AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

(AMRITAPURI, BENGALURU, COIMBATORE, CHENNAI)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M. Tech. in EMBEDDED SYSTEMS

(MTC-EBS)

CURRICULUM AND SYLLABI

(2025)

Program 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: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Program Specific Outcomes (PSOs)

PO4/PSO1: Conduct research and develop innovative embedded systems by integrating microcontrollers, IoT, Real-time computing and Intelligent algorithms to address challenges in Robotics, Automotive, and Smart Systems.

PO5/PSO2: Apply Signal and Image Processing, Artificial Intelligence, Operating Systems and Embedded System Design techniques to build innovative industrial solutions.

CURRICULUM

M.Tech. Embedded Systems

Duration: 2 years, Total 69 credits

I Semester

Course Code	Type	Course Title	L T P	Credits
25ES601	Subject Core	Embedded Software Development Essentials	2 0 3	3
25EE601	Subject Core	Advanced Digital Signal Processing	3 0 3	4
25ES602	Subject Core	Embedded Computing using ARM	3 0 3	4
25ES603	Subject Core	Machine Learning for Embedded Systems	3 0 3	4
25ES604	Subject Core	Embedded System Design	2 0 3	3
25RM603	Subject Core	Research Methodology	2 0 0	2
23HU601	Humanities	Career Competency – I	0 0 3	P/F
22ADM501	Humanities	Glimpses of Indian Culture		P/F
			Total	**20**

II Semester

Course Code	Type	Course Title	L T P	Credits
25ES611	Subject Core	Real-time Operating Systems	3 0 3	4
25ES612	Subject Core	FPGA System Design	3 0 3	4
25ES613	Subject Core	Internet of Things	3 0 3	4
25ES614	Subject Core	Distributed Computing Architectures	2 0 0	2
	Elective	Elective I	3 0 0/ 2 0 3	3
	Elective	Elective II	3 0 0/ 2 0 3	3
25ES698	Internship	Industry Internship	0 0 3	1
25AVP501	Humanities	Mastery Over Mind	1 0 2	2
23HU611	Humanities	Career Competency – II	0 0 3	1
			Total	**24**

III Semester

Course Code	Type	Course Title	L T P	Credits
25ES798	Project	Dissertation I	0 0 30	10
			Total	**10**

IV Semester

Course Code	Type	Course Title	L T P	Credits
25ES799	Project	Dissertation II	0 0 45	**15**

List of Electives

Course Code	Course Title	L T P	Credits
25ES631	Computer Vision for Embedded Systems Applications	3 0 0	3
25ES632	Hyperspectral Data Processing for Embedded Systems	3 0 0	3
25AI652	Deep Learning	2 0 3	3
25ES634	Edge AI on Embedded Platforms	2 0 3	3
25AI654	Cyber Systems and Security	3 0 0	3
25ES636	Hardware Software Co-Design	3 0 0	3
25ES637	Embedded Systems for Automotive Applications	2 0 3	3
25ES638	Embedded Systems for Robotics	2 0 3	3
25ES639	Embedded Systems in Biomedical Applications	3 0 0	3
25ES640	Video Processing	3 0 0	3
25ES641	GPU Architecture and Programming	2 0 3	3
25ES642	Advanced Image Processing and Computer Vision	3 0 0	3
25ES643	Cryptography and Network Security	3 0 0	3
25ES644	Web Technologies and Applications	3 0 0	3
25ES645	Mobile Application Development	2 0 3	3
25ES646	Advanced Mobile and Wireless Networks	3 0 0	3
25ES647	Multi Core Architectures	2 0 3	3
25ES648	Fault Tolerant System	2 0 3	3
25ES649	Embedded Systems in Smart Grid	2 0 3	3
25ES650	Design For IoT and Cloud Computing	2 0 3	3
25ES651	Intelligent Systems Design	3 0 0	3

SYLLABUS

SEMESTER I

25ES601	Embedded Software Development Essentials	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To introduce the foundational concepts of Version Control Systems, Coding Standards, Code Documentation, Structured Programming and Object-Oriented Programming.

Course Outcomes:

CO1: Understand the basics of version control system and documentation.
CO2: Develop structured programming using C.
CO3: Develop code using object-oriented concepts.
CO4: Analyse programs for real world applications.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	1	3	1	1	1
CO2	2	2	2	2	2
CO3	2	2	3	2	3
CO4	3	2	3	3	3

Syllabus:

Functions, Pointers, Structure, Data Structures- Stacks and Queues, Linked List. Introduction to Object oriented design pattern. Basic elements, mutable and immutable type, tuples, list, and dictionaries. Control statements, loops, Functions, modules, Exception and assertions. Classes, Access Modifiers, dunder/magic methods, object-oriented programming, abstraction, inheritance, encapsulation, polymorphism, Code testing. Coding standard and guidelines. Code documentation. Porting to microcontrollers, Memory-mapped register access, interrupts, startup code, Code Analysis and Performance tuning. Version control system, benefits, Types of Version Control Systems, Centralized Version Control Systems, Distributed Version Control Systems.

TEXTBOOKS/ REFERENCES:

1. Jon Loeliger, Matthew McCullough, "Version Control with Git", *O'Reilly Media*, Inc 2nd Edition, 2012.
2. Naomi Ceder, "The Quick Python Book", 4th Edition, *Shelter Island, NY, USA: Manning Publications*, 2024.
3. Robert Martins, "Clean Code", *Pearson Education*, second edition, 2012.
4. Xavier Rival and Kwangkeun Yi , "Introduction to Static Analysis an Abstract Interpretation Perspective", *MIT Press*, January 2020

25EE601	Advanced Digital Signal Processing	L-T-P-C: 3-0-3-4

Pre-requisite: Nil

Course Objective:

- To apply digital signal processing techniques to analyse, model, and simulate electrical systems.
- To design and implement advanced filters and multirate methods for real-time signal processing applications.

Course Outcomes:

CO1: Analyse sampling, aliasing, FFT, and implement IIR/FIR filters using MATLAB.

CO2: Apply signal processing methods to model, simulate, and solve problems in electrical networks and systems.

CO3: Analyse and implement advanced digital filters such as Adaptive Filters and Kalman Filters for real-time applications.

CO4: Demonstrate the principles of multirate signal processing and discrete wavelets as filter banks in electrical systems.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	2	2	1	3
CO2	2	2	3	1	3
CO3	3	2	3	2	3
CO4	3	2	3	2	3

Syllabus:

Review of Signal Processing Techniques - Adaptive Filters, Estimation Theory, Multi-rate Digital Signal Processing Basic Concepts. Introduction to Wavelet Transforms—Discrete Wavelet Transforms- Discrete Wavelets and Filter Banks. Introduction to Kalman Filter and Variations. Applications.

Two dimensional signals and systems–Sampling in two dimensions–Two dimensional discrete transforms— DCT – DWT– Applications–2D Hadamard Transform, Walsh Transform, KLT, Application – Z Transform and its properties –Image Acquisition– Enhancement- Filtering in Spatial and Frequency domain. Morphological operations, Image segmentation, Feature Extraction, Image Compression– 3D signals and Systems–3D sampling and reconstruction– Digital Video Processing – Case Studies

TEXTBOOKS/ REFERENCES:

1. Rafael C. Gonzalez, “Digital Image Processing”, Third Edition, PHI Private Limited, New Delhi, 2008.
2. John W. Wood, “Multidimensional Signal, Image, Video Processing and Coding”, Elsevier, 2006.
3. Mitra S.K., “Digital Signal Processing, A Computer-Based Approach”, 4th Edition, McGraw-Hill, 2013.
4. Ifeachor E. C. and Jervis B. W., “Digital Signal Processing: A Practical Approach”, 2nd Edition, Pearson Education, 2009.
5. Vaidyanathan P. P, “Multirate Systems and Filter Banks”, Prentice Hall, 1993.
6. Simon Haykin, “Adaptive Filter Theory”, 4th Edition, Pearson Education, 2008.

25ES602	Embedded Computing Using ARM	L-T-P-C: 3-0-3-4

Pre-requisite: Nil

Course Objectives:

- To understand the architecture and performance characteristics of embedded processors, with emphasis on RISC-based systems.
- To gain comprehensive knowledge of ARM architecture, programming models, instruction set, and exception handling.
- To develop practical skills in programming ARM-based microcontrollers and applying them in real-world embedded systems.

Course Outcomes:

CO1: Explain the architecture, pipelining, memory systems, and performance metrics of embedded processors.
CO2: Describe the ARM processor architecture, instruction set, addressing modes, and programming model.
CO3: Illustrate the architecture and peripheral features of ARM-based microcontrollers.
CO4: Design and develop embedded applications using ARM microcontrollers for real-world use cases.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	2	3	2	2
CO2	2	2	3	2	2
CO3	2	2	3	3	2
CO4	3	2	3	3	3

Syllabus:

An Introduction to Embedded Processors. RISC versus CISC. CPU Performance Metrics. Benchmark. RISC processor design. Pipelined data path design. Pipeline Hazards. Memory system design - Memory Management unit - Cache Memory - Virtual Memory. Introduction to ARM processors. Evolution. Advanced ARM Architecture. Core Architecture, Processor, Programmers Model, Interrupt & Exception Model, Memory Model, Instruction Set, and Addressing modes. Assembly Language Programming. Introduction to ARM-based Microcontrollers. Architecture. Peripherals – Ports, Timers, PWM, ADC, UART, SPI, I2C. Application development – Bare-metal Programming, Rapid Prototyping with libraries. Case studies with real-world automation applications.

