Course Code	**ROB224001**						
Course Name	**PLC & SCADA Programming**						
Type of Course	DCC						
Teaching Scheme and Credits Weekly Working Hrs	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
	03		--		--		03
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
	20	--	--	--	20	60	100

Prerequisites for the Course: Basic Electrical and Electronics Engineering , Mathematics

The course aims to:

Course Objectives	Description
1	To introduce the fundamentals, evolution, architecture, and working principles of Programmable Logic Controllers (PLC).
2	To develop students' ability to design, write, and implement PLC programs using standard programming techniques like ladder logic and functional block diagrams.
3	To familiarize students with the hardware components, addressing methods, and communication protocols used in PLC-based systems.
4	To provide a comprehensive understanding of SCADA and Distributed Control Systems (DCS), including their structure, operation, and applications in industrial automation.
5	To enable students to apply PLC and SCADA concepts for real-time industrial process control applications involving sensors, actuators, and control logic.

On completion of the course, learner will be able to–

Course Outcomes	Description
CO1	Understand basic concepts of PLCs and SCADA in automation
CO2	Identify PLC hardware and software components
CO3	Develop and simulate PLC programs using ladder logic
CO4	Design basic SCADA systems for industrial monitoring
CO5	Apply PLC-SCADA integration in real-world automation

Course context, Relevance, Practical Significance:

This course introduces the fundamentals of PLC and SCADA programming, focusing on automation and real-time control in industrial systems. It equips students with hands-on skills to design, simulate, and troubleshoot automation processes used in manufacturing, robotics, and smart infrastructure.

Course Contents:

Unit and Chapter	Contents	Lecture Hours
1	**Introduction to PLCs and SCADA Systems** Introduction to Automation, Evolution and Importance of PLCs- History, advantages over traditional control systems, and applications, SCADA Systems: Introduction to Supervisory Control and Data Acquisition systems, their components, and significance, real-world industrial applications	7
2	**PLC Hardware and Software Components** PLC Architecture: Central Processing Unit (CPU), memory, power supply, and I/O modules, Input/ Output Modules: Types, specifications, and interfacing techniques, Programming Devices: Tools and software used for PLC programming	7
3	**PLC Programming Techniques** Programming Languages: Introduction to Ladder Logic- Introduction to Ladder Diagram syntax and rungs, Rules of ladder logic programming, Function Block Diagram, and Structured Text, Latching and interlocking circuits, Basic Instructions: Bit logic operations, timers- On-Delay Timer, Off-Delay Timer, Retentive Timer, Counter Instructions, Up-Counter, Down-Counter and arithmetic operations, Advanced Instructions: Data handling, analog processing, and PID control. Real Time Applications using ladder logic programming method- Traffic light control system, Conveyor belt control system, Applications of counters in Industrial Automation, Application of Timers in Automation	7
4	**SCADA System Design and Implementation** Functions of SCADA, SCADA Architecture- Basic components: RTU, PLC, HMI, SCADA Software, Centralized vs distributed SCADA ,systems, Communication in SCADA, Human-Machine Interface (HMI), Difference Between SCADA, DCS, PLC, and HMI, Industrial Applications and Case Studies	7
5	**Industrial Application** Automatic water level controller, Start-Stop motor control with interlock, Two-tank liquid filling system, Automatic street light control using LDR, Lift (Elevator) control logic, Conveyor-Based Sorting Robot Using Color Sensors and Diverter Logic, Robotic Welding System Using Timers and Safety Interlocks, Lift (Elevator Type) Robotic Movement Using Level Sensors and Timers case studies using PLC and SCADA interfacing	7

Course Mapping

Unit and Chapter	Bloom's Taxonomy Level	CO Mapped	PO Mapped	PSO Mapped
1	Remember Understand	1,2	PO1, PO2, PO5, PO10	1,2
2	Apply, Analyse	1	PO1, PO2, PO3, PO4, PO5, PO12	1,2
3	Analyse, Evaluate	1,3	PO1, PO2, PO3, PO4, PO5, PO12	1,2
4	Analyse, Evaluate	3,4	PO1, PO2, PO3, PO4, PO5, PO11, PO12	1,2
5	Apply, Create	3,4	PO1, PO2, PO3, PO4, PO5, PO10, PO11, PO12	1,2

References Books

1. J. W. Webb and R. A. Reis, *Programmable Logic Controllers: Principles and Applications*, 5th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2002. ISBN: 978-0130607188.

