply linguistic concepts such as syntax, semantics, and word representation models.
CO2: Apply and evaluate classical NLP models such as POS tagging, Named Entity Recognition, and Dependency Parsing.
CO3: Implement evaluation metrics such as precision, recall, F-score, BLEU, and ROUGE for NLP tasks.
CO4: Develop NLP pipelines using machine learning and deep learning models.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	2	2
CO2	3	1	3	2	2
CO3	2	2	3	3	2
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Unit I

Computational linguistics- Introduction, syntax, semantics, morphology, collocation and other NLP problems. Word representation: One-hot encoding, Bag-of-Words (BoW) Dictionary: Term Frequency – Inverse Document Frequency (TF-IDF), Embedding: Word2vec, Glove and Fast text.

Unit II

Language Model-n-gram, Sequences and sequential data: Part-of-Speech tagging-HMM and CRF, Named Entity Recognition, Dependency parsing. Evaluation metrics for NLP models-Precision, Recall, F score, ROUGE, BLEU scores and Visualization

Unit III

Machine learning and deep learning for NLP, Sequence to sequence modelling (Encoder

decoder), Attention mechanism, Transformer Networks – BERT, A brief introduction to Reinforcement learning for NLP. NLP application introduction- Sentiment Analysis, Machine translation, Question Answering, Text summarization.

Textbook(s)

1. Christopher Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT press, 1999
2. Daniel Jurafsky, James H Martin, Speech and language processing, Prentice Hall, 2008

Reference(s)

1. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly Media, Inc.", 2009.
2. Douglas O'Shaughnessy, Speech Communication, University Press, 2001

25MT655 Sensor Networks LTPC-3-0-0-3

Learning Objectives

LO1: To understand the architecture, components, and protocols used in sensor networks.
LO2: To explore energy-efficient design, data management, and deployment strategies in sensor networks.
LO3: To implement and program real-world sensor network applications using suitable platforms and tools.
LO4: To analyze advanced trends, including integration with IoT/CPS and applications in smart domains.

Course Outcomes

CO1: Describe the fundamental architecture, components, and protocols used in wireless sensor networks.
CO2: Analyze sensor network topologies, localization techniques, and energy-efficient communication strategies.
CO3: Design and implement secure and functional sensor networks using platforms such as Arduino, Contiki, or TinyOS.
CO4: Apply data analytics and machine learning techniques for processing sensor network data.
CO5: Integrate sensor networks with cloud platforms and other technologies like IoT and WSANs for domain-specific applications.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	2	2
CO2	3	2	3	2	3
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Unit I

Introduction to Sensor Networks- Introduction to sensor networks: definitions, applications, and characteristics; Sensor network architecture and components: sensors, microcontrollers, communication modules, and power sources; Communication protocols and standards for sensor networks: IEEE 802.15.4, ZigBee, and LoRaWAN; Energy-efficient design principles for sensor networks: power management, duty cycling, and sleep/wake scheduling: Data collection and processing in sensor networks: data aggregation, compression, and filtering.

Unit II

Sensor Network Design and Implementation - Sensor network topology and deployment: star, mesh, and tree topologies; Localization and tracking in sensor networks: triangulation, trilateration, and fingerprinting; Security and privacy in sensor networks: encryption, authentication, and key management; Programming and development tools for sensor networks: Arduino, Contiki, and TinyOS; Hands-on lab sessions: designing and implementing a sensor network using wireless sensor nodes and microcontrollers.

Unit III

Advanced Topics in Sensor Networks- Emerging trends and applications in sensor networks: smart cities, precision agriculture, and healthcare; Big data analytics and machine learning for sensor networks: data mining, classification, and prediction; Cloud-based sensor networks: architecture, services, and platforms; Integration of sensor networks with other systems and technologies: Internet of Things (IoT), Cyber-Physical Systems (CPS), and Wireless Sensor-Actuator Networks (WSANs); Final project: developing a sensor network application for a specific domain or problem.

Textbook(s)

1. Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks: An Information Processing Approach,
2. N. Sastry and S. Shakkottai, "Building Wireless Sensor Networks: Theoretical and Practical Perspective,
3. Chiara Buratti, Marco Stango, and Roberto Verdone "Sensor Networks with IEEE 802.15.4 Systems: Distributed Processing, MAC, and Connectivity"

Reference(s)

1. Wenbo Mao, Wei Li, and Sushil Jajodia, "Security in wireless sensor networks"
2. Ali H. Al-Bayatti, Azween Abdullah, and Mazin Abed Mohammed, "Machine learning for wireless sensor networks: A comprehensive survey"

25MT656 Power Electronics L-T-P-C: 3-0-0-3

Learning Objectives

LO1: Understand the characteristics, operation, and selection criteria of power semiconductor devices, including wide bandgap devices.

LO2: Learn the principles and performance analysis of phase-controlled converters and choppers under various load conditions.

