Master of Technology
(Thinking Systems)

Curriculum

(With effect from academic year 2026-27 onwards)

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TY B.Tech. Electronics & Telecommunication Engineering Curriculum
With effect from Academic Year 2026–2027
Approved in the 32nd Academic Council Meeting, dated 28th July 2026

M. Tech. Programme Components

Components		Total Credits
Programme Core Course (PCC)	Program Courses	20
Programme Elective Course (PEC)	Program Electives	10
Open Elective (OEC) other than a particular program	Open Electives	02
Vocational and Skill Enhancement Course (VSE)	Skill Courses	02
Ability Enhancement Course (AEC) Technical Presentation	Humanities, Social Science and Management (HSSM)	02
Entrepreneurship / Economics / Management Courses (EEM)		02
Indian Knowledge System (IKS)		02
Research Methodology (RMC)	Experiential Learning Courses	02
Dissertation / Project / Internship (DIS/INT)		20
Co-curricular Courses (CCC)	Liberal Learning Courses	Audit
	Total Credits	62

M. Tech. (Thinking Systems)

Program Outcomes

PO1 - Research and Investigation: An ability to independently carry out research/investigation and development work to solve practical problems

PO2 - Technical Communication: An ability to write and present a substantial technical report or document

PO3 - Domain Mastery: An ability to demonstrate a degree of mastery over the area of specialization at a level higher than the requirements of an undergraduate (Bachelor's) program

Program Specific Outcomes

PSO1 - Design and develop intelligent systems by applying principles of machine learning, cognitive computing, and reasoning architectures to model and solve complex real-world problems

PSO2 - Apply research methodologies and advanced computational tools to innovate, prototype, and deploy AI-driven solutions across interdisciplinary domains

Department of Electronics and Telecommunication Engineering
Teaching and Evaluation Scheme for NEP Compliant Curriculum
M. Tech. (Thinking Systems) Full Time
(From 2026-2027 onwards)

Semester I

Sr. No.	Category	Course Code	Courses	Scheme of Teaching (Hrs / Week)			Total Credits	Scheme of Evaluation (Marks)			
								Theory			Total
				L	T	P		ISE I	ISE II	ESE	
1	PCC	ECPCC8001	Advanced Digital Signal Processing	3	-	-	3	20	20	60	100
2	PCC	ECPCC8002	Advanced Sensors & Perception Systems	3	-	-	3	20	20	60	100
3	PCC	ECPCC8003	Machine Learning & Deep Learning	3	-	-	3	20	20	60	100
4	PCC	ECPCC8004	Lab - Machine Learning & Deep Learning	-	-	2	1	-	25	25	50
5	PEC (Any one course from this group)	ECPEC8001	1. AI – Driven Industrial Automation & Cognitive Robotics	3	-	-	3	20	20	60	100
		ECPEC8002	2. ML Ops	3	-	-	3	20	20	60	100
6	PEC (Any one course from this group)	ECPEC8003	1. Unmanned Aerial Systems & Drone Swarms Intelligence	3	-	-	3	20	20	60	100
		ECPEC8004	2. Cyber Security for Autonomous Systems	3	-	-	3	20	20	60	100
7	RMC	ECRMC8001	Research Methodology	2	-	-	2	10	10	30	50
8	VSE	ECVSE8001	Development of an Autonomous Thinking System	-	-	4	2	-	25	25	50
9	CCC (Audit Course)	INCCC5101	Stress Management Through Yoga	-	-	2	-	-	-	-	-
			Total Semester I	**17**	**-**	**8**	**20**	**110**	**160**	**380**	**650**

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Semester II

Sr. No.	Category	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)			
								Theory			Total
				L	T	P		ISE I	ISE II	ESE	
1	PCC	ECPCC8005	Natural Language Processing & Generative Systems	3	-	-	3	20	20	60	100
2	PCC	ECPCC8006	Lab - Natural Language Processing & Generative Systems	-	-	2	1	-	25	25	50
3	PCC	ECPCC8007	Embedded AI & Edge Computing	3	-	-	3	20	20	60	100
4	PCC	ECPCC8008	Image, Video Analytics and Computer Vision	3	-	-	3	20	20	60	100
5	PEC	ECPEC8005	Lab- Signal & Image Processing	-	-	2	1	-	25	25	50
6	PEC (Any one course from this group)	ECPEC8006	1. Advanced AI Systems	3	-	-	3	20	20	60	100
		ECPEC8007	2. AI for VLSI & Chip Design	3	-	-	3	20	20	60	100
		ECPEC8008	3. Cyber Physical Systems	3	-	-	3	20	20	60	100
7	AEC	ECAEC8001	Seminar	-	-	4	2	-	25	25	50
8	OEC	ECOECxxxx	Open Elective Course	2	-	-	2	10	10	30	50
9	DIS	ECDIS8001	Dissertation - I	-	-	4	2		50	50	100
			Total Semester II	**14**	**-**	**12**	**20**	**90**	**215**	**395**	**700**