2. J. W. Webb and R. A. Reis, *Programmable Logic Controllers: Principles and Applications*, 5th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2002. ISBN: 978-0130607188.
3. S. Mukhopadhyay and S. Sen, *Industrial Instrumentation and Control*, 2nd ed. New Delhi, India: PHI Learning, 2016. ISBN: 978-8120352445

Text Books

1. Programmable Logic Controllers: Principles and Applications – *John W. Webb, Ronald A. Reis* ISBN: 978-0130607188
2. Programmable Logic Controllers *Frank D. Petruzella* ISBN: 978-0073510880
3. SCADA: Supervisory Control and Data Acquisition *Stuart A. Boyer* ISBN: 978-1936007097

e Resources

NPTEL (IIT Courses) – Industrial Automation and Control

https://nptel.ac.in/courses/108/102/108102045

(Includes PLC, SCADA, and automation systems)

Useful websites / Video

Channel Name	Useful For	Link

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low, 2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2	-	-	-	-	-	-	-	1	-	1	2	1
CO 2	3	2	-	-	1	-	-	-	-	1	-	2	2	2
CO 3	3	3	2	-	3	-	-	-	2	2	2	2	3	3
CO 4	2	2	3	-	3	-	-	-	2	2	2	2	2	3
CO5	2	3	3	2	3	2	1	1	3	2	2	2	3	3

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for CCE	Marks Allotted
1	Tests on each unit using LMS (Each test for 10 M and total will be converted out of 5 M)	05
2	Quiz on each topic of having 3 marks and total marks is converted into 5marks	05
3	Timely Assignment Submission	10
	Total	20

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairman**

Course Code	**ROB224002**						
Course Name	**Machine Vision System**						
Type of Course	DCC						
Teaching Scheme and Credits Weekly Working Hrs	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
	03		--		--		03
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
	20	--	--	--	20	60	100

Prerequisites for the Course: Fundamentals of Electronics Engineering, Sensors Technology, Robot Programming, Artificial Intelligence for Robotics

The course aims to:

Course Objectives	Description
1	Introduce the fundamentals of image acquisition, processing, and analysis for automated inspection and control.
2	Familiarize students with key components of machine vision systems, including cameras, lighting, lenses, and image sensors.
3	Develop skills in digital image processing techniques such as filtering, edge detection, segmentation, and feature extraction.
4	Equip students with the knowledge to integrate machine vision with robotics and automation systems for industrial applications.
5	Expose students to machine learning and AI-based approaches used in vision-based recognition and decision-making.

On completion of the course, learner will be able to–

Course Outcomes	Description
CO1	Describe the stages of digital image processing
CO2	Demonstrate the role of image processing in different fields such as robotics, medical, engineering, agriculture, food industry, etc.
CO3	Apply various machine learning algorithms for image processing and analysis
CO4	Develop algorithms for machine vision in robotic applications

Course context, Relevance, Practical Significance:

The **"Machine Vision"** course is a vital interdisciplinary subject integrating **optics, electronics, signal processing, computer vision, and artificial intelligence**. It serves as a bridge between theoretical image processing and real-world vision systems used in automation, robotics, and quality inspection systems.

This course provides foundational and advanced knowledge in:

- Image acquisition and enhancement
- Image segmentation, restoration, and compression
- Motion analysis
- Machine learning and deep learning applications in vision

Course Contents:

Unit and Chapter	Contents	Lecture Hours
1	**Introduction to machine vision** Machine vision components - Lighting system, optical system, sensors, steps of vision processing, communications. Machine vision functions – measurement, counting, decoding, and location. Selection of appropriate vision system based on application parameters (e.g., resolution, frame rate, environment, and lighting).Hardware integration of multiple vision systems (multi-camera setups, synchronization, and interfacing). Applications of machine vision in automotive industry, manufacturing, electronics, semiconductors, and robotics. Benefits of vision system.	7
2	**Image Acquisition and enhancement** Image acquisition: Image acquisition concept, quantum detectors, Image acquisition models, Charged coupled device (CCD), Complementary metal oxide semi-conductors (CMOS). Image Enhancement in spatial domain: Point operator, Spatial filter, Linear and non-linear filtering, bilateral filtering, histogram equalization Image enhancement in frequency domain: 2D Fourier transforms, smoothing frequency domain filters – ideal, butter worth, Gaussian low pass filters.	7
3	**Image restoration and image compression** Image restoration: Noise reduction by frequency domain filtering, Arithmetic mean filters, geometric mean filters, adaptive filters, Band pass and band reject filters. Image compression: Steps involved in image compression, Lossless compression techniques – Run length encoding, Huffman encoding, area coding. Lossy compression: Predictive coding, transform coding, wavelet coding. Performance measures of compression – Compression ratio, S/N ratio, speed.	7
4	**Image segmentation and representation** Image segmentation: Approach based classification – Region based, boundary based. Technique based classification – structural, stochastic, hybrid. Techniques of image segmentation – Thresholding, edge based, watershed, clustering, Image representations: Color based image representations, Texture based image representations, Shape based image representation	7
5	**Motion estimation and Deep learning algorithms in image processing** Hierarchical motion estimation, Fourier based alignment, incremental refinement, parametric motion, layered motion, Optical flow, Block matching algorithm. Supervised learning algorithms: Bayesian classification, logistic regression, support vector machines. Unsupervised learning algorithms: Clustering, Principal Component Analysis. Deep Neural networks. Convolutional Neural Networks.	7

Course Mapping

Unit and Chapter	Bloom's Taxonomy Level	CO Mapped	PO Mapped	PSO Mapped
1	Remember, Understand	1,2	PO1, PO2, PO5, PO10	1,2
2	Apply, Analyse	1	PO1, PO2, PO3, PO4, PO5, PO12	1,2
3	Analyse, Evaluate	1,3	PO1, PO2, PO3, PO4, PO5, PO12	1,2
4	Analyse, Evaluate	3,4	PO1, PO2, PO3, PO4, PO5, PO11, PO12	1,2
5	Apply, Create	3,4	PO1, PO2, PO3, PO4, PO5, PO10, PO11, PO12	1,2

References Books

1) Richard Szeliski, Computer Vision: Algorithms and Applications, Springer Nature, ISBN: 9783030343729
2) Refael C. Gonzalez and Richard E, Woods Digital Image Processing, Addison-Wesley ISBN: 9780133356724

Text Books

1) Refael C. Gonzalez and Richard E. Woods, Digital Image Processing Using MATLAB, Addison Wesley, ISBN: 9780070702622
2) Scott E Umbaugh, Computer Vision and Image Processing Prentice-Hall International, ISBN: 9781439802052
3) 5) Jain A.K., Fundamentals of Digital Image Processing, Prentice-Hall of India, ISBN-100133361659

e Resources

NPTEL Courses:

- NPTEL – Digital Image Processing by Prof. P.K. Biswas
- Computer Vision by Prof. J. Sivaram (IIT Madras)

Free Toolkits for Practice:

- Google Colab – Run Python image processing code online
- MATLAB Online – MATLAB without installation (limited access)
- OpenCV-Python Tutorials

Useful websites / Video

1) https://www.youtube.com/playlist?list=PL4C939ED22F991970
2) https://www.youtube.com/@PyImageSearch
3) https://www.youtube.com/watch?v=YRhxdVk_sIs
4) https://www.youtube.com/c/MurtazasWorkshopRoboticsandAI/playlists
5) https://www.youtube.com/playlist?list=PLm_MSClsnwm-0Z_G1fQkNYN9ArsJFDC0f

Strength of CO - PO/PSO Mapping (Sample):
Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	--	--	--	2	--	-	--	--	--	--	2	2	2
CO 2	2	2	--	--	2	2	1	1	--	2	--	2	2	2
CO 3	3	3	2	2	3	--	--	1	--	2	2	3	3	2
CO 4	3	3	3	2	3	1	1	1	2	2	2	3	3	3

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for CCE	Marks Allotted
1	Tests on each unit using LMS	10
2	Timely Assignment Submission	10
	Total	20

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairman**

Course Code	ROB224003						
Course Name	PLC & SCADA Programming Lab						
Type of Course	PCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	--		--		2		1
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	--	25	25	--	--	--	50

Prerequisites for the Course:
Basic Electrical and Electronics Engineering , Mathematics

The course aims to:

Course Objectives	Description
1	To introduce students to the fundamentals of Programmable Logic Controllers (PLC), including architecture, hardware components, and programming interfaces
2	To develop the ability to write, simulate, and test ladder logic programs using basic instructions, timers, counters, and control structures.
3	To enable students to design and implement automation solutions for electro-pneumatic, electro-hydraulic, and robotics-based systems using PLCs
4	To provide practical exposure to SCADA systems for developing and monitoring real-time process control applications, and integrating SCADA with PLC for complete industrial automation.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Identify and demonstrate basic PLC hardware components, communication setup, and software interface for automation systems.	1, 2
CO2	Develop and test basic ladder logic programs using logical operations, timers, and counters for discrete control applications	3
CO3	Design and implement PLC programs for electro-pneumatic, electro-hydraulic, and electro-mechanical systems in automation	4, 5
CO4	Develop SCADA-based process control applications and integrate them with PLC systems for industrial automation.	3, 4

Course context, Relevance, Practical Significance:
Introduces the fundamentals of PLC and SCADA systems for industrial automation and control. Highly relevant to modern industries adopting automation, robotics, and Industry 4.0 technologies. Provides hands-on skills in designing, programming, and simulating real-time control systems.

Course Contents:

Experiment No.	Contents	Pr. Hours	Cos Mapped
1	Familiarization of PLC environment and establishing connections	2	CO1
2	Develop and test logic using PLC Ladder for; i) AND, OR and Latching operation ii) Simple ladder logic program using timers	2	CO2

	iii) Simple ladder logic program using counters		
3	PLC programming for Electro-pneumatic system	2	CO3
4	PLC programming for Electro-hydraulic system	2	CO3
5	PLC programming for robotics and electro-mechanical system	2	CO3
6	Develop process control application using SCADA	2	CO3
7	Interface SCADA with PLC for given application	2	CO3
8	Design of digital system in virtual simulation using SCADA	2	CO4

References Books

[1] J. W. Webb and R. A. Reis, *Programmable Logic Controllers: Principles and Applications*, 5th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2002. ISBN: 978-0130607188.

[2] S. K. Singh, *Industrial Instrumentation and Control*, 3rd ed. New Delhi, India: McGraw-Hill Education, 2013. ISBN: 978-1259062577.

[3] S. A. Boyer, *SCADA: Supervisory Control and Data Acquisition*, 4th ed. Research Triangle Park, NC, USA: ISA, 2010. ISBN: 978-1936007097.

[1] S. K. Singh, *Industrial Instrumentation and Control*, 3rd ed. New Delhi, India: McGraw-Hill Education, 2013. ISBN: 978-1259062577.

[2] M. D. Singh and J. G. Joshi, *PLC and SCADA Theory and Practice*, 1st ed. New Delhi, India: Laxmi Publications, 2014. ISBN: 978-8131808970.

e Resources

1] Siemens TIA Portal – *Getting Started with PLC Programming*
Available: https://new.siemens.com/global/en/products/automation/topic-areas/tia-portal.html
[2] Rockwell Automation – *RSLogix 500 and Studio 5000 Resources*
Available: https://www.rockwellautomation.com/en-us/support/documentation/software.html
[3] Automation Direct – *PLC Learning Resources and Tutorials*
Available: https://www.automationdirect.com/adc/overview/catalog/programmable-controllers/plc-training

Useful websites / Video

1] S**iemens Automation Learning Portal**
https://new.siemens.com/global/en/products/automation/topic-areas/tia-portal.html
Official resource for Siemens PLC programming and TIA Portal training.
2] **Rockwell Automation – Learning+**
https://www.rockwellautomation.com/en-us/training.html
Courses and documentation for RSLogix 500, Studio 5000, and SCADA systems.

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2	1	1	1	1					1	1	2	1
CO 2	1	1	3			1						1	2	1

CO 3	1	1	2	2	2								2	1
CO 4	1	1	3	2	2	1			1				2	1

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Mathematics

Course Code	**ROB224004**						
Course Name	**Machine Vision System Lab**						
Type of Course	DCC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	--		--		2Hrs		01
Assessment Scheme (Marks)	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
	--	25	25	--	--	--	50

Prerequisites for the Course: Python Programming, Artificial Intelligence for Robotics

The course aims to:

Course Objectives	Description
1	To introduce fundamental concepts and tools for digital image processing and computer vision using OpenCV.
2	To provide hands-on experience in image acquisition, enhancement, transformation, and segmentation techniques.
3	To develop practical skills in using machine vision for object detection, classification, and robotic vision applications.
4	To integrate machine learning and deep learning algorithms with image processing for intelligent vision systems.