TEXTBOOKS/ REFERENCES:

1. Steve Furber, “ARM System-on-Chip Architecture”, Pearson India, 2015.
2. Joseph Yiu, “The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors”, Third Edition, Newnes, 2013.
3. Cem Ünsalan , Hüseyin Deniz Gürhan, Mehmet Erkin Yücel, “Embedded System Design with ARM Cortex-M Microcontrollers: Applications with C, C++ and MicroPython”, Springer Cham, 2022.
4. Yifeng Zhu, Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C, E-Man Press LLC, Fourth Edition, 2023.
5. David A. Patterson, John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", 5th Edition, Morgan Kaufmann, 2014.
6. ARM Microcontroller User Manual.

25ES603	Machine Learning for Embedded Systems	L-T-P-C:3-0-3-4

Pre-requisite: Nil

Course Objectives:

- To introduce foundational concepts in machine learning and their relevance to embedded systems.
- To develop practical skills for designing, training, and deploying ML models using platforms like Edge Impulse.
- To explore model optimization and deployment strategies tailored for resource-constrained embedded environments.

Course Outcomes:

CO1: Explain key machine learning concepts and evaluate models using appropriate metrics for classification, regression, and anomaly detection.

CO2: Apply algorithms such as SVMs, neural networks, and CNNs to solve classification and regression problems using embedded datasets.

CO3: Build end-to-end ML applications on Edge Impulse, including data acquisition, feature engineering, model training, and validation.

CO4: Optimize and deploy trained models to embedded platforms using frameworks such as TensorFlow Lite and TFLM, considering hardware constraints and sensor fusion.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	2	3	2	3
CO2	3	2	3	2	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3

Syllabus:

Machine Learning Basics: learning types, classification/regression, model types, dimensionality issues, linear/logistic regression. Evaluation metrics for classification, regression, and anomaly detection. TinyML overview and key use cases.

Support vector machines for regression and classification. Neural Networks, Ensemble methods, Introduction to Convolutional Neural Network (CNN), Reinforcement Learning. End-to-end development of ML applications using Edge Impulse: data collection from sensors, Data pre-processing, feature extraction, feature selection, model training.

Model optimization techniques for embedded ML: quantization, pruning, model size vs performance trade-offs. Hardware constraints and selection criteria for ML deployment. Multi-sensor fusion. Deployment frameworks: TensorFlow Lite, TensorFlow Lite for Microcontrollers (TFLM).

Ethics and safety in embedded AI.

TEXTBOOKS/ REFERENCES:

1. Pete Warden, Daniel Situnayake, "TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers", *O'Reilly Media*, 2020.
2. Simon Haykin, "Neural Networks and Learning Machines", *Pearson*, 2020.
3. Xiaofei Wang, Yi Pan, "Edge AI: Machine Learning for Embedded Systems", *Springer*, 2022.
4. Daniel Situnayake, Ian Buckley, "Practical TinyML: Deploying Machine Learning on Microcontrollers with TensorFlow Lite", *O'Reilly Media*, 2022.
5. Tom M. Mitchell, "Machine Learning", *McGraw-Hill*, 1st edition 1997.

25ES604	Embedded System Design	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To introduce fundamental concepts, architecture, and design challenges of embedded systems.
- To understand hardware and software design approaches of embedded systems.
- To familiarize modelling and interfacing of embedded processors.
- To explore embedded system design challenges.

Course Outcomes:

CO1: Understand the fundamentals of embedded and distributed systems.
CO2: Familiarize different communication methods.
CO3: Understand hardware and software design approaches of embedded systems.
CO4: Familiarize embedded system memory hierarchy, models and design challenges.

CO-PO Mapping:

PO/PSO CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	2
CO2	2	1	2	2	2
CO3	3	2	3	3	2
CO4	3	2	3	3	2

Syllabus:

Introduction to embedded systems: Definition and characteristics of embedded systems, Categories, Functional, Temporal and dependability requirements, Embedded system building blocks, embedded systems design, applications.

Embedded hardware and software design fundamentals: History of processor architectures: scalar, vector, superscalar architecture, VLIW, EPIC, SMT, Multicore and multiprocessor architectures. Memory systems and memory hierarchy. Sensors and actuators: Types, Interfacing, Signal conditioning. Signal and communication interfaces. Embedded Firmware: RTOS, Device drivers, Application software, Software development life cycle. Selection criteria for components of embedded systems.

Embedded system models and design challenges: Introduction to distributed system models: High-performance computing, Grid computing, Cloud computing, Many-core computing, Many-task computing, Data-intensive computing, Parallel architecture, and Multithreaded programming. Design challenges: Power, Performance, Security, Reliability, Development and debugging tools: Compilers, Linkers, Linker scripts, Loaders, Emulators, Debuggers.

TEXTBOOKS/ REFERENCES:

1. F. Vahid and T. Givargis, Embedded System Design: A Unified Hardware/Software Introduction, 3rd ed. Hoboken, NJ, USA: John Wiley & Sons, 2002.
2. K. V. Shibu, Introduction to Embedded Systems, 2nd ed. New Delhi, India: Tata McGraw-Hill Education, 2016.
3. B. P. Douglas, Real-Time UML: Developing Efficient Objects for Embedded Systems, 2nd ed. Boston, MA, USA: Addison-Wesley, 2004.
4. G. Coulouris, J. Dollimore, T. Kindberg, G. Blair, "Distributed Systems: Concepts and Design," Addison Wesley, Fifth edition, 2012.

25RM603	RESEARCH METHODOLOGY	L-T-P-C: 2-0-0-2

Pre-requisite: Nil

Course Objectives:

- To enable students to define research problems, review, analyze as well as to evaluate literature and possibly to formulate effective solutions.
- To prepare students either for a research thesis or for an industry-based project.
- To provide oral and written communication skills.
- To inculcate a strict adherence to the principles of research ethics and values

Course Outcomes:

CO1: Understand the basic concepts of research and its methodologies
CO2: Understand and apply the process of searching for, selecting and critically analysing research articles and papers
CO3: Formulate and evaluate research questions and apply the process of designing a research study and interpreting the outcomes of the study
CO4: Write and present a research report and thesis.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	2	2	2
CO2	3	2	2	2	2
CO3	3	2	3	2	2
CO4	2	3	3	2	2

Syllabus:

Meaning of Research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Approaches to Research - Quantitative vs. Qualitative Approach, Understanding Theory, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs Theoretical Research, Importance of reasoning in research.

Problem Formulation, Understanding Modelling & Simulation, Conducting Literature Review, Referencing, Information Sources, Information Retrieval, Role of libraries in Information Retrieval, Tools for identifying literatures, Indexing and abstracting services, Citation indexes

Experimental Research: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results

Preparation of Dissertation and Research Papers, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Tables and illustrations and Citation.

Intellectual property rights (IPR) – patents – copyrights - Trademarks - Ethics of Research, Scientific Misconduct - Forms of Scientific Misconduct – Plagiarism - Unscientific practices in thesis work.

Text Book(s)/Reference(s):

1. Bordens, K. S. and Abbott, B. B., “Research Design and Methods – A Process Approach”, 11thEdition, McGraw-Hill, 2022.
2. Roy Sabo and Edward Boone, “Statistical Research Methods: A Guide for Non Statisticians”, Springer, 2013.

3. Davis, M., Davis K., and Dunagan M., “Scientific Papers and Presentations”, 3rd Edition,Elsevier Inc., 2013.
4. Ron Iphofen (Ed), “Handbook of Research Ethics and Scientific Integrity”, Springer, 2020.
5. Elsevier, “Ethics in Research & Publication”, https://www.elsevier.com/ data/assets/pdf_file/0008/653885/Ethics-in-research-and-publication-brochure.pdf

23HU601	CAREER COMPETENCY I	L-T-P-C: 0-0-3-P/F

Pre-requisite:
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.
C05: 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.
C06: 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/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
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, 3rd Edition, 2015
• R.S. Aggarwal, “Quantitative Aptitude for Competitive Examinations”, S. Chand Publishing, 2015
• R.S. Aggarwal, “A Modern Approach to Verbal & Non-Verbal Reasoning”, S. Chand Publishing, Revised -2015
• Sarvesh Verma, “Quantitative Aptitude-Quantum CAT” , Arihant Publications, 2016
• www.mbatious.com
• 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**

SEMESTER II

25ES611	Real Time Operating Systems	L-T-P-C: 3-0-3-4

Pre-requisite: Embedded system design

Course Objectives:

- To understand the fundamentals, features, and classification of real-time operating systems and need of real time operating systems (RTOS) in embedded application development.
- To understand real time tasks, its attributes, and tasks scheduling approaches.
- To familiarize deadlock issues and tasks synchronization methods in real time systems.
- To design and develop simple embedded applications using RTOS environments.