List of Open Electives

Sr. No.	Course code	Open Elective Course	Course offering Department
1	AMOEC5214	Basics of Finite Element Analysis	Applied Mechanics
2	CEOEC6003	Disaster Management	Civil
3	MEOEC6104	Additive Manufacturing	Mechanical
4	EEOEC5105	Data Science for Engineering Applications	Electrical
5	ECOEC5007	Artificial Intelligence of Things	Electronics
6	CSOEC6002	Data Science	Computer Science & Engineering

Semester III

Sr. No.	Category	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)			
				L	T	P		Theory			Total
								ISE I	ISE II	ESE	
1	EEM	ECEEMXXXX	Humanity Course	2	-	-	2	10	10	30	50
2	IKS	INIKS6001	Vedic Approach to Mathematics	2	-	-	2	10	10	30	50
3	DIS	ECDIS9001	Dissertation – II	-	-	16	8	-	100	100	200
			Total Semester III	**4**	**-**	**16**	**12**	**20**	**120**	**160**	**300**

List of Humanities II to be offered in PG Semester III (Second Year)

Sr. No.	Course code	Humanities Course	Course offering Department
1	MEEEM6101	Entrepreneurship Skills	Mechanical
2	MEEEM6103	Industrial Management	Mechanical
3	EEEEM5101	Energy Audit & Management	Electrical
4	ECEEM6004	AI Governance & Ethics	Electronics

Semester IV

Sr. No.	Category	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)			
				L	T	P		Theory			Total
								ISE I	ISE II	ESE	
1	OJT	ECINT9001	Industry Training/ Internship/ On job Training	-	-	-	10	-	100	100	200
			Total Semester IV	**-**	**-**	**-**	**10**	**-**	**100**	**100**	**200**

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ECPCC8001 Advanced Digital Signal Processing

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	ISE I	20 Marks
Total Credits	3	ISE II	20 Marks
		ESE	60 Marks

Course Educational Objectives:

- To expose the students to the fundamentals of digital signal processing in frequency domain & its application.
- To teach the fundamentals of digital signal processing in time-frequency domain & its application.
- To compare Architectures & features of Programmable DSP processors.
- To discuss Application development with commercial family of DS Processors.
- To introduce the concept of Wavelet, transform in context of real time applications.
- To implement DSP algorithms using DSP Processors.

Course Outcomes: After completing the course students will be able to

CO1	K2	Understand Discrete-Time Signals and Systems
CO2	K3	Design Digital FIR and IIR Filters
CO3	K2	Explain Parametric and Non-Parametric Statistical Models
CO4	K2	Deconstruct Signals using Wavelet Transform
CO5	K2	Elaborate Digital Signal Processor Architectures

Detailed Syllabus:

UNIT-1	**Introduction to Digital Signal Processing** Introduction, A Digital Signal-Processing System, The Sampling Process, Discrete Time Sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear Time-invariant Systems, Decimation and Interpolation, Digital Filters, Random signal
UNIT-2	**FIR and IIR Filters** Difference equation for digital filters: Definition and properties. FIR filters, IIR filters. Digital filter design techniques: Impulse invariance. Bilinear transformation, finite difference, window design methods, frequency sampling optimization algorithms. **Adaptive Filters** Principles of adaptive filter, FIR adaptive filters, Newton Descent algorithm, LMS algorithm, Adaptive noise cancellation, Adaptive equalizer, adaptive echo cancellation
UNIT-3	**Spectral Estimation:** Non-parametric methods and parametric methods. **Linear Prediction and Coding** Forward and backward linear prediction, Filtering-FIR Wiener filter, Filtering and linear prediction, non-causal and causal IIR wiener filter, Discrete Kalman filter.
UNIT-4	**Wavelet Transform** Introduction to continuous wavelet transform- discrete wavelet transform- orthogonal wavelet decomposition- Multiresolution Analysis-Wavelet function- DWT, bases, orthogonal Basis-Scaling function, Wavelet coefficients, ortho normal wavelets and their relationship to filte

	interpolation (i) Decomposition filters, (ii) reconstruction, the signal- Example MRA- Haar and Daubechies wavelet.
UNIT-5	**Architectures Of Commercial Digital Signal Processors** Introduction, categorization of DSP Processors, Fixed Point (Black fin), Floating Point (SHARC), TI TMS 320c6xxx & OMAP processors TMS320C54X & 54xx on Basic Architecture – comparison: of functional variations of Computational building blocks, MAC, Bus Architecture and memory, Data Addressing, Parallelism and pipelining, Parallel I/O interface, Memory Interface, Interrupt, DMA (one example Architecture in each of these case studies).