On completion of the course, learner will be able to–

Course Outcomes	Description
CO1	Understand and implement basic digital image processing operations using OpenCV.
CO2	Apply machine vision techniques like geometric transformation, segmentation, and object detection in real-world scenarios.
CO3	Utilize image enhancement, compression, and edge detection algorithms for feature extraction.
CO4	Design and develop machine vision systems integrated with deep learning for robotic and industrial applications.

Course context, Relevance, Practical Significance:

The Machine Vision Lab is designed to equip students with essential practical skills in digital image processing and machine vision techniques using OpenCV. Through a series of experiments, students explore real-world applications such as object detection, camera calibration, and deep learning-based classification. These skills form the backbone for robotics, industrial automation, and AI-based visual systems.

Course Contents:

Sr. No.	Contents	Pr. Hrs.
1	Introduction to OpenCV and accessing the image elements.	2
2	Basic Image Handling and processing operations on the image	2
3	Programming for Perspective Transformation	2
4	Camera Calibration for robot vision system	2
5	Program for Image enhancement and image compression	2
6	Program for Edge Detection of a given object using image processing	2
7	Color and shape identification using machine vision	2
8	Application of deep learning algorithms for machine vision	2

Course Mapping

Practical No.	COs	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
1	CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	CO1	3	3	-	-	2	-	-	-	-	-	-	-	2	-
3	CO2	3	2	2	-	2	-	-	-	-	-	-	-	3	-
4	CO2	3	2	2	2	3	-	-	-	-	-	-	-	-	3
5	CO3	3	2	-	2	2	-	-	-	-	-	-	-	3	-
6	CO3	3	2	-	2	2	-	-	-	-	-	-	-	3	-
7	CO2, CO3	3	3	3	2	3	-	-	-	-	-	-	-	3	-
8	CO4	3	3	3	2	3	-	-	-	-	-	2	2	-	3

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairman**

Course Code	ROB224005						
Course Name	Elective 4 (A) Deep Learning						
Type of Course	DEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		0		0		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	-	-	-	20	60	100

Prerequisites for the Course: Students are expected to have a good understanding of Data Analytics and Python Programming.

The course aims to:

Course Objectives	Description
1	To understand the basics of neural networks.
2	Comparing different deep learning models.
3	To understand the Recurrent and Recursive nets in Deep Learning
4	To understand the basics of deep reinforcement Learning models.
5	To analyze Types of Networks.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understand the basics of Deep Learning and apply the tools to implement deep learning applications	2
CO2	Evaluate the performance of deep learning models (e.g., with respect to the bias-variance trade-off, overfitting and underfitting, estimation of test error).	2
CO3	To apply the technique of Convolution (CNN) and Recurrent Neural Network (RNN) for implementing Deep Learning models	2
CO4	To implement and apply deep generative models	2

Course context, Relevance, Practical Significance:

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Unit 1: Foundations of Deep learning:** What is machine learning and deep learning?, Supervised and Unsupervised Learning, bias variance tradeoff, hyper parameters, under/over fitting regularization, Limitations of machine learning, History of deep learning, Advantage and challenges of deep learning. Learning representations from data , Understanding how deep learning works in three figures, Common Architectural Principles of Deep Network, Architecture Design, Applications of Deep learning, Introduction and use of popular industry tools such as	7	1