LO3: Analyze single-phase and three-phase inverters and their control strategies such as sine PWM and square wave.

LO4: Explore practical aspects of power electronic systems including losses, heat dissipation, filtering, and power quality.

Course Outcomes:

CO1: Understand the static and dynamic characteristics of power semiconductor devices and various power electronic converters.

CO2: Analyze the behaviour of converters and their control under different modes of operation.

CO3: Design different converter circuits under different operating modes.

CO4: Evaluate the performance of power converters for various applications.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	-	-	1
CO2	3	3	1	1	1
CO3	3	2	3	1	1
CO4	3	2	3	1	1

Unit 1

Power Semiconductor Devices: Power diodes, Thyristors, BJT, Power MOSFET, IGBT - Structure, turn ON and turn OFF operation, steady state and switching characteristics. Introduction to wide band gap power semiconductor devices, Comparison and selection of controllable switches – Introduction to driver circuits - Power loss in switching devices, Temperature rise and heat sink.

Unit 2

Phase Controlled Converters: Single phase and Three phase Converters in CCM - performance parameters, DCM operation, Analysis of Single-phase converter with different loads - Non-Sinusoidal Analysis. Inverter mode of operation - Effect of Source Inductance. Single-phase AC Voltage Controllers with different loads - Thyristor Controlled Reactor. Choppers: Step down and step up choppers - Steady state operation - CCM. Applications of choppers - power factor correction.

Unit 3 Inverters: Single phase half bridge and full bridge inverter, Inverter control - square wave, sine PWM - Unipolar and Bipolar voltage switching, performance parameters, AC and DC side current. Three phase inverters – sine PWM. Rectifier mode of operation - AC side filter – Applications.

Textbooks

1. Ned Mohan, Tore M. Underland and William P. Robbins, "Power Electronics: Converters, Applications and Design", Third Edition, John Wiley & Sons, 2007.

2. Erickson, Maksimovic, and Dragan "Fundamentals of Power Electronics", Kluwer academic publishers, 2020.

References:

1. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

2. Joseph Vithayathil "Power Electronics" Tata McGraw Hill, 2010.

3. Muhammed H Rashid, "Power Electronics- circuits, devices and applications" Pearson Education; Fourth edition 2017.

4. Shaffer, Randall, "Fundamentals of Power Electronics with MATLAB", Firewall media, 2013

25MT657 Advanced Topics in Intelligent Systems II LTPC-3-0-0-3

Learning Objectives

LO1: Understand and classify modern sensing technologies, including MEMS/NEMS, vision systems, LiDAR, and AI-enabled sensors.

LO2: Explore advanced actuation systems including soft actuators, EAPs, SMA-based systems, and their applications in robotics and wearables.

LO3: Learn principles of sensor fusion, SLAM, and localization for autonomous robotic navigation.

LO4: Study path planning and navigation techniques for intelligent and behavior-based mobile robots.

Course Outcomes

CO1: Evaluate and integrate advanced sensor technologies for intelligent robotic systems.

CO2: Analyze and apply advanced actuation mechanisms including smart materials and soft actuators in real-world robotic and biomedical systems.

CO3: Implement sensor fusion strategies for SLAM, localization, and mapping using probabilistic filters and multiple sensor modalities.

CO4: Design and simulate global and local path planning algorithms for autonomous robot navigation in structured and unstructured environments.

CO-PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	-	3	2	2
CO 2	2	-	2	2	-
CO 3	3	-	3	2	2
CO 4	2	2	3	3	2

Unit I

MEMS and NEMS Sensors (Micro/Nano Electro Mechanical Systems), Smart Sensors (with self-diagnostics, calibration, and communication features), Wireless Sensor Networks (WSN), Biosensors and Chemical Sensors, Optical and Photonic Sensors, Infrared Sensors and LiDAR, Time-of-Flight (ToF) and Ultrasonic Range Finders, Light Detection, Image, and Vision Systems, AI/ML-based Sensor Fusion, 3D Vision Sensors (Structured Light, Stereo Vision, Depth Cameras), IoT-enabled Sensor Systems, Distance Measuring and Proximity Sensors.

Unit II

Force, Torque and Power Measurement, Flow Measurement (Ultrasonic, Magnetic, Coriolis), Advanced Temperature Measurement Systems, Piezoelectric Actuators (Advanced Applications), Hydraulic and Pneumatic Actuation Systems, Magneto strictive Actuators, Shape Memory Alloy (SMA) Actuators, Electroactive Polymer Actuators (EAPs), Soft Actuators and Artificial Muscles, Robotic Grippers and Haptics, Actuators in Wearables and Biomedical Devices, Wireless and Remote-Controlled Actuation Systems.