TEXT AND REFERENCE BOOKS

1. Proakis, J. G., Rader, C. M., Ling, F., and Nikias, C. L, Advanced Digital Signal Processing, Macmillan,1992
2. J.G. Proakis & D. G. Manotakis Digital Signal Processing, Principles algorithms & applications, PHI
3. Monson H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc, Singapore,2002
4. John J. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Pearson Education,2002
5. Rabiner, L. R. and Schafer, R. W Theory and Application of Speech Processing, PHI,1978
6. Widrow, B. and Stearns, S. D Adaptive Signal Processing, PHI,1985
7. Haykin, S, Adaptive Filter Theory, PHI,2001
8. Emmanuel C Ifeachor, Barrie W Jrevis, Digital Signal Processing, Pearson Education

9.Analog Devices & Texas Instruments Users Manuel of TMS320CX and ADSP2106x

Assessment:

ISE I, II	Shall be based on Class Tests/ Assignments/ Quizzes / Field Visits/ Presentations / Course Projects

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1 (Research)	PO2 (Report)	PO3 (Mastery)
CO1	1	1	2
CO2	3	1	3
CO3	2	1	2
CO4	2	1	2
CO5	1	1	2

1 – Low, 2 – Medium, 3 – High

Assessment Table:

Assessment Tools	**K2**	**K3**	**K2**	**K2**	**K2**
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
ISE I (CT-20 Marks)	10	10	00	00	00
ISE II (TA-20 Marks)	00	10	00	10	00
ESE (60 Marks)	12	12	12	12	12

ECPCC8002: Advanced Sensors & Perception Systems

Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	**ISE I**	20 Marks
Total Credits	3	**ISE II**	20 Marks
		ESE	60 Marks
		Total	100 Marks

Course Outcomes: After completing the course students will be able to

CO1	Understand and classify the working principles, static and dynamic characteristics of different sensors (proximity, inertial, vision, LIDAR, radar) used in modern perception systems.
CO2	Apply appropriate signal conditioning, calibration and interfacing techniques to acquire accurate and reliable data from sensors for perception applications.
CO3	Analyze multi-sensor data association and fusion algorithms (Kalman Filter, Extended/Unscented Kalman Filter, Particle Filter) to estimate the state of a dynamic system.
CO4	Design and evaluate an integrated multi-sensor perception system (vision, LIDAR, radar and inertial sensors) for a real-world application.

Detailed Syllabus:

UNIT-1	**Introduction to Sensors and Sensing Principles** Introduction to sensors and perception systems, classification of sensors, static and dynamic characteristics of sensors overview of sensing modalities, EMS-based sensors and their applications, sensor selection criteria for perception systems.
UNIT-2	**Sensor Signal Conditioning and Interfacing** Signal conditioning circuits: amplification, filtering, linearization; ADC/DAC interfacing; wired and wireless sensor interfacing protocols; introduction to smart sensors and sensor networks; daq for real-time perception.
UNIT-3	**Range and Vision Sensors for Perception** Ultrasonic and infrared range sensors, LIDAR (2D/3D) principles and scanning techniques, RADAR sensing for object detection and ranging, feature extraction basics for perception, comparison of vision, LIDAR and RADAR modalities for autonomous systems.
UNIT-4	**Sensor Fusion** Centralized and decentralized sensor fusion architectures, complementary and adaptive fusion techniques
UNIT-5	**Applications of Perception Systems** Simultaneous Localization and Mapping (SLAM) for autonomous mobile robots and unmanned vehicles, sensor fusion in advanced driver assistance systems (ADAS), industrial perception systems for automation and quality inspection, emerging trends in AI-assisted perception.

TEXT AND REFERENCE BOOKS

Text Books

1. Fraden, J., Handbook of Modern Sensors: Physics, Designs, and Applications, Springer, 2016.
2. Siegwart, R., Nourbakhsh, I. R., and Scaramuzza, D., Introduction to

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Robots, MIT Press, 2nd Edition, 2011.

Reference Books

1. Groves, P. D., Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems, Artech House, 2nd Edition,

2. Murphy, R. R., Introduction to AI Robotics, MIT Press, 2000.

4. Sonka, M., Hlavac, V., and Boyle, R., Image Processing, Analysis, and Machine Vision, Cengage Learning, 4th Edition

Assessment: ISE I (Class Test), ISE II (TA) & ESE

Assessment:

ISE I, II	Shall be based on Class Tests/ Assignments/ Quizzes / Field Visits/ Presentations / Course Projects

Mapping of Course Outcomes with Program Outcomes:

Outcomes	PO1	PO2	PO3
CO1	2	1	3
CO2	2	1	3
CO3	3	2	3
CO4	3	2	3

1 - Low, 2 - Medium, 3 – High

ECPCC8003: Machine Learning & Deep Learning

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs / Week	ISE I	20 Marks
Total Credits	3	ISE II	20 Marks
		ESE	60 Marks

Course Educational Objectives:

- To design and implement key components of intelligent agents.
- To apply knowledge represents technique and problem-solving strategies to common AI applications.
- To apply and integrate various artificial intelligence techniques in intelligent system.
- To build rule based and other knowledge intensive problem solvers.
- To apply various classifiers for real world applications.