	TensorFLow, Keras, PyTorch, Caffe, Shogun.		
2	**Unit 2 Deep Neural Networks(DNNs):** Introduction to Neural Networks :The Biological Neuron, The Perceptron, Multilayer Feed-Forward Networks , Training Neural Networks :Backpropagation and Forward propagation Activation Functions :Linear ,Sigmoid, Tannh, Hard Tanh, Softmax, Rectified Linear, Loss Functions :Loss Function Notation , Loss Functions for Regression , Loss Functions for Classification, Loss Functions for Reconstruction, Hyperparameters : Learning Rate, Regularization, Momentum, Sparsity, Deep Feedforward Networks – Example of Ex OR, Hidden Units, cost functions, error backpropagation, Gradient-Based Learning, Implementing Gradient Descent, vanishing and Exploding gradient descent, Sentiment Analysis, Deep Learning with Pytorch, Jupyter, colab.	7	2
3	**Unit 3: Convolution Neural Network(CNN):** Introduction, CNN architecture overview, The Basic Structure of a Convolutional Network- Padding, Strides, Typical Settings, the ReLU layer, Pooling, Fully Connected Layers, The Interleaving between Layers, Local Response Normalization, Training a Convolutional Network.	7	3
4	**Unit 4: Recurrent Neural Networks:** Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory. Practical Methodology: Performance Metrics, Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyper parameters.	7	3
5	**Unit 5: Deep Generative Models:** Introduction to deep generative model, Boltzmann Machine, Deep Belief Networks, Generative adversarial network (GAN), discriminator network, generator network, types of GAN, Applications of GAN networks	7	4

References Books

1. Richard S. Sutton and Andrew G. Barto, “Reinforcement Learning: An Introduction”
2.SethWeidman, “Deep Learning from Scratch: Building with Python from First Principles”O’Reily
3. Francois Duval, “Deep Learning for Beginners, Practical Guide with Python and Tensorflow”

Text Books

1. Goodfellow, I., Bengio, Y.,,Courville, A, “Deep Learning”, MIT Press, 2016.
2. Josh Patterson & Adam Gibson, “Deep Learning”
3. Charu Agarwal, “Neural Networks and deep learning”, A textbook
4. Nikhil Buduma, “Fundamentals of Deep Learning”, SPD
5. Francois chollet, “Deep Learning with Python”

e Resources

https://www.ibm.com/think/topics/deep-learning

Useful websites / Video

1. https://onlinecourses.nptel.ac.in/noc20_cs62/preview

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2	-	-	1	-	-	-	-	-	-	2	1	-
CO 2	2	2	2	-	2	-	-	-	-	-	-	1	1	-
CO 3	2	2	2	-	2	-	1	-	-	-	-	1	1	-
CO 4	1	2	1	-	2	-	1	-	-	-	-	1	1	-
CO 5	2	2	2	-	2							1	-	-

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on each Unit	10
2	LMS Test on Each Unit	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	ROB224005B						
Course Name	Humanoid Robots						
Type of Course	DEC (Department Elective Course)						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		-		-		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	-	-	-	20	60	100

Prerequisites for the Course:

1. Design of Machine elements
2. Robot Kinematics and Dynamics

The course aims to:

Course Objectives	Description
1	Understand the fundamental architecture and components of humanoid robots, including mechanical structure, sensors, actuators, and control systems.
2	Gain proficiency in programming techniques specific to humanoid robots for motion control and interaction.
3	Apply principles of kinematics and dynamics to analyse and simulate the movement of humanoid robots.
4	Explore and emulate neuro-mechanisms to enable bio-inspired control and behaviour in humanoid robots.
5	Identify opportunities and propose innovative applications of humanoid robots in various real-world domains.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Demonstrate the architecture of humanoid robot	Understand
CO2	Program the humanoid robot	Understand
CO3	Perform kinematic and dynamic analysis of humanoid robot	Understand
CO4	Emulate Neuro mechanism with humanoid robots	Understand
CO5	Create new applications of humanoid robot	Apply

Course context, Relevance, Practical Significance:

This course offers a comprehensive introduction to humanoid robots, covering their design, kinematics, dynamics, neuro-inspired control, and cooperative manipulation. It emphasizes the integration of mechanical systems with intelligent programming to emulate human-like motion and cognition. With growing relevance in healthcare, service, and industrial sectors, the course equips students with practical skills in analysis, simulation, and control of humanoid robots, enabling them to contribute to innovative real-world applications and emerging technologies.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Introduction to Humanoid Robots:** Historical development, trends in humanoid robots, design-human likeness, trade off in humanoid robot design, human friendly humanoid robot design, characteristics of humanoid robots	7	CO1
2	**Kinematics of Humanoid Robots:** Coordinate Transformations, Characteristics of Rotational Motion, Robot Data Structure and Programming, Kinematics of a Humanoid Robot: forward and inverse kinematics, Numerical Solution to Inverse Kinematics, Inverse Kinematics with Singularity Robustness	7	CO2
3	**Dynamics of Humanoid Robots:** Angular Momentum and Inertia Tensor of Rigid Body, zero moment point – measurement, 2D analysis, 3D analysis, derivation and calculation, 3D Walking Pattern Generation, ZMP Based Walking Pattern Generation, Dynamic Simulation	7	CO3
4	**Humanoid robots and neuroscience:** Humanoid Robotics Perspective to Neuroscience, Emulating the Neuro-Mechanisms with Humanoid Robots, Foveal Vision for Humanoid Robots, Humanoid Locomotion and the Brain, Cognitive Humanoid Robots	7	CO4
5	**Co-operative object manipulation and control:** Multi-fingered grasping, multi-arm object manipulation control, co-operation between multiple humanoids, leader follower type co-operative object manipulation, symmetry type co-operative object manipulation	7	CO5

References Books

1. Shuuji Kajita, Hirohisa Hirukawa, Kensuke Harada, Kazuhito Yokoi, Introduction to Humanoid Robotics, Springer, ISBN: 9783642545368
2. Gordon Cheng, Humanoid Robotics and Neuroscience: Science, Engineering and Society, CRC Press
3. Nenchev D. N., Konno a., Tsujita T, 'Humanoid robots-Modeling and Control' Butterworth Heinemann Publishing, ISBN: 9780128045602
4. S. L. Hamilton, Humanoid Robots, Abdo Publishing, ISBN: 9781532171437

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2	3	1	2	1	1	1	2	2	2	2	2	2
CO 2	3	2	3	2	3	1	1	1	2	2	2	3	2	2
CO 3	3	3	3	3	3	1	1	1	2	2	2	3	2	2
CO 4	2	2	3	2	3	2	1	2	2	2	2	3	2	2
CO 5	2	3	3	2	3	3	2	2	3	3	3	3	2	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Tests on each unit using LMS	10
2	Assignment on each unit	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	ROB224005C						
Course Name	Intelligent Manufacturing Systems						
Type of Course	DEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		--		--		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	--	--	--	20	60	100

Prerequisites for the Course:
1.Artificial Intelligence for Robotics
2.Swarm Intelligence for Robotics,
3.Flexible Manufacturing systems.

The course aims to:

Course Objectives	Description
1	Understand basic concepts of Manufacturing Systems
2	Demonstrate the applications of intelligent systems in industrial planning and decision making
3	Introduce applications of intelligent systems to optimize manufacturing processes

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom'sLevel
CO1	Explain the components of manufacturing systems	2
CO2	Demonstrate various layers of intelligent manufacturing framework	3
CO3	Apply intelligence systems for optimization of manufacturing processes	3
CO4	Analyze the strategies to solve complex decision making problems in manufacturing systems.	4

Course context, Relevance, Practical Significance:
Intelligent Manufacturing Systems (IMS) are highly relevant in the fields of robotics and automation because they form the backbone of modern, efficient, and adaptive industrial production.IMS integrates artificial intelligence (AI), machine learning, and data analytics to enable robots and automated systems to make real-time decisions, predict maintenance needs, optimize production processes dynamically etc.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Introduction to Manufacturing systems** Importance of manufacturing systems, functions and characteristics of manufacturing systems, Types of manufacturing systems: Mass customization, custom manufacturing, flexible manufacturing system, continuous manufacturing system, Intermittent manufacturing systems	7	CO1
2	**Component of Intelligent Manufacturing Technologies** Development of Intelligent systems for Design, Supporting	7	CO1, CO2

	technologies for IMS: Industry Internet of Things, Cyber Physical Systems, Cloud computing, RFID Technologies, Data Analytics, other Information and Communications Technology, Digital twin.		
3	**Layers of an Intelligent Manufacturing Framework** Perception Layer (Physical Layer), Network Layer (Communication Layer), Data Processing Layer, Intelligence Layer, Control Layer, Application Layer	7	CO2
4	**Intelligent Design of manufacturing Systems** Production planning using fuzzy cognitive maps, computer aided process planning, Methods for inventory space allocation and storage processes analysis, Optimization of production costs and methods finding of the best process plan, Methods for production equipment selection and layout, Heuristic scheduling of multiple resources, Line balancing, group technology, Fuzzy multiple attribute decision making methods	7	CO3
5	**Intelligent techniques for manufacturing process optimization** Parametric optimization of machining processes using Taguchi design of experiments, response surface methodology, principal component analysis and evolutionary optimization methods. Applications of Fuzzy Logic and Neural Networks for manufacturing process modelling and optimization.	7	CO4