Course Outcomes:

CO1: Understand the basics of real time operating systems and RTOS kernel.
CO2: Familiarize task management strategies and real-time scheduling algorithms.
CO3: Understand deadlock condition, avoidance mechanisms, and task synchronization approaches.
CO4: Develop real time applications using RTOS.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	2
CO2	2	1	3	2	2
CO3	2	1	3	2	2
CO4	3	2	3	3	3

Syllabus

Introduction to operating systems (OS): Introduction to OS, Functions of OS, General purpose operating systems functionalities, system calls, architecture, OS for single processor and multiprocessor systems, User mode and Kernel mode operations, Kernel services.

Task timer and memory management: Tasks, task states and transitions, task attributes, types, task control block, task creation, deletion, and task priorities. Introduction to real-time scheduling, Kernel, Scheduler, Dispatcher, and preemption-context switching. Task scheduling, uniprocessor and multiprocessor scheduling algorithms. Inter task communication and synchronization: Common resource sharing problem, critical section, Lock/Unlock, Semaphores, Mutex, Mailbox, Queue, Pipes, Deadlock, methods for handling deadlocks, deadlock prevention, avoidance and recovery solutions.

Timer and memory management. Exception, interrupt handling. Priority inversion problem and solution. Introduction to device IO management-device driver, Familiarization of FreeRTOS – architecture, porting. Introduction to Embedded Linux. Real time applications.

TEXTBOOKS/ REFERENCES:

1. Silberschatz, P. B. Galvin, G. Gagne, "Operating System Concepts", 8th Edition, *Wiley*, 2009.
2. Krishna, C. M., Shin, K. G., "Real-Time Systems", First Edition, *McGraw-Hill*, 2017.
3. Richard Barry, "Mastering the FreeRTOS™ Real Time Kernel A Hands-On Tutorial Guide", First Edition, *Real Time Engineers Ltd*., 2016.
4. Jean J. Labrosse, "µC/OS - III The Real Time Kernel User's Manual", *Micrium Press*, 2009.

25ES612	FPGA System Design	L-T-P-C: 3-0-3-4

Pre-requisite: Nil

Course Objectives:

- Understand FPGA architecture and design flow, including logic implementation (LUTs, I/O blocks), HDL-based modelling, and synthesis of combinational/sequential systems.

Course Outcomes:

CO1: Understand synthesizable HDL modelling of digital subsystems.
CO2: Formulate architecture of systems at the RTL abstraction.
CO3: Implement digital systems in FPGA platforms and evaluate them based on tool reports.
CO4: Employ custom and block design to realize embedded systems for FPGA implementation.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	2
CO2	2	2	3	3	2
CO3	3	2	3	3	2
CO4	3	2	3	3	3

Syllabus:

Introduction to FPGAs – Design flow – Circuit Fabrics – LUTs and IO Blocks – FPGA Technology overview – Digital Design for FPGAs - High Level System Architecture and Specification: Behavioural modelling and simulation - Hardware description languages – Design of combinational and sequential subsystems – Case Study of RTL Design for FPGAs – Interpreting Synthesis and Implementation reports

Design of data path and controller subsystems – FIFOs - Memory controllers – Platform FPGAs - DSP blocks – FPGA Block RAMs - Synthesis issues – System Level synthesis from high level languages

Block-based design flow – Case study of block-based design of a digital system – FPGA processor fabrics and bus interfaces – FPGA based embedded design flow.

TEXTBOOKS/ REFERENCES:

1. Michael D. Ciletti, “Advanced Digital Design with Verilog HDL”, Second Edition, *Pearson Higher Education,* 2011.
2. Stephen Brown and Zvonko Vranesic, “Fundamental of Digital Logic with VHDL Design”, Third Edition, *McGraw Hill*, 2009.
3. Samir Palnitkar, “Verilog HDL, A Guide to Digital Design and Synthesis”, Second Edition, *Pearson Education,* 2003.
4. T. R. Padmanabhan and B. Bala Tripura Sundari, “Design Through Verilog HDL”, *Wiley Interscience*, 2004.
5. Wayne Wolf, “FPGA-Based System Design”, *Prentice Hall India Pvt. Ltd*., 2005.

25ES613	Internet of Things	L-T-P-C: 3-0-3-4

Pre-requisite: Nil

Course Objectives:

- To introduce foundational concepts, reference frameworks, and enabling technologies of the Internet of Things (IoT), covering both hardware and software elements including devices, communication, services, security, and applications.
- To provide a thorough understanding of networking fundamentals, including ISO/OSI and TCP/IP models, IoT communication protocols, and sensor network architecture and design principles.
- To explore modern computing paradigms such as Cloud, Edge, and Fog computing, and examine emerging trends and real-world applications of IoT in domains like smart cities, healthcare, industry, and automation.

Course Outcomes:

CO1: Explain the core concepts, frameworks, and functional blocks involved in IoT systems.
CO2: Identify and describe the hardware and software components of IoT, including sensing, communication, and service layers.
CO3: Analyse the role of communication protocols in IoT across different layers of the technology stack.
CO4: Design IoT-based solutions for real-world applications using appropriate technologies and architectures.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	2	3	2	2
CO2	2	1	3	2	2
CO3	2	1	3	2	3
CO4	3	2	3	3	3

Syllabus:

Introduction to IoT - Definitions, Evolution 4.0, 5.0, frameworks and key technologies. Functional blocks of IoT systems: hardware and software elements - devices, communications, services, management, security, and application. Challenges to solve in IoT.

Basics of Networking & Sensor Networks - Applications, challenges - ISO/OSI Model, TCP/IP Model. Sensor network architecture and design principles. IoT technology stack - overview of protocols in each layer. Communication Protocols and models, Application protocols for the transfer of sensor data - MQTT, CoAP, HTTP, AMQP, etc.

Introduction to Cloud, Fog and Edge Computing – common IoT platforms – Modern trends in IoT – Industrial IoT, Wearable. Applications of IoT - Smart Homes/Buildings, Smart Cities, Smart Industry, Smart Medical care, Smart Automation, Smart Grid etc.

TEXTBOOKS/ REFERENCES:

1. Andrew S. Tanenbaum and David J. Wetherall, “Computer Networks”, 5th Edition, *Pearson Education*, 2011.
2. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, 1st Edition, *John Wiley and Sons Ltd.*, 2005.
3. Rayes, Ammar, Salam, Samer “Internet of Things from Hype to Reality”, 1st Edition, *Springer*, 2017.
4. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on Approach", 1st Edition, *Universities Press*, 2015.
5. Rajkumar Buyya, Amir Vahid Dastjerdi, "Internet of Things: Principles and Paradigms", 1st Edition, *Morgan Kaufmann*, 2016.
6. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", 1st Edition, *Wiley*, 2013.

25ES614	Distributed Computing Architectures	L-T-P-C: 2-0-0-2

Pre-requisite: Embedded system design

Course Objectives:

- To understand the fundamentals and classifications of distributed computing architectures.
- To analyse the impact of parallel architectures on embedded system design and performance.
- To familiarize different levels of distributed execution models.
- To familiarize real-world embedded distributed architectures and applications.

Course Outcomes:

CO1: Understand the basics of distributed computing systems.
CO2: Analyse the significance of time and various time synchronization methods in distributed computing systems.
CO3: Examine the significance and requirements of real time communication systems.
CO4: Illustrate various distributed system models.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	2
CO2	2	1	3	2	2
CO3	2	1	3	2	3
CO4	2	2	3	2	2

Syllabus:

Introduction to distributed computing systems (DCS), DCS design goals, Fundamental issues and challenges, System architecture, Model of distributed computations, Distributed and Centralized architecture. Distributed Coordination: Temporal ordering of events, Lamport's logical clocks, Vector clocks; Ordering of messages, Process synchronization, Global states and snapshot recording algorithms. Modelling of distributed real-time systems. Basics of real time systems: Functional, Temporal and Dependability requirements.

Real time communication, Requirements of real time communication system, Flow Control-Explicit and Implicit, Thrashing, Inter-process communication: Message passing communication, Remote procedure call, Group communication, Deadlocks in distributed systems, Load scheduling and balancing techniques, Consistency Models, Fault Tolerance.

Introduction to Distributed System Models, High-Performance Computing, Grid Computing, Cloud Computing, Many-core Computing, Many-Task Computing, Data-Intensive Computing, GPU architectures, Parallel architectures, and Multithreaded programming. Usage of tools for parallel and distributed programming.

TEXTBOOKS/ REFERENCES:

1. "Distributed Systems: Concepts and Design" (6th Edition, 2024), George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, *Pearson.*
2. "Distributed and Cloud Computing: From Parallel Processing to the Internet of Things" (2nd Edition, 2022), Kai Hwang, Jack Dongarra, Geoffrey Fox, *Morgan Kaufmann*.
3. "Distributed Systems" (3rd Edition, 2017), Andrew S. Tanenbaum, *Maarten van Steen Pearson*.
4. "Real-Time Systems: Design Principles for Distributed Embedded Applications" (3rd Edition, 2022), Hermann Kopetz, *Springer*.
5. "Fog and Edge Computing: Principles and Paradigms" (2nd Edition, 2023), Rajkumar Buyya, Satish Narayana Srirama, *Wiley*.

25ES698	INDUSTRY INTERNSHIP	L-T-P-C: 0-0-3-1

Pre-requisite: Nil.