Course Outcomes: Students will be able to

CO1	Learn the difference between classification & prediction algorithms in machine learning.
CO2	Develop an appreciation for what is involved in learning models from data.
CO3	Understand a wide variety of learning algorithms.
CO4	Understand how to evaluate models generated from data.
CO5	Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Detailed Syllabus:

UNIT-1	**Machine learning:** Supervised vs. Unsupervised vs. Reinforcement learning paradigms, Linear and Logistic Regression, Decision Trees and Random Forests, Clustering.
UNIT-2	**Deep Learning:** Multilayer Perceptron (MLP), activation functions, Feedforward backpropagation algorithm. Optimization & regularization. Convolutional Neural Networks (CNNs). Recurrent Neural Networks (RNNs) and LSTMs.
UNIT-3	**Advanced Deep Learning & Reasoning:** The Attention Mechanism, Transformers, Language as a Reasoning Tool
UNIT-4	**Reinforcement Learning**: The Agent-Environment Loop, Markov Decision Processes (MDP), Deep Q-Networks (DQN)
UNIT-5	**Generative AI & Explainable Thoughts:** Generative Networks, Explainable AI (XAI)

Textbooks

1. Artificial Intelligence: A Modern approach, Stuart Russell and Peter Norvig , Pearson, second Edition
2. Toshinori Munakata, "Fundamentals of the New Artificial Intelligence", Springer, 2ndedition
3. Jacek M. Zurada, "Introduction to Artificial Neural Network", Tata McGraw-Hill
4. "Machine Learning" by Tom M Mitchell, Tata McGraw-Hill
5. "Machine Learning for Hackers" by Drew Conway and John Myles White, Tata McGraw-Hill
6. "Introduction to Machine Learning" by Alex Smola and S.V.N. Vishwanathan
7. "Introduction to Octave", Dr. P. J. G. Long
8. Artificial Intelligence – A Practical Approach : Patterson , Tata McGraw Hill, 3rd
9. Deep Learning- Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press, 1st Edition (2016)

Reference Books

1) Elaine Rich, Kevin Knight, B. Nair, "Artificial Intelligence", Tata McGraw-Hill, 3rd edition
2) "Artificial Intelligence for Humans" by Jeff Heaton

Assessment: ISE I (Class Test), ISE II (TA) & ESE

Assessment:

ISE I, II	Shall be based on Class Tests/ Assignments/ Quizzes / Field Visits/ Presentations / Course Projects

Mapping of Course Outcomes with Program Outcomes:

Outcomes	PO1	PO2	PO3
CO1	1	1	1
CO2	1	2	2
CO3	1	3	2
CO4	1	3	3
CO5	2	3	3

1 – Low, 2 – Medium, 3 – High

ECPCC8004: Lab Machine Learning & Deep Learning

Teaching Scheme		Examination Scheme	
Practical	2 Hrs/Week	ISE II	25 Marks
Total Credits	1	ESE	25 Marks

Course Educational Objectives:

The students are encouraged to focus on different machine learning libraries (eg. Scikit, tensorflow, pyTorch etc.) to implement the basic algorithms in Python to understand machine learning and deep learning. Students are also encouraged to learn the toolboxes provided by matlab for machine learning and deep learning.

Course Outcomes: Students will be able to

CO1	Understand to apply the ML & DL theory to real-world machine learning based Artificial Intelligence application.
CO2	Learning machine learning algorithms relevant to current industrial practice.
CO3	Learning, applying, and implementing Deep learning networks
CO4	Build thinking system application.

List of Experiments:

- Perform practical of ML & DL Using Matlab/Python programming language
- Perform any ten experiments (5 from ML & 5 from DL) from the given list.

Mapping of Course Outcomes with Program Outcomes:

Outcomes	PO1	PO2	PO3
CO1	1	2	1
CO2	2	2	2
CO3	1	1	2
CO4	1	1	2

1 – Low, 2 – Medium, 3 – High

Note:	ML: Expt. 1 to 10 DL: Expt 11 to 21
1	Fit the given set of data points using the Linear regression algorithm. Plot the graph and estimate the value for unknown input.
2	Classify the brain tumor dataset using Logistic regression algorithm. Find out the accuracy of the algorithm.
3	Implement Naive Bayes Classifier on the iris data set. Comment on accuracy, precision and recall rate obtained.
4	Mnist dataset contains the data of 10 numbers. Classify the data using K-nearestneighbour classifier. Comment on the misclassified data.

5	Write a program to classify Mnist dataset using decision tree algorithm. Compare the results obtained with that of K-nearest neighbor classifier.
6	Classify the iris data set using SVM classifier.
7	Use Expectation Maximization algorithm to Cluster the randomly generated dataset. Write k-nearest neighbor clustering algorithm to cluster the data. Compare the results obtained by two algorithms.
8	Study of Bayesian networks
9	Study of Ensembles methods for classification
10	Evaluating and Comparing different Classifiers Experimentally on Iris data set.
11	Implement a simple linear regression model using automatic differentiation (Autograd) and Visualize the computation graph.
12	Study the Impact of Hyperparameters and Optimizers by training a Multi-Layer Perceptron (MLP) on an image dataset and plot training loss curve for SGD optimizer.
13	Study the Impact of Hyperparameters and Optimizers by training a Multi-Layer Perceptron (MLP) on an image dataset and plot training loss curve for RMSProp optimizer
14	Study the Impact of Hyperparameters and Optimizers by training a Multi-Layer Perceptron (MLP) on an image dataset and plot training loss curve for Adam optimizer. Compare the training loss curves from experiment #12 and #13.
15	Mitigating Overfitting with Regularization- Observe the effect of Dropout on overfitting vs. underfitting
16	Mitigating Overfitting with Regularization- Observe the effect of Batch Normalization on overfitting vs. underfitting.
17	Design a custom CNN architecture to classify images from a dataset. Plot the confusion matrix for the test set
18	Utilize pre-trained state-of-the-art models like ResNet-50 or VGG-16 for transfer learning for object classification and compare the convergence speed of Transfer Learning vs. training from scratch
19	Implement an LSTM network to predict the next value in the sequence based on a window of past values.
20	Implement a model to classify reviews as positive or negative sentiment.
21	Implement a basic DCGAN (Deep Convolutional GAN) and train it on the MNIST dataset to generate new handwritten digits from random noise vectors