Unit III

Sensor Fusion (IMU, GPS, Wheel Encoders, Lidar, Vision), SLAM (Simultaneous Localization and Mapping), Obstacle Detection and Avoidance (using Lidar, ToF, Ultrasonic, Vision). Probabilistic Localization (Kalman Filter, Particle Filter), Occupancy Grid Mapping, Visual Odometry, Map-based vs. Map-less Navigation. Global Path Planning (A*, Dijkstra, RRT), Local Path Planning (Dynamic Window Approach, Potential Fields), Trajectory Generation and Following, Reactive and Behavior-based Navigation.

Textbooks:

1. Robert H. Bishop (2017) Mechatronic Systems, Sensors, and Actuators: Fundamentals and Modeling; The Mechatronics Handbook, Second Edition
2. S.J. Russell and P. Norvig. Artificial Intelligence: A Modern Approach (3rd edition), Prentice-Hall, 2010.
3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Second Edition, O'Reilly Media, 2019.

Reference

4. Clarence W. de Silva (2015) Sensors and Actuators: Engineering System Instrumentation, Second Edition
5. Andrzej M Pawlak (2006) Sensors and Actuators in Mechatronics: Design and Applications
6. S.K.Bhattacharya, Control System Engineering, 3rd Edition, Pearson, 2013.
7. Benjamin.C.Kuo, ―Automatic control systems‖, Prentice Hall of India, 7th Edition,1995.
8. R Beale & T Jackson, "Neural Computing, An Introduction", Adam Hilger, 1990.

25AVP501 MASTERY OVER MIND 1-0-2-2

PG SYLLABUS

COURSE OBECTIVES

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., & Friese, 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 Amritanandamyi 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.

GLIMPSES OF INDIAN CULTURE

P/F

22ADM501: GLIMPSES OF INDIAN CULTURE

A. Prerequisite: nil

B. Nature of Course: Theory

C. Course Objectives:

- 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 [Bloom's Taxonomy]
CO01	**Recall key concepts and terms associated with Sanatana Dharma, scriptures, and core cultural elements of India.**	Remembering

	Statement: Demonstrate the ability to remember essential terms, concepts, and principles discussed in the chapters on Sanatana Dharma, scriptures, and cultural aspects.	
CO02	**Explain the concepts of Īśvara, Guru Tattva, Avatara Tattva, and the Theory of Karma as foundational elements of Indian cultural philosophy.** Statement: Understand the profound meanings of Īśvara, Guru, Avatara, and Karma, elucidating their importance in shaping Indian cultural thought.	Understanding
CO03	**Apply the knowledge of Purusharthas, Sanyasa, and Yajna to analyze real-life ethical and spiritual scenarios.** Statement: Utilize insights from Purusharthas, Sanyasa, and Yajna to navigate ethical dilemmas and make informed decisions**.**	Applying
CO04	**Analyze the symbolism in cultural practices, Nataraja iconography, and temple architecture.** Statement: Deconstruct the layers of symbolism in various cultural aspects, including Nataraja representation and temple architecture, unraveling their deep meanings.	Analyzing
CO05	**Evaluate the significance of temples as cradles of culture and explore alternative systems in India's cultural landscape.** Statement: Assess the role of temples in preserving cultural heritage and critically examine the diversity of cultural and spiritual systems in India.	Evaluating
CO06	**Develop projects or presentations that highlight the essence of Sanatana Dharma, sadhana, and the cultural significance of symbols.** 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**
PO1: Engineering Knowledge **PO2: Problem Analysis** **PO3: Design/Development of Solutions** **PO4: Conduct Investigations of complex problems** **PO5: Modern tools usage** **PO6: Engineer and Society** **PO7: Environment and Sustainability** **PO8: Ethics** **PO9: Individual & Teamwork** **PO10: Communication** **PO11: Project management & Finance** **PO12: Lifelong learning** **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.	• CO 1: Recall key concepts and terms associated with Sanatana Dharma, scriptures, and core cultural elements of India. • CO 2: Explain the concepts of Īśvara, Guru Tattva, Avatara Tattva, and the Theory of Karma as foundational elements of Indian cultural philosophy • CO 3: Apply the knowledge of Purusharthas, Sanyasa, and Yajna to analyze real-life ethical and spiritual scenarios. • CO 4: Analyze the symbolism in cultural practices, Nataraja iconography, and temple architecture. • CO 5: Evaluate the significance of temples as cradles of culture and explore alternative systems in India's cultural landscape. • CO 6: Develop projects or presentations that highlight the essence of Sanatana Dharma, sadhana, and the cultural significance of symbols.

E. CO-PO Mapping: [affinity#: 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

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

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	-
TOTAL	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, 6th 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, 1st 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
- www.cambridgeenglish.org
- www.englishforeveryone.org
- 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, 3nd 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
- www.campusgate.co.in
- 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
Pass / Fail		

*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.

C05: 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

C06: 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, Cryptarithmetic 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
- 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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