Course Objectives:

- To expose the students to industry setting and get acquainted with its various functions.
- To gain direct experience to relate and reinforce the concepts learned in the classroom
- To promote collaboration between industry/Research Laboratory and the institution

Course Outcomes:

CO1: Familiarize with the industry environment/Research Laboratory.
CO2: Understand the application of theoretical concepts in a practical setting.
CO3: Prepare technical documents/presentations related to the work completed.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	-	-	-	-	-
CO3	-	-	-	-	-

Syllabus:

Students have to undergo minimum of two week of practical training in Embedded Systems or allied industries/research laboratory of their choice with the approval of the department. At the end of the training student should submit a report and certificate of completion to the department in the prescribed format.

Evaluation Pattern:

This course is mandatory. The student shall make a report. The committee constituted by the department which will assess the student based on the report submitted.

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/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
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.

TEXTBOOKS/ 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", JosseyBass, 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

• 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

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

SEMESTER III

25ES798	DISSERTATION I	L-T-P-C: 0-0-30-10

Course Objectives:
The students are made to choose a suitable problem, comprehend and analyse the problem after detailed literature survey.

Course Outcomes:
CO1: Identify a topic based on recent literature in embedded systems.
CO2: Formulate the framework for implementation.
CO3: Choose computational and analytical tools for implementation
CO4: Communicate technical content orally and document the findings

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	3	3	2
CO2	3	2	3	3	2
CO3	3	**1**	3	3	3
CO4	2	3	3	2	2

SEMESTER IV

25ES799	DISSERTATION II	L-T-P-C: 0-0-45-15

Course Objectives:
The students are made to work on the problem selected and comprehend and analyse the results.

Course Outcomes:
CO01: Plan the project implementation with embedded system domain knowledge.
CO02: Implementation of project methodology in software/hardware aspects.
CO03: Analyse the results and perform comparative analysis with existing frameworks.
CO04: Prepare technical reports, research papers, and disseminate knowledge.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	3	3	2
CO2	3	2	3	3	2
CO3	3	**1**	3	3	3
CO4	2	3	3	2	2

ELECTIVES

25ES631	Computer Vision for Embedded Systems Applications	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To introduce the fundamentals of computer vision and image processing with a focus on embedded system constraints.
- To equip students with practical skills to implement vision algorithms for object detection, recognition, and tracking.
- To familiarize students with hardware platforms and optimization techniques for deploying vision systems in real-time.
- To enable students to design efficient computer vision applications for domains such as robotics, surveillance, and IoT using embedded devices

Course Outcomes:

CO1: Understand the principles of computer vision and their relevance to embedded platforms**.**
CO2: Apply image preprocessing, feature extraction, and object recognition techniques.
CO3: Implement real-time computer vision algorithms on embedded systems.
CO4: Evaluate and optimize performance of embedded vision applications for power, speed, and accuracy.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	3
CO2	2	1	3	2	3
CO3	3	2	**3**	3	3
CO4	3	2	3	3	3

Syllabus:

Introduction to Computer Vision – Image Formation and Representation – Color Models – Camera Calibration and Lens Distortion – Basics of Embedded Architectures for Vision – ARM Cortex, Raspberry Pi, NVIDIA Jetson, FPGAs – Interfacing Cameras with Embedded Platforms.

Image Enhancement and Filtering – Edge Detection (Sobel, Canny) – Morphological Operations – Feature Detection (Harris, FAST, ORB) – Object Recognition using Feature Descriptors – Embedded Optimization for Preprocessing – Real-Time Constraints and Memory Considerations.

Face and Object Detection using Haar Cascades, HOG, and CNNs – Motion Detection and Tracking (Kalman Filter, Optical Flow) – Lightweight Deep Learning Models (MobileNet, YOLO-tiny) – Model Deployment with TensorFlow Lite and OpenCV on Edge Devices – Case Studies: Smart Surveillance, Vision for Robotics, IoT Cameras.

TEXTBOOKS/ REFERENCES:

1. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", *Cambridge University Press*, First Edition, 2012.
2. Szeliski Richard, "Computer Vision: Algorithms and Applications", *Springer*, Second Edition, 2022.
3. Adrian Kaehler and Gary Bradski, "Learning OpenCV 4: Computer Vision with Python", *O'Reilly Media*, Second Edition, 2019.
4. Joseph Howse, "OpenCV for Embedded Systems and IoT", *Packt Publishing*, First Edition, 2020.
5. David G. Lowe, "Embedded Computer Vision", *Springer*, First Edition, 2014.

25ES632	Hyperspectral Data Processing for Embedded Systems	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To introduce the fundamentals of hyperspectral imaging, sensor technology, and the structure of hyperspectral data cubes.
- To impart knowledge of preprocessing techniques and dimensionality reduction methods for effective hyperspectral data handling.
- To enable students to understand and implement various spectral classification algorithms suitable for real-time decision-making.
- To develop skills for deploying hyperspectral data processing techniques on low-power embedded systems for field applications.

Course Outcomes:

CO1: Explain the fundamentals of hyperspectral imaging and data cube characteristics.
CO2: Apply preprocessing and dimensionality reduction techniques to enhance data interpretability.
CO3: Implement spectral classification algorithms and evaluate their performance on real-world data.
CO4: Design and optimize hyperspectral data processing pipelines for deployment on embedded systems.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	3
CO2	2	1	3	2	3
CO3	3	2	3	2	3
CO4	3	2	3	3	3

Syllabus:

Hyperspectral Image Cube Formation – Multispectral vs Hyperspectral Imaging – Electromagnetic Spectrum – Sensor Architectures – Radiometric and Geometric Calibration – Noise Sources – Hyperspectral image Acquisition using FS23 and ADC Considerations for Embedded Systems.

Radiometric Normalization – Spectral Filtering – Spectral Signature Extraction – Dimensionality Reduction: PCA, ICA, MNF – Band Selection vs Band Extraction – Feature Visualization – Embedded Optimization of Preprocessing Pipelines.

Spectral mapping – Pixel Purity Index (PPI) – Minimum Noise Fraction (MNF) – Mixture Tuned Matched Filtering (MTMF) – Review of Classification Techniques: Supervised – Unsupervised – Hybrid - Quantification in Hyperspectral Images Using Classical Least Squares Models - Spectral Angle Mapper (SAM) – Accuracy Assessment and Performance Metrics – Case Studies in Agriculture and Remote Sensing.

TEXTBOOKS/ REFERENCES:

1. Chein-I Chang, “Hyperspectral Data Exploitation: Theory and Applications”, *Wiley*, First Edition, 2007.
2. Da-Wen Sun, “Hyperspectral Imaging for Food Quality Analysis and Control”, *Academic Press*, First Edition, 2010.
3. John A. Richards and Xiuping Jia, “Remote Sensing Digital Image Analysis: An Introduction”, *Springer*, Fifth Edition, 2013.
4. Chein-I Chang, “Hyperspectral Imaging: Techniques for Spectral Detection and Classification”, *Springer*, Second Edition, 2015.
5. Sudeep Jayasumana, “Machine Learning for Hyperspectral Data Processing”, *Springer*, First Edition, 2021.

25AI652	Deep Learning	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To impart foundational knowledge of deep learning architectures, data preprocessing, and model optimization techniques applicable to electrical engineering problems.
- To enable students to design, implement, and evaluate CNN and RNN-based models for real-world applications.

Course Outcomes:

CO1: Understand the core concepts of AI, ML, and DL along with key neural network components.
CO2: Design and evaluate deep neural networks using various optimization strategies and regularization techniques to improve training performance and generalization.
CO3: Implement convolutional neural networks (CNNs) for visual and signal-based tasks, and utilize transfer learning and model interpretability methods.
CO4: Develop sequence models using RNN, LSTM, and GRU architectures for time-series forecasting and event detection in real life problems.
CO5: Explore and apply advanced architectures such as GANs and Transformers for complex generative and attention-based modelling tasks.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	3
CO2	3	2	3	2	3
CO3	3	2	3	2	3
CO4	3	2	3	2	3
CO5	3	2	3	2	3

Syllabus:

Overview of AI, ML, and DL, Multi-layer perceptron, Activation functions (ReLU, Sigmoid, Tanh), Loss functions and cost, Performance analysis of Classifier and Regression model. Essential Data Pre-processing for Deep Learning. Backpropagation and gradient descent, Stochastic Gradient Descent (SGD), RMSProp, Adam. Weight initialization. Overfitting and underfitting. Regularization techniques: regularization, dropout, Batch normalization. Deep Neural Networks.

Convolution layers, pooling layers, CNN architectures. 1D CNNs for signal processing, Transfer learning and fine-tuning pre-trained models, Visualization techniques: saliency maps, Grad-CAM for explaining CNN decisions, Application of CNN.

Comparison between static and sequential data, Sequence modelling, RNN architecture, Limitations of RNNs: vanishing/exploding gradients, short memory retention, Internal structure of LSTM, Gated Recurrent Unit (GRU) Networks, Comparison in terms of performance and complexity, Advanced architectures: GAN, Transformers.