ECPEC8001: AI – Driven Industrial Automation & Cognitive Robotics

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	**ISE I**	20 Marks
Tutorial	-	**ISE II**	20 Marks
Total Credits	3	**ESE**	60 Marks
		Total	100 Marks

Course Outcomes: After completing the course, students will be able to

CO1	Analyze the architecture of AI-driven industrial automation systems and cognitive robots used in modern manufacturing environments. [Analyze (BL4)]
CO2	Apply machine learning, deep learning and cognitive-architecture techniques to build perception, reasoning, planning and control modules for intelligent industrial robots. [Apply (BL3)]
CO3	Evaluate the performance, safety and reliability of AI-based automation and multi-robot cognitive [Evaluate (BL5)]
CO4	Design and develop an AI-driven cognitive robotic solution / industrial automation framework for a practical problem [Create (BL6)]

Detailed Syllabus

UNIT 1	**Introduction to Industrial Automation and Cognitive Robotics** Evolution of industrial automation: fixed, programmable and flexible automation; Industry 4.0/5.0 perspective; automation pyramid and its integration with AI; cognitive robotics vs. conventional industrial robotics; collaborative robots (cobots) in smart factories.
UNIT 2	**Machine Learning and Deep Learning for Industrial Automation** Supervised, unsupervised and reinforcement learning for industrial applications; predictive maintenance and fault/anomaly detection using ML/DL; introduction to edge-AI for real-time industrial decision making.
UNIT 3	**Cognitive Robotics: Perception, Reasoning and Planning** Robot perception using vision, LiDAR and tactile sensing; sensor fusion; Simultaneous Localization and Mapping (SLAM); reinforcement learning for robotic manipulation and grasping.
UNIT 4	**Multi-Robot Systems and Swarm Intelligence in Automation** Multi-agent and multi-robot systems; swarm robotics and bio-inspired coordination; industrial communication and coordination of cobots on assembly and material-handling lines.
UNIT 5	**Case Studies, Safety, Ethics and Industrial Deployment** AI-driven automation case studies from automotive, electronics manufacturing emerging trends towards human-centric Industry 5.0.

Text and Reference Books

1. Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 3rd Edition, Wiley, 2020.
2. R. K. Mittal and I. J. Nagrath, "Robotics and Control", Tata McGraw-Hill, New Delhi.
3. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 4th Edition, Pearson, 2020.
4. Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", 4th Edition, Pearson, 2015.
5. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
6. Frank L. Lewis, S. S. Ge (Eds.), "Autonomous Mobile Robots: Sensing, Control, Decision Making and Applications", CRC Press.

Assessment:

ISE I, II	Shall be based on Class Tests/ Assignments/ Quizzes / Field Visits/ Presentations / Course Projects

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3
CO1	2	1	3
CO2	2	1	3
CO3	3	2	2
CO4	3	3	2

PO1: Research and Investigation | *PO2: Technical Communication* | *PO3: Domain Mastery*

1 – Low, 2 – Medium, 3 – High

ECPEC8002: ML Ops

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	ISE I	20 Marks
Total Credits	3	ISE II	20 Marks
		ESE	60 Marks

Course Educational Objectives:

- To understand why traditional software engineering rules change when code depends on unpredictable real-world data.
- To learn how to build reliable, reproducible data pipelines that feed clean information into learning models.
- To master the art of writing software tests explicitly designed to catch silent failures in machine learning code.
- To learn how to wrap a deep learning model inside a clean, accessible web service (API).
- To understand how to track a model's health after deployment and plan for automated updates.

Course Outcomes: Students will be able to

CO1	Analyze the software engineering differences between traditional systems and data-driven systems.
CO2	Design version-controlled data pipelines that ensure identical results across different environments.
CO3	Write automated code tests to validate data schemas, model boundaries, and output shapes.
CO4	Package an ML model as a functional, production-ready web application endpoint.
CO5	Implement simple monitoring logic to detect when real-world data drift is corrupting an AI's accuracy.