TEXTBOOKS/ REFERENCES:

1. Goodfellow, Y, Bengio, A. Courville, "Deep Learning", *MIT Press*, 2016.
2. S. Haykin, "Neural Networks and Learning Machines", 3rd Edition, *Pearson*, 2008.
3. Aditi Majumder, M. Gopi, Introduction to Visual Computing: Core Concepts in Computer Vision, Graphics, and Image Processing, *CRC Press*; 1 edition, 2018.
4. Francois Chollet, "Deep Learning with Python", 2nd Edition, *Manning Publications*, 2021.

25ES634	Edge AI on Embedded Platforms	L-T-P-C: 2-0-3-3

Pre-requisite: Basic knowledge of embedded systems, C/C++ programming and machine learning concepts.

Course Objectives:

- To understand the concepts and constraints of Edge AI for embedded platforms.
- To gain proficiency in using AI toolchains and deploying models on NPUs and embedded accelerators.
- To analyse and evaluate the performance, security, and practical applications of Edge AI systems.

Course Outcomes:

CO1: Understand the architecture and design trade-offs of Edge AI systems.
CO2: Apply embedded AI toolchains for model conversion, optimization, and deployment.
CO3: Analyse AI model performance metrics in embedded contexts.
CO4: Evaluate security and integration aspects of AI-enabled embedded systems.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	1	2	3	2
CO2	2	3	2	3	2
CO3	3	2	3	3	2
CO4	2	2	3	2	3

Syllabus:

Introduction to Edge AI and Embedded Inference. Overview of Edge AI – definitions, applications, and market trends. Comparison with cloud-based inference. Characteristics of embedded platforms for AI: constraints and design trade-offs. Overview of typical edge AI workflows – data collection, model training, deployment. Introduction to neural network models: CNN, DNN, quantization, pruning, and compression for edge inference. Overview of popular model formats – ONNX, TFLite, and CoreML. Embedded AI Toolchains and Deployment Pipelines. Introduction to hardware accelerators: NPU, DSP, GPU in embedded SoCs. Overview of AI toolchains: NXP eIQ (for i.MX), TI TIDL (for Sitara, Jacinto SoCs), Coral Edge TPU, and NVIDIA Jetson. Model optimization: post-training quantization, compilation, and deployment. Use of ONNX Runtime, TensorFlow Lite, and vendor SDKs. Layer mapping and performance profiling. Deployment flow: preprocessing, inference, and post-processing on the device. Applications, Security, and Performance Evaluation. Application case studies: real-time object detection, smart camera, human presence detection, gesture control, predictive maintenance. Integrating edge AI with peripherals (camera, microphone, sensors). Performance metrics: latency, throughput, power, and memory. Challenges in model accuracy vs efficiency. Introduction to secure model deployment – model integrity, secure boot, and encrypted weights. Future directions: federated learning, Edge-to-Cloud AI, TinyML.

TEXTBOOKS/ REFERENCES:

1. G. M. Iodice, TinyML Cookbook – Second Edition. *Birmingham, UK: Packt Publishing*, Nov. 2023.
2. S. Guo and Q. Zhou, Machine Learning on Commodity Tiny Devices. *CRC Press*, Oct. 2022.
3. D. A. Patterson and J. L. Hennessy, Computer Organization and Design: RISC-V Edition – The Hardware Software Interface, 2nd ed. *Burlington, MA, USA: Morgan Kaufmann*, 2021.
4. Texas Instruments, "TIDL (TI Deep Learning) User Guide," [Online]. Available: https://www.ti.com/tool/TIDL.
5. NXP Semiconductors, "eIQ Machine Learning Software Development Environment," [Online]. Available: https://www.nxp.com/eiq.
6. IEEE Standards Association, IEEE P2805: Standard for Functional Requirements for AI Edge Devices (Draft), IEEE, 2023.
7. P. Pareek, S. Mishra, M. J. C. S. Reis, and N. Gupta, Cognitive Computing and Cyber Physical Systems. Cham, Switzerland: *Springer*, Feb. 2025.

25AI654	Cyber Systems and Security	L-T-P-C: 3-0-0-3

Pre-requisite: Nil.

Course Objectives:

- To understand and evaluate security challenges in cyber-physical systems (CPS) and electrical infrastructures, including smart grids and IoT-enabled networks.
- To apply standards, secure protocols, and cryptographic techniques to protect systems in the Electrical and Electronics domains.

Course Outcomes:

CO1: Understand cyber threats and vulnerabilities in electrical and industrial cyber-physical systems.
CO2: Comprehend various standards and best practices towards the design of secure electrical automation systems.
CO3: Implement secure communication protocols and access control in various electrical applications.
CO4: Develop cryptographic and machine learning-based techniques for intrusion detection and threat mitigation in smart energy environments.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	3
CO2	2	2	3	2	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3

Syllabus:

Introduction - Overview of computer networks, network security, and Application layer. Overview of HTTP, FTP, SMTP, and DNS, and socket programming. Hijacking, spoofing, and DoS attacks. Firewalls, Intrusion Detection Systems (IDS), and Intrusion Prevention Systems (IPS). Digital Forensics. Transport layer and UDP, TCP. UDP flooding, TCP spoofing, TCP connection hijacking, TCP SYN flood. Cryptography and System Hardening: Public key infrastructure (PKI), symmetric and asymmetric cryptography, key management systems, ECC and AES integration for CPS security. Secure boot, firmware signing, and Over-The-Air (OTA) update mechanisms for edge and embedded devices. Network layer – Addressing schemes (IPv4 and IPv6), Routing algorithms, Routing protocols in the Internet (OSPF, RIP, and BGP), BGP security, ICMP, NAT, IPSec, and IPSec Authentication. Header, Encapsulating Security Header and Payload, IPSec Key Exchange, and VPNs. Link layer - Introduction and services, Link layer addressing, Multiple Access Protocols, Ethernet, ARP, Attacks against, and vulnerabilities in ARP. Secure Software Development Life Cycle (SSDLC). Industrial Communication Protocols and Security Considerations: DNP3 (with Secure Authentication), Modbus (with Modbus Secure/TLS), IEC 61850 (with IEC 62351 extensions), and OPC-UA. Role-Based Access Control (RBAC) in Automation Systems. ISA/IEC 62443 Standard Compliance. Control System Security: ISA/IEC 62443, IEEE C37.240, and NIST SP 800-82 standards. Application of machine learning models for threat detection and behaviour profiling in electrical networks.

TEXTBOOKS/ REFERENCES:

1. Arshad, M. (Ed.), "Cybersecurity Issues in Smart Grids and Future Power Systems", *MDPI*, 2023.
2. Wang, W., & Lu, C., "Power Systems Cybersecurity: Methods, Concepts, and Best Practices", *Springer*, 2023.
3. AccessEngineering, "Intrusion Detection Systems and Network Security", *McGraw-Hill*, 2021.
4. Gerardus Blokdyk, "Intrusion Detection: A Complete Guide – 2021 Edition", *The Art of Service*, 2021.
5. Mathur, A., "Modern Cryptography for Cybersecurity Professionals", *Packt Publishing*, 2021.
6. Rosulek, M., "The Joy of Cryptography", 1st Edition, 2021.

7. Van Oorschot, P. C., “Computer Security and the Internet: Tools and Jewels from Malware to Bitcoin”, 2nd Edition, *Springer*, 2021.
8. IEEE Standard 1686-2023, “Standard for Cybersecurity Capabilities of Intelligent Electronic Devices”, *IEEE*, 2023.
9. IEEE C37.240- 2021, “Cybersecurity Requirements for Substation Automation, Protection, and Control Systems”, *IEEE*, 2021.

25ES636	Hardware Software Co-Design	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To Introduce the system-level design methodologies, Hardware-Software Co-Design concepts, and the use of languages for system-level specification, modelling, and design.
- To provide knowledge on design representation, models of computation, system partitioning, scheduling, and communication strategies for efficient system-level synthesis.
- To impart hardware-software co-simulation techniques, verification methods, virtual prototyping, performance optimization, and implementation on FPGAs.

Course Outcomes:

CO1: Understand the need for hardware software co-design in the design flow process.

CO2: Analyse hardware-software co-design problems for systems with moderate complexity.

CO3: Apply hardware-software co-design methods and techniques for embedded systems.

CO4: Apply different levels of abstractions and models for verification of embedded co-design.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	3	2	3	3	2
CO3	3	2	3	3	2
CO4	3	2	3	3	2

Syllabus:

Introduction to System Level Design –Generic Co-Design Methodology–Hardware-Software Co-Design Models and Architectures –Languages for System Level Specification, Design and Modelling.

Design Representation for System Level Synthesis –Models of Computation–Architectural, Selection–Partitioning–Scheduling and Communication.

Hardware - Software Co-Simulation of Embedded Systems–Synthesis–Verification and Virtual Prototyping - Implementation Case Studies – Performance Analysis and Optimization – Re-Targetable Code Generation – FPGAs and Heterogeneous platforms

TEXTBOOKS/ REFERENCES:

1. Patrick R. Schaumont, "A Practical Introduction to Hardware/Software Co-design", Second Edition, *Springer*, 2013.
2. Jorgen Staunstrup and Wayne Wolf, "Hardware/Software Co-design: Principle and Practice", *Kluwer Academic Publishers*, 1997.
3. Giovanni De Micheli, "Readings in Hardware Software Co-design ", *Morgan Kaufmann,* Academic Press, 2002.
4. Daniel D. Gajski, Frank Vahid, Sanjiv Narayan, Jie Gong, "Specification and Design of Embedded Systems", *Pearson Education publishing*, 1994 edition, 2008 Impression.
5. Vivado Design Suite User Guide: Embedded Processor Hardware Design UG898 (v2017.3) October 27, 2017.