Detailed Syllabus:

UNIT-1	**Software Engineering vs. Machine Learning:** Traditional Software vs. Machine Learning, ML systems; "Changing anything changes everything" principle, The Reproducibility Problem, AI system- the code logic, the specific dataset version, and the resulting trained model weights.
UNIT-2	**Data Engineering & Versioning (The Input Pipeline):** Data Pipelines, Data Versioning Concepts, Data Quality Testing
UNIT-3	**Building and Testing Automated ML Workflows:** Modular Coding, Automated Training Pipelines, Testing ML Code
UNIT-4	**Model Serving & Software Integration:** Model Packaging, Creating Web Services, Inference Strategies
UNIT-5	**Model Monitoring & Lifecycle Management:** The Silent Failure Problem, Data and Concept Drift, Feedback Loops

Textbooks

1. Chip Hu yen, “Designing Machine Learning Systems: An Iterative Process for Production-Ready Applications”, O’Reilly Publication, 1st Edition (2022)
2. Mark Treveil, Nicolas Omont, Clément Stenac, et al., “Introducing MLOps: How to Scale Machine Learning in the Enterprise”, O'Reilly Media ,1st Edition (2020)
3. Noah Gift and Alfredo Deza, “ Practical MLOps: Operationalizing Machine Learning Models”, O'Reilly Media EDITION: 1st Edition (2021)

Reference Books

1. Ben Wilson, “Machine Learning Engineering in Action”, Manning Publication, 1st Edition (2022)
2. Hannes Hapke and Catherine Nelson, “Building Machine Learning Pipelines: Automating Model Lifecycles”, O'Reilly Media, 1st Edition (2020)

Assessment:

ISE I, II	Shall be based on Class Tests/ Assignments/ Quizzes / Field Visits/ Presentations / Course Projects

Mapping of Course Outcomes with Program Outcomes:

Outcomes	PO1	PO2	PO3
CO1	1	2	1
CO2	1	2	2
CO3	1	2	2
CO4		3	2
CO5	1	2	3

1 – Low, 2 – Medium, 3 – High

ECPEC8003: Unmanned Ariel Systems (UAS) and Drone Swarm Intelligence

Teaching Scheme		**Evaluation Scheme**	
Lectures	03 Hrs/Week	ISE I	20 Marks
Total Credits	03	ISE II	20 Marks
		ESE	60 Marks

Course description: This course introduces students to the theoretical and practical aspects of the Unmanned Ariel systems and Drone Swarm Intelligence.

Course Outcomes:
After completing the course, students will be able to:

CO1	Understand the architecture and components of Unmanned Aerial Systems (UAS)
CO2	Explain UAS flight dynamics and autonomous navigation strategies
CO3	Design UAV communication architectures.
CO4	Apply optimization algorithms for drone swarm intelligence and coordination

Detailed Syllabus:

Unit 1	**Fundamentals of Unmanned Aerial Systems** Introduction, History and Evolution of UAVs, Classification, sensors and components of UAS, Ground Control Station (GCS), Mission planning
Unit 2	**UAV Dynamics, Navigation and Autonomous Control** Fundamentals of Flight Mechanics, Aerodynamics, Six Degrees of freedom (6-DOF), Stability and control, Guidance, Navigation and Control (GNC), Path planning techniques, Autonomous Landing and Take-Off, SLAM (Simultaneous Localization and Mapping)
Unit 3	**Drone Communication Networks** UAV Communication Architecture, Communication Protocols- MAVLink, TCP/IP, UDP, LTE/5G; FANET (Flying Ad Hoc Networks), Mesh Networking, IoT-enabled Drone Networks, Multi-Agent System
Unit 4	**Drone Swarm Intelligence** Introduction, Biological Inspirations, Swarm Robotics, Characteristics of Drone Swarms, Collective Decision Making, Swarm Behaviors, Swarm Optimization Algorithms
Unit 5	**Security and Applications** GPS Spoofing, Jamming, Secure Communication, Cooperative UAV Missions, Search and Rescue Operations, Disaster Response, Precision Agriculture, Smart Cities

Dr. Sunil Hirekhan
Head E&TC

Dr. Anil Karwankar
Dean Academics

TY B.Tech. Electronics & Telecommunication Engineering Curriculum
With effect from Academic Year 2026–2027
Approved in the 32nd Academic Council Meeting, dated 28th July 2026

Textbooks:

1. Randal W. Beard and Timothy W. McLain, *Small Unmanned Aircraft: Theory and Practice*, Princeton University Press.
2. Kimon P. Valavanis and George J. Vachtsevanos (Eds.), *Handbook of Unmanned Aerial Vehicles*, Springer
3. Ying Tan (Ed.), *Handbook of Swarm Intelligence: Concepts, Principles and Applications*, Springer.
4. Marco Dorigo and Thomas Stützle, *Ant Colony Optimization*, MIT Press Pearson – 2020

Reference Books

1. Adam Clarke, *Drone Technology and Applications*.
2. Luis Mejias, *Autonomous Flying Robots*.
3. Carlos Gershenson, *Self-Organizing Systems*.