25ES637	Embedded Systems for Automotive Applications	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To provide a comprehensive understanding of automotive fundamentals, functional domains, electrical subsystems.
- To introduce key electronic systems in modern vehicles, including powertrain control, chassis control, body electronics, safety systems, HVAC, hybrid vehicles, and emerging technologies like drive-by-wire and autonomous vehicles.
- To impart knowledge on automotive communication protocols such as CAN, LIN, Flex-Ray, MOST, and standards like AUTOSAR and OSEK VDX.

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:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	2	1	3	2	2
CO3	3	2	3	3	3
CO4	3	2	3	3	3

Syllabus:

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 – Automotive Safety 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, *Springer Vieweg*, 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.

25ES638	Embedded Systems for Robotics	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To introduce the fundamentals of robotics, including the role of embedded systems, sensors, actuators, and control techniques.
- To develop an understanding of industrial robot, kinematics, dynamics, and control, focusing on direct and inverse kinematic models, workspace analysis, and manipulator transformation techniques.
- To provide knowledge on mobile and autonomous robots, including localization, path planning, swarm robotics, collaborative robots.

Course Outcomes:

CO1: Understand the architecture and components of robotic systems.

CO2: Develop the kinematic models of manipulators

CO3: Develop the inverse kinematic models for manipulators.

CO4: Implement algorithms in autonomous mobile robot path planning, localization and control.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	2	1	3	2	2
CO3	3	1	3	3	2
CO4	3	2	3	3	2

Syllabus

Robots and Embedded Systems-Sensors, Microcontrollers and Actuators in Robots - Control - On-Off Control, PID Control, Velocity Control and Position Control, Recent Trends in Robotics-Milli/Micro/Nano Robot- Human-robot interaction.

Industrial Robots - Evolution of robotics, Robot anatomy, Manipulation and Control. Direct Kinematic Model - Denavit-Hartenberg Notation, Kinematic Relationship between adjacent links, Manipulator Transformation Matrix; Inverse Kinematic Model – Manipulator Workspace, Solvability, Solution techniques, Closed form solution. Introduction to Robot dynamics & Control.

Mobile Robots, Concepts of Localization, and path planning. Autonomous robots- Swarm and Collaborative robots. Robot Operating System: architecture, sensors, actuators and platforms supported.

TEXTBOOKS/REFERENCES:

1. Thomas Bräunl, “Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems”, Third Edition, *Springer-Verlag Berlin Heidelberg*, 2008.
2. R.K.Mittal and I.J.Nagrath, “Robotics and Control”, *Tata McGraw-Hill Publishing Company Ltd.*, New Delhi, 2003.
3. John J. Craig, “Introduction to Robotics: Mechanics and Control”, Fourth Edition, *Pearson*, 2018.
4. Anis Koubaa, “Robot Operating System (ROS) The Complete Reference”, First Volume, *Springer*, 2016.
5. K.S. Fu, R.C. Gonzalez and C.S.G. Lee, “Robotics: Control, Sensing, Vision, and Intelligence”, *McGraw-Hill*, New York, 1987.

25ES639	Embedded Systems in Biomedical Applications	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To introduce the fundamentals of biomedical devices, origin of bio-potentials, electrode systems, and amplifiers for physiological signal acquisition and modelling.
- To provide an understanding of embedded systems used in patient monitoring and diagnostic devices, for measuring physiological parameters such as electrical potentials, sounds, and blood pressure.
- To impart modern m-Health technologies, including wireless sensor networks, mobile health systems, data-driven healthcare, cloud integration.

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:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	3
CO2	2	1	3	3	3
CO3	2	1	3	3	3
CO4	3	2	3	3	3

Syllabus:

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 Biomedical Sensing, 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.

25ES640	Video Processing	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To introduce the fundamentals of video processing, spatio-temporal sampling, and motion analysis techniques.
- To develop an understanding of motion-compensated filtering, video enhancement, and restoration methods.
- To provide insights into video compression, watermarking, video analytics, and surveillance applications

Course Outcomes:

CO1: Understand the attributes of video data.

CO2: Familiarise the various motion analysis schemes.

CO3: Develop applications for video restoration, super resolution, and Mosaicking.

CO4: Apply video processing techniques for watermarking and compression.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	3
CO2	2	1	3	2	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3

Syllabus

Introduction, Spatio-temporal sampling; Sampling structure conversion (without using motion), Motion Analysis, Real versus apparent motion, Spatial-temporal constraint methods (optical flow equation), Block-matching methods, Mesh-based methods, Region-based (parametric) motion modeling, Motion segmentation and layered video representations.

Motion-compensated (MC) filtering, Noise reduction, Signal recovery and general inverse problems, Restoration (deblurring), Super resolution, Mosaicking, Deinterlacing, Frame-rate conversion (MC-Interpolation).

Video Watermarking, Video Compression, Frame-based compression (principles behind MPEG-1/2), Scalable or layered frame-based compression, Object-based compression (principles behind MPEG-4). Surveillance - Video indexing, summarization, and retrieval, Object detection and tracking, Video Analytics.

TEXTBOOKS / REFERENCES:

1. Y. Wang, J. Ostermann, and Y. Q. Zhang, "Video Processing and Communications", *Prentice Hall*, 1st edition, 2002.
2. M. Tekalp, "Digital Video Processing", *Prentice Hall*, 2nd edition, 2005.
3. J. W. Woods, "Multidimensional signal, image and video processing and coding", *Academic Press / Elsevier*, 2nd edition, 2012.
4. Linda G. Shapiro and George C. Stockman, "Computer Vision", *Prentice-Hall Inc*., 1st edition, New Jersey, 2001.

25ES641	GPU Architecture and Programming	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To introduce modern computer architectures, including RISC pipelines, GPU structures, and CUDA programming basics.
- To develop skills in GPU optimization techniques, including memory coalescing, synchronization, and efficient kernel design.
- To provide an understanding of OpenCL for heterogeneous computing and its application in neural network training and inference.

Course Outcomes:

CO1: Understand the fundamentals of parallel programming.

CO2: Familiarise the various OpenCL device architectures.

CO3: Analyse OpenCL case studies.

CO4: Develop an application using GPU.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	2	1	3	2	2
CO3	3	2	3	3	3
CO4	3	2	3	3	3

Syllabus:

Review of Traditional Computer Architecture – Basic five stage RISC Pipeline, Cache Memory, Register File, SIMD instructions, GPU architectures - Streaming Multi Processors, Cache Hierarchy, The Graphics Pipeline, Introduction to CUDA programming.

Multi-dimensional mapping of dataspace, Synchronization, Warp Scheduling, Divergence, Memory Access Coalescing, Optimization examples: optimizing Reduction Kernels, Optimization examples: Kernel Fusion, Thread and Block.

OpenCL basics, OpenCL for Heterogeneous Computing, Application Design: Efficient Neural Network Training/Inferencing.

TEXTBOOKS / REFERENCES:

1. Jason Sanders and Edward Kandrot, "CUDA by Example: An Introduction to General-Purpose GPU Programming", *Addison-Wesley*, 1st edition, 2010.
2. Benedict Gaster,Lee Howes, David R. Kaeli, "Heterogeneous Computing with OpenCL", *Morgan Kaufmann*; 1st edition, 2011.
3. David Kirk and Wen-meiHwu, "Programming Massively Parallel Processors", *Morgan Kaufmann*, 3rd edition, 2010.
4. John L.Hennessy and David A. Patterson, "Computer Architecture -- A Quantitative Approach", *Morgan Kaufmann*, 5th edition, 2011.

25ES642	Advanced Image Processing and Computer Vision	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To introduce the fundamentals of image formation, representation, and feature extraction techniques.
- To develop an understanding of visual matching methods and neural networks for pattern classification.
- To give an insight on applications of image processing in medical imaging, object tracking, recognition, and remote sensing.

Course Outcomes:

CO1: Familiarise the fundamentals of image processing.

CO2: Understand neural networks for Image classification problems.

CO3: Apply advanced image processing techniques.

CO4: Design solutions for real-world image processing problems.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	3
CO2	2	1	3	2	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3

Syllabus:

Review of Image Processing - Image Formation, Capture and Representation, Linear Filtering, Correlation, Convolution. Visual Features and Representations: Edge Detection, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Histogram of Oriented Gradients, Scale Invariant Feature Transform, Speeded up Robust Features, Saliency. Visual Matching: Bag-of-words, VLAD; RANSAC, Hough transform; Pyramid Matching; Optical Flow

Basics of Artificial Neural Network for Pattern Classification, Convolutional Neural Networks

Applications – Medical Image Segmentation, Motion Estimation and Object Tracking, Face and Facial Expression Recognition, Image Fusion, Gesture Recognition, Remote sensing etc.

TEXTBOOKS / REFERENCES:

1. Ralph Gonzalez, Richard Woods, Steven Eddins, "Digital Image Processing Using MATLAB", *McGraw Hill Education*, 2nd edition, 2017.
2. Richard Szeliski ,"Computer Vision: Algorithms and Applications", *Springer*, 2010.
3. Laurene Fausett, "Fundamentals of Neural Networks Architectures, Algorithms and Applications", *Pearson*, 1st edition, 2004.
4. Forsyth & Ponce, "Computer Vision-A Modern Approach," *Pearson Education*, 2nd edition 2015.
5. M.K. Bhuyan, "Computer Vision and Image Processing: Fundamentals and Applications", *CRC Press*, 1st edition, 2019.

25ES643	Cryptography and Network Security	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To introduce classical and modern symmetric encryption techniques, cryptosystems, and secure hash functions.
- To develop an understanding of digital signatures, authentication protocols, and web security mechanisms.
- To provide knowledge on system security concepts including intrusion detection, malware, firewalls, and IoT security.

Course Outcomes:

CO1: Understand various encryption techniques.

CO2: Understand the number theory in cryptographic schemes.

CO3: Illustrate various authentication protocols.

CO4: Analyse various software threats and counter measures.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	2	1	3	2	2
CO3	2	2	3	2	3
CO4	3	2	3	3	3

Syllabus:

Classical Encryption Techniques – Symmetric Cipher Model – Steganography – AES Cipher -Symmetric Cipher – Multiple Encryption and triple DES – Blocks Cipher – stream Cipher – Confidentiality using symmetric encryption – Placement of encryption function – random number generation – Asymmetric encryption & key exchange- RSA, Diffie-Hellman key exchange, ECC basics. PKI and Digital Certificates – X.509, Certificate Authorities. Introduction to number theory – Cryptosystems – message authentication and Hash functions – requirements – functions – course – Hash and MAC algorithms – secure Hash algorithms – Digital signatures and authentication protocols – standard – authentication applications – overview architecture – web security - socket layer and transport layer security – Intruders – Detection – Malicious software – viruses and related threats –denial of service - counter measures – firewalls – design principles – trusted systems - firmware security - IoT security.

TEXTBOOKS / REFERENCES:

1. William Stallings, “Cryptography and Network Security – Principles and Practices”, Seventh Edition, *Prentice Hall*, 2017.
2. Douglas R Stinson, “Cryptography: Theory and Practice”, Fourth Edition, *Chapman and Hall/CRC*, 2018.
3. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, *Universities Press*, 2015.
4. Mark Ciampa, “Security+ Guide to Network Security Fundamentals”, Fifth Edition, *Cengage Learning*, 2014.

25ES644	Web Technologies and Applications	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To introduce the fundamentals of website creation, browser operations, server types, and authoring tools.
- To develop skills in client-side and server-side scripting using PHP, MySQL integration, and XML processing.
- To enable the design of interactive web applications, database systems, and information retrieval applications.

Course Outcomes:

CO1: Comprehend the concepts of responsive web design.

CO2: Apply markup and scripting languages to design and validate dynamic web pages.

CO3: Evaluate the appropriateness of client/server applications.

CO4: Develop client/server applications with database.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	2	2	3	2	2
CO3	3	2	3	3	2
CO4	3	2	3	3	2

Syllabus:

Web essentials: Creating a website – Working principle of a website – Browser fundamentals – Authoring tools – Types of servers: Application Server – Web Server – Database Server; Scripting essentials: Need for Scripting languages – Types of scripting languages – Client-side scripting

Server-side scripting – PHP – Working principle of PHP – PHP Variables – Constants – Operators – Flow Control and Looping – Arrays – Strings – Functions – File Handling – PHP and MySQL – PHP and HTML – Cookies – Simple PHP scripts. XML-Documents and Vocabularies-Versions and Declaration-Namespaces- DOM based XML processing Event-oriented Parsing: XML-Documents and Vocabularies-Versions and Declaration - Namespaces - DOM based XML processing Event-oriented Parsing

Application essentials: Creation of simple interactive applications – Simple database applications – Multimedia applications – Design and development of information systems – Personal Information System – Information retrieval system – Social networking applications.

TEXTBOOKS / REFERENCES:

1. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5", Fifth Edition, *O'REILLY*, 2018.
2. Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", *Pearson Education*, 2006.
3. Robert. W. Sebesta, "Programming the World Wide Web", Eighth Edition, *Pearson Education*, 2015.
4. Bates, "Web Programming: Building Internet Applications", Third Edition, *Wiley*, 2010.
5. R. Kelly Rainer, Casey G. Cegielski, Brad Prince, "Introduction to Information Systems", Eighth Edition, *Wiley Publication*, 2019.

25ES645	Mobile Application Development	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To introduce mobile application development platforms, UI components, layouts, and activity management.
- To develop skills in data storage, background tasks, location services, notifications, and efficient data transfer.
- To design, publish, and monetize mobile applications across various form factors with enhanced user experience.

Course Outcomes:

CO1: Understand Android programming.

CO2: Develop Android programs.

CO3: Develop mobile applications with cloud services.

CO4: Analyse various services of mobile applications development.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3
CO4	3	2	3	3	3

Syllabus:

Introduction to mobile application development platforms, Application Development-Layouts, Views, Resources, Activities, Intents, Background tasks, Connecting to the Internet, Fragments, Preferences. User Interaction – input, menu items, custom views, User Experience – themes and styles, lists and adapters, material design, adaptive layouts, accessibility, localization, debugging the UI Storing Data, SQLite database, Sharing Data, content resolvers and providers, loaders to load data.

Services, background work, alarms, broadcast receivers, Notification, widgets, location-based services and Google maps. transferring data efficiently, publishing app, Multiple form factors, sensors, Google cloud messaging, monetizing mobile app.

TEXTBOOKS / REFERENCES:

1. Phillips, Stewart, Hardy and Marsicano, “Android Programming (Big Nerd Ranch Guide)”, Fourth Edition, *Big Nerd Ranch Guides*, 2019.
2. Hellman, “Android Programming – Pushing the limits”, First Edition, *Wiley*, 2013.
3. Tejinder Randhawa, “Mobile Applications Design, Development and Optimization”, *Springer International Publishing*, 2021.
4. Joseph Annuzzi Jr., Lauren Darcey, and Shane Conder, “Advanced Android Application Development”, Fourth Edition, *Addison-Wesley Professional*, 2014.

25ES646	Advanced Mobile and Wireless Networks	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To introduce wireless networking fundamentals, including OFDM, MIMO, and MAC protocols for efficient communication.
- To provide knowledge on multi-gigabit wireless networks, next-generation technologies,
- To Impart knowledge on emerging mobile networks, including drone communications, autonomous vehicle connectivity, and advanced localization techniques.

Course Outcomes:

CO1: Understand the capabilities of Wi-Fi based communication systems.

CO2: Comprehend next generation 5G communication networks.

CO3: Familiarise different localization techniques in communication networks.

CO4: Design wireless networks for real world applications.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	2	1	3	2	3
CO3	2	1	3	2	3
CO4	3	2	3	3	3

Syllabus:

Wireless networking - Physical layer- OFDM and 802.11 PHY, Multi-antenna systems and MIMO, Overview of 802.11n/ac PHY. MAC layer- CSMA/CA and Wi-Fi MAC overview, Wide bandwidth channel access techniques (802.11n/ac), Energy efficiency and rate control.

Multi-gigabit wireless networks - GSM, 3G/4G, UMTS, CDMA, HSDPA, QoS Management. Next generation (5G) wireless technologies- Upper Gigahertz and Terahertz wireless communications - Millimetre wave networking, Directionality and beam forming, Mobility and signal blockage, IEEE 802.11ad (60 GHz WLAN) MAC and PHY overview. Visible light communication - High-speed networking using LEDs, IEEE 802.15.7 PHY and MAC overview. Sensing through visible light, Visible light indoor localization and positioning, Wi-Fi fingerprinting - protocols and challenges, Non-WiFi localization.

Future mobile networks - Drone networking- multi-UAV networks, architectures and civilian applications, Communication challenges and protocols for micro-UAVs. Connected and autonomous cars- Wireless technologies for Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) communications, Automotive surrounding sensing with GHz and THz signals.

TEXTBOOKS / REFERENCES:

1. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", Second Edition, *Pearson Education*, 2009.
2. Matthew Gast, "802.11n/ac: A Survival Guide", First Edition, *O'Reilly Media*, 2013.
3. Pei Zheng Larry Peterson Bruce Davie Adrian Farrel, "Wireless Networking Complete", First Edition, *Morgan Kaufmann*, 2009.
4. William Lee, "Wireless and Cellular Telecommunications", Third Edition, *McGraw Hill*, 2006.
5. Saad Asif, "5G Mobile Communications Concepts and Technologies", First Edition, *CRC Press*, 2018.

25ES647	Multi Core Architectures	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To introduce computer performance metrics, instruction-level parallelism, and advanced processor design techniques.
- To provide knowledge on multi-core architectures, memory hierarchy, cache coherence, and large-scale storage systems.
- To develop an understanding of power optimization, fault tolerance, and programming environments for multi-core and embedded systems.