Mapping of Course Outcome with Program Outcomes, Program Specific Outcomes:

Outcomes	PO01	PO02	PO03	PSO1	PSO2
CO1	1	1	2		
CO2	2	2	1		
CO3	3	2	1		
CO4	1	2	2		

3 – High, 2 – Medium, 1- Low

Assessment:

ISE I, II	Shall be based on Class Tests/ Assignments / Quizzes /Field visits/ Presentations / Course Projects

Assessment Table:

Assessment Tools	**K2**	**K2**	**K2**	**K3**
	CO1	**CO2**	**CO3**	**CO4**
ISE I (20 Marks)	10	10	00	00
ISE II (20 Marks)	00	05	10	05
ESE (60 Marks)	15	15	20	10

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ECPEC8004: Cyber Security for Autonomous Systems

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	**ISE I**	20 Marks
Total Credits	3	**ISE II**	20 Marks
		ESE	60 Marks

Course Outcomes: After completing the course students will be able to

CO	Course Outcome: After completing the course, students will be able to
CO1	Explain the fundamental concepts of cyber-physical systems security (K2)
CO2	Analyze vulnerabilities across the sensing, communication and control layers of autonomous system architectures (K4)
CO3	Apply lightweight cryptographic techniques, secure communication protocols, key-management schemes and access-control mechanisms to protect data and command channels of autonomous systems.(K3)
CO4	Formulate an appropriate cybersecurity strategy for a given autonomous system in line with relevant standards (ISO/SAE 21434, IEC 62443).(K3)

Detailed Syllabus (33 – 36 Hours):

UNIT-1	**Introduction to Cyber-Physical & Autonomous Systems Security** Overview of autonomous systems: robotics, unmanned aerial systems, autonomous vehicles and industrial automation; Cyber-Physical Systems (CPS) architecture and security fundamentals; CIA triad in the CPS context
UNIT-2	**Threats and Vulnerabilities in Autonomous System Architectures** **Sensor-layer attacks:** GPS spoofing/jamming, LiDAR and camera spoofing, sensor fusion attacks; Communication-layer attacks; **Control-layer attacks**: actuator attacks, false data injection, denial of service; AI/ML model attacks: adversarial examples, data poisoning
UNIT-3	**Cryptographic Foundations and Secure Communication** Cryptographic primitives for resource-constrained/embedded devices: symmetric and asymmetric cryptography, hash functions; Secure key management for autonomous fleets; Secure communication protocols: TLS/DTLS, secure MQTT
UNIT-4	**Intrusion Detection, Resilience and Defense Mechanisms** Intrusion Detection Systems (IDS) for CPS: signature-based, anomaly-based and specification-based approaches; Machine learning and deep learning-based IDS for autonomous systems;
UNIT-5	**Standards, Regulations and Emerging Trends** Cybersecurity standards and frameworks: ISO/SAE 21434, IEC 62443 (Industrial automation

	and control systems), NIST Cybersecurity Framework; Digital twin security; Introduction to quantum-safe cryptography

Text and Reference Books

1. Nina Godbole & Sunit Belapure, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley India.
2. Colbert, E. J. M. and Kott, A. (Eds.), Cyber-security of SCADA and Other Industrial Control Systems, Springer, 2016.
3. Loukas, G., Cyber-Physical Attacks: A Growing Invisible Threat, Butterworth-Heinemann (Elsevier), 2015.
4. Shancang Li and Li Da Xu, Securing the Internet of Things, Syngress (Elsevier), 2017.
5. Ahmad, T. and Morris, T., Cybersecurity for Industrial Control Systems: SCADA, DCS, PLC, HMI and SIS, CRC Press, 2018.

Assessment:

ISE I, II	Shall be based on Class Tests/ Assignments/ Quizzes / Field Visits/ Presentations / Course Projects

Mapping of Course Outcomes with Program Outcomes

Outcomes	PO1	PO2	PO3
CO1	2	1	3
CO2	3	1	3
CO3	2	2	3
CO4	3	2	3

PO1: Research and Investigation | PO2: Technical Communication | PO3: Domain Mastery

1 – Low, 2 – Medium, 3 – High

ECRMC8001: Research Methodology		
Teaching Scheme	**Examination Scheme**	
Lectures: 2 Hrs. / Week	ISE I	10 Marks
Credits: 2	ISE II	10 Marks
	End Semester Examination	30 Marks

Course Description:

Research methodology is the systematic and rigorous process of designing, conducting, analyzing and reporting the research. It includes the techniques to collect and interpret data and it analysis. The intent of the course is to make students aware of the details associated with formal research. By doing this course, students will be able to take up research activities in a more systematic and formal manner right from the beginning.

Course Outcomes:

After completing the course students will be able to:

CO1	Identify and frame the research problem statement
CO2	Handle data and interpret
CO3	Comprehend and represent the research carried out and follow the ethical practices

Detailed Syllabus:

Unit 1	Introduction to Research methodology, Surveys, Data Collections, Importance of Review of Literature
Unit 2	Data Preparation and representation, Data Analysis, Sampling, Statistics and Regression
Unit 3	Technical writing, Referencing styles and bibliography, technical presentation, ICT and AI tools for Research, Ethics in research, Plagiarism, IPR and infringement

Textbooks:

1. Research Methodology Methods and Techniques, C R Kothari, Guarav Garg, New Age International Publishers
2. Advanced Engineering Mathematics, H K Dass, S. Chand
3. Research Methodology, Ranjit Kumar, 2nd edition, Pearson Education

Mapping of Course outcomes with Program Outcomes:

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1		1	2			1	1	1		2			1
CO2	2	2	1	1	2				1	1		2	1	1	2
CO3	1			1	2			2	1	3		2			