Course Outcomes:

CO1: Understand instruction level and thread level parallelism and branch prediction techniques.
CO2: Develop static and dynamic scheduling algorithms.
CO3: Analyse memory hierarchy design and cache coherency problem.
CO4: Discuss concepts on multi-issue and multi-core processors with power optimization.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	3	1	3	3	2
CO3	3	2	3	3	2
CO4	3	2	3	3	2

Syllabus:

Review of Computer Design - Measuring performance Instruction level parallelism - Branch prediction techniques - Static & Dynamic scheduling – Speculation - Limits of ILP. Thread-level parallelism, multi-issue, and multi-core processors – Homogenous and Heterogenous multicore systems.

Shared and Distributed memory -Transaction Memory issues Memory hierarchy design - Cache coherence, Memory wall problem - Advanced Cache Memory design - Virtual Memory, Storage Systems - Ware-house Scale Computers Power optimization- Dynamic Voltage Frequency Scaling - Multi-core architectures for embedded systems – Fault Tolerant aspects for multi core systems- Programming environments for multi-core.

TEXTBOOKS / REFERENCES:

1. Peter S. Pacheco, "An Introduction to Parallel Programming," *Morgan Kauffman/Elsevier*, 2011.
2. Yan Solihin, "Fundamentals of Parallel Multicore Architecture", *CRC Press*, 2016.
3. Georgios Kornaros, "Multi-core Embedded Systems", *CRC Press, Taylor and Francis Group*, First edition, 2019.
4. Victor Alessandrini, , "Shared Memory Application Programming, Concepts and Strategies in Multicore Application Programming", 1st Edition, *Morgan Kaufmann*, 2015.
5. Darryl Gove, "Multicore Application Programming for Windows, Linux, and Oracle Solaris", *Pearson*, 2011.

25ES648	Fault Tolerant System	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To introduce the goals, applications, and fault models pertaining to computing systems.
- To provide knowledge on hardware, software, and time redundancy techniques for designing fault-tolerant systems.
- To familiarize reliability evaluation methods and real-world case studies of fault-tolerant systems across critical domains.

Course Outcomes:

CO1: Understand basics of fault tolerance and fault models.

CO2: Discuss various forms of redundancies and fault tolerant design techniques.

CO3: Develop concepts on system reliability.

CO4: Comprehend different fault tolerant design concepts.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	3	1	3	3	2
CO3	3	2	3	3	2
CO4	3	2	3	3	2

Syllabus:

Goals and Applications of Fault Tolerant Computing - Reliability, Availability, Safety, Dependability, Long Life, Critical Computation, High Availability Applications, Fault Tolerance as a Design Objective. Fault Models - Faults, Errors, and Failures, Causes and Characteristics of Faults, Logical and Physical Faults, Error Models.

Fault Tolerant Design Techniques: Hardware redundancy, Software Redundancy, Time redundancy and Information redundancy. Check pointing, Fault tolerant networks, Reconfiguration-based fault tolerance.

Reliability Evaluation Techniques - Failure Rate, Mean Time to Repair, Mean Time Between Failure, Reliability Modelling, Fault Coverage, M-of-N Systems, Markov Models, Safety, Maintainability, Availability. Case studies of fault tolerant systems and current research issues - Space Shuttle, Tandem 16 Non-Stop System, Recovery oriented computing, Fault tolerant platforms for Automotive Safety-Critical, Reliability and Fault tolerance in Collective Robot Systems.

TEXTBOOKS / REFERENCES:

1. Israel Koren and C. Mani Krishna, "Fault Tolerant Systems", *Elsevier*, 2nd edition, 2020.
2. D. K. Pradhan, "Fault-Tolerant Computing, Theory and Techniques", *Prentice-Hall*, 1998
3. M. L. Shooman, "Reliability of Computer Systems and Networks Fault Tolerance Analysis and Design," *Wiley*, 2003
4. Elena Dubrova, "Fault-Tolerant Design," *Springer-Verlag New York*, 2013.
5. Barry W. Johnson, "Design and Analysis of Fault-Tolerant Digital System", *Addison*, 2009.

25ES649	Embedded Systems in Smart Grid	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To introduce smart grid concepts, technologies, and differences from conventional power systems.
- To develop understanding of smart grid components, including sensors, embedded devices, communication standards, and system automation.
- To explore IoT applications, case studies, and advanced management strategies for smart grids and microgrids.

Course Outcomes:

CO1: Understand the fundamentals of power system management and automation.

CO2: Explore the features of Smart grid.

CO3: Learn different Sensors and embedded devices used in smart grid.

CO4: Examine the different communication standards, technologies and protocols for smart grid.

CO5: Investigate the IoT applications in Smart grid.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	2	1	3	2	2
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Syllabus:

Smart grid definition. Smart grid vs conventional grid. Smart Grid technologies- Power system and ICT in Generation, Transmission and Distribution. Basic understanding of power systems. Management aspects (Utility, Operator, Consumer). Evolution of automation in power system. Smart Grid features- Distributed generation, storage, DD, DR, AMI, WAMS, WACS). Sensors - CT, PT; Embedded Devices - IED, PMU, PDC, CT, PT, relays, DR Switch; Algorithms; Communication- Standards, Technology, and protocols. Cyber Security, IoT applications in power system – Case study 1 generation control, load management, dynamic pricing etc.; IoT for domestic prosumers. Case Study 2 -Smart microgrid simulator (SMGS), DR, DD, Energy storage, Communication, Case Study 3: AI-driven demand forecasting & anomaly detection.

TEXTBOOKS / REFERENCES:

1. James Momoh, "Smart Grid: Fundamentals of Design and Analysis", *Wiley. IEEE Press*, March 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu and Akihiko Yokoyama, Smart Grid: Technology and Applications", *Wiley*, February 2012.
3. Nouredine Hadjsaïd and Jean Claude Sabonnadière, "Smart Grids", *Wiley ISTE*, May 2012.
4. Ali Keyhani and Muhammad Marwali, "Smart Power Grids", *Springer*, 2011.
5. Vijay Madisetti and Arshdeep Bahga, "Internet of Things: A Hands-on Approach", *Hardcover –Import*, 2014.

25ES650	Design for IoT and Cloud Computing	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives:

- To introduce the evolution of embedded systems towards intelligent and IoT-enabled solutions, including design considerations and development tools.
- To familiarize IoT architectures, rapid prototyping, and application development for real-world domains.
- To provide knowledge on cloud computing models, distributed systems, and developing cloud-integrated web and database applications for IoT connectivity.

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:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	2	1	3	2	2
CO3	3	2	3	3	3
CO4	3	2	3	3	3

Syllabus:

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: Healthcare and 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 server 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 Models (SaaS, PaaS, &IaaS)", *Wiley CIO Series*, January 2014.
5. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud", *O'Reilly*, 2009.

25ES651	Intelligent Systems Design	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives:

- To introduce the architectures of intelligent systems, including sensors, actuators, and AI techniques.
- To provide an understanding of intelligent agents and supporting technologies like data mining, knowledge management, and automation.
- To explore various intelligent system types and Behaviour-Oriented Design (BOD) principles for developing agent-based intelligent solutions.

Course Outcomes:

CO1: Understand the need and scope of intelligent systems and the role of embedded engineers in the design of such systems.

CO2: Familiarize the components of intelligent systems especially intelligent agents and its applications.

CO3: Analyse the various types of intelligent systems.

CO4: Understand Behaviour Oriented Design and process of defining agents.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	3
CO2	2	1	3	2	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3

Syllabus

Intelligent Systems – Definition, Need and role of embedded engineers. Architectures of intelligent systems – Automation, sensors, artificial intelligence techniques, actuators. Intelligent agents – definition, applications of intelligent agents in science, technology, business and commercial. Supporting technologies - Data mining, knowledge management, control and automation. Types of systems – Expert Systems, Recommendation Systems, Cognitive Systems, Swarm intelligent systems, Hybrid computing systems. Behaviour Oriented Design (BOD) – Definition, Extension to object-oriented design, process of specifying agency, specifying the agent's priorities using POSH dynamic plans.

TEXTBOOKS/REFERENCE:

1. Karray F, Karray FO, De Silva CW, "Soft computing and intelligent systems design: theory, tools, and applications", *Pearson Education*; 2009.
2. Larry Bielawski, Robert Lewand, "Intelligent Systems Design: Integrating Expert Systems, Hypermedia, and Database Technologies", First Edition, *Wiley Professional Computing*.
3. Alexander M. Meystel, James S. Albus, "Intelligent Systems: Architecture, Design, and Control", First Edition, *Wiley – Interscience Publication*, 2002.
4. Anindita Das, "Artificial Intelligence and Soft Computing for Beginners", 2nd Edition, *Arizona Business Alliance*, 2014.

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.** Statement: Demonstrate the ability to remember essential terms, concepts, and principles discussed in the chapters on Sanatana Dharma, scriptures, and cultural aspects.	Remembering
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.**	Analyzing

	Statement: Deconstruct the layers of symbolism in various cultural aspects, including Nataraja representation and temple architecture, unraveling their deep meanings.	
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 Sivanand*a

G. Evaluation Pattern: 60:40

Component	Weightage	Remarks
Internal	60	-
External	40	-
TOTAL	100	