1 – Low, 2 – Medium, 3 – High

Assessment:

ISE I, II	Shall be based on Class Tests/ Assignments/ Quizzes / Field Visits/ Presentations / Course Projects

Assessment table

Assessment Tool	**K2 (A3)**	**K2**	**K2 (A3)**
	CO1	**CO2**	**CO3**
ISE I (10 Marks)	5	5	-
ISE II (10 Marks)	-	10	-
ESE (30 Marks)	5	20	5

ECVSE8001: Development of an Autonomous Thinking System

Teaching Scheme		**Evaluation Scheme**	
Practical	04 Hrs/Week	ISE II	25 Marks
Total Credits	02	ESE	25 Marks

Course Outcomes:

CO1	Formulate a well-scoped problem statement suitable for an autonomous system, individually.
CO2	Design a system architecture that incorporates perception/input handling, an internal reasoning or decision-making mechanism, and an action/output mechanism, with minimal human intervention during operation.
CO3	Implement and integrate appropriate AI/ML components to realize autonomous or semi-autonomous behavior.
CO4	Test and validate the system's performance, robustness, and degree of autonomy using defined metrics/scenarios
CO5	Document the work in a structured technical report and defend the design choices and outcomes before an external jury.

- The system must be conceived, designed, and substantially implemented by the student alone.
- Students are expected to invest a minimum of 50 hours of individual effort across the semester for the project.
- Use of open-source libraries / frameworks is permitted and encouraged. Any external code, dataset, or pre-trained model used must be clearly cited / acknowledged.
- The system must operate on its own once initiated for a defined task, i.e., it should perceive/receive input, reason or decide internally, and act/output without requiring the student to manually intervene at each decision step during operation. The student must be able to explain and demonstrate where and how autonomy/decision-making occurs in the system.
- By the end of the semester, the student must produce a functional (even if limited scope) running system, not only a design document or presentation slides.
- Students must maintain a lab logbook / version-controlled repository (e.g., Git) showing incremental progress across the semester, reviewable at any point by the guide.

ISE II

The evaluation is done through project reviews (2 to 3). The student must prepare typed copy of report of about 70 pages or more, on the work carried out by the student in respect of the project assigned. It should be in the prescribed format.

Practical Examination:
It shall consist of demonstrations of designed, developed autonomous thinking system and viva voce based on it. The said examination will be conducted by a panel of two examiners; one of them will be a guide and another will be an external examiner. The external examiner will be either from the allied industry or a senior faculty member from another institute.

Mapping of Course Outcome with Program Outcomes, Program Specific Outcomes:

PO	01	02	03	PSO1	PSO2
CO1	2		2	2	2
CO2	2		2	2	3
CO3	2		2	2	3
CO4	2		2	2	2
CO5		3	1	1	1

3 – High, 2 – Medium, 1- Low

Assessment Table:

Assessment Tool	K2	K3	K3	A4	A3
	CO1	CO2	CO3	CO4	CO5
ISE II (25 Marks)	5	5	5	5	5
Practical Examination (25 Marks)	5	5	5	5	5

INCCC5101: Stress Management Through Yoga		
Teaching Scheme	**Examination Scheme**	
Practice : 2 hrs /week	**Credits: Audit Course**	

Course Objectives:

This course aims at enabling students:

1. To get awareness of Physical, Mental, Social and Spiritual health
2. To learn to manage the Stress through art of Yoga.
3. Understand and perform skill of Yoga Asanas
4. Gain knowledge and benefits of Pranayam and Dhyan
5. Importance of diet, food and nutrition.

Course Outcomes:

	The students will be able to -
CO1	Aware regarding healthy and peaceful living
CO2	Understand the cause of stress and its relief
CO3	Perform skills of Yoga Asanas and Meditation
CO4	Bring peace and harmony in society at large
CO5	Aware of yogic diet, food and nutrition.

Detailed Syllabus:

Unit1	Introduction, meaning and definition of health, various dimensions of health, like, Physical, Mental, Social and Spiritual health
Unit2	Concept of stress according to yoga, causes and consequences of stress, stress management through Yoga.
Unit3	Introduction and definition of yoga, Fundamental concept of yoga, relationship of yoga and health.
Unit4	Yogic sukshmavyayam, Maharshi Patanjali Ashtang Yog sutra, different types and benefits of asanas (min. five in each pose), Suryanamaskar, different types and benefits of Pranayam (min. Five), Meaning and importance of dhyan .
Unit5	Importance of yogic diet, food and nutrition.
List of Practice Sessions	1. Practice of Yogic Sukshma Vyayam 2. Practice of different Asanas 3. Practice of different Pranayam 4. Practice of Dhyan

Text and Reference books:

1. K, N, Udupa, Stress and its Management by Yoga, Motilal Banaridas Publishers
2. Acharya Yetendra, Yoga and Stress Management, Finger print Publications
3. B. K. S. Iyengar, Light on Yoga, Harper Collins Publisher, New Delhi, 2005
4. Swami Vivekanand, Patanjali Yog Sutra, Geeta Press, Gorakhpur
5. Swami Ramdev, Pranayam Rahasya, Divya Prakashan, 2009.