References Books

1. Sunil Pathak, "Intelligent Manufacturing", Springer, 2021
2. KamalakantaMuduli, V. P. Kommula, Devendra K. Yadav, M. ChithiraiPonSelvan, JayakrishnaKandasamy (Eds.), "Intelligent Manufacturing Management Systems", Scrivener Publishing LLC, 2023
3. LejlaBanjanović-Mehmedović, FahrudinMehmedović Intelligent Manufacturing Systems Driven by Artificial Intelligence in Industry 4.0, IGI Global, 2020

Text Books

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 8th edition, PHI, 2008.
2. Hamid R. Parsaei and Mohammad Jamshidi, "Design and Implementation of Intelligent Manufacturing Systems", PHI, 2009
3. Andre Kusaic, " Intelligent Manufacturing Systems", PHI,1989

e Resources

1. https://pchats.tripod.com/int_manu.pdf

Useful websites / Video

1. https://www.youtube.com/watch?v=De8MQWbhu3k

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping

Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2	2										1	
CO 2	2	2	3		2				2	2	1		2	
CO 3	2	2	2	3	2	1	1				2	2	1	
CO 4	2	2	3	3	2	1	1		1		2	2	1	

GuidelinesforContinuousComprehensiveEvaluationofTheoryCourse		
Sr. No.	**ComponentsforContinuousComprehensiveEvaluation**	**MarksAllotted**
1	Tests on each unit using LMS (Each test for 20 M and total will be converted out of 10 M)	5
2	Timely Assignment Submission	10
3	Real life case studies to solve real life problems using evolutionary computing	5
	Total	

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	**ROB224001**						
Course Name	**Embedded System For Robotics**						
Type of Course	DCC						
Teaching Scheme and Credits Weekly Working Hrs	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
	03		--		--		03
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
	20	--	--	--	20	60	100

Prerequisites for the Course: Fundamentals of Electronics Engineering, Microprocessor & Microcontroller

The course aims to:

Course Objectives	Description
1	To introduce the fundamentals of embedded systems and their significance in robotic applications.
2	To understand the architecture and functionality of microcontrollers commonly used in robotics.
3	To develop skills in embedded C/C++ programming for real-time robotic control applications.
4	To learn about various sensors and actuators used in robotic systems and how to interface them with embedded hardware.
5	To explore communication protocols (e.g., I2C, SPI, UART, CAN) essential for data exchange between embedded components in robots.

On completion of the course, learner will be able to–

Course Outcomes	Description
CO1	Demonstrate the concept of embedded system, microcontroller, different components of microcontroller and their interactions.
CO2	Get familiarized with programming environment to develop embedded solutions.
CO3	Program ARM microcontroller to perform various tasks.
CO4	Demonstrate the key concepts of embedded systems such as I/O, timers, interrupts and interaction with peripheral devices

Course context, Relevance, Practical Significance:

The course **"Embedded Systems"** introduces students to the design and development of intelligent, autonomous, and real-time systems that form the backbone of modern electronic and robotic applications. It covers foundational concepts, including the architecture of embedded systems, programming techniques, real-time operating systems, communication protocols, and device drivers. This course bridges hardware and software concepts, empowering students to build real-world embedded solutions with an emphasis on reliability, efficiency, and performance.

Course Contents:

Unit and Chapter	Contents	Lecture Hours
1	**Fundamentals of Embedded System** Basic structure of embedded systems: Power-supply, Sensors, A-D/D-A converters, processor and ASICs and Actuators, memory. Communication Interface, Real time operating systems, Safety and reliability, environmental issues. Ethical practice. Characteristics, advantages and disadvantages of embedded systems.	7
2	**Embedded Hardware and Design** Microcontroller Unit (MCU) 48, A Popular 8-bit MCU, Memory for Embedded Systems, Low Power Design, Pullup and Pulldown Resistors, Introduction to ARM-v7-M (Cortex-M3), ARM-v7-R (CortexR4) and comparison in between them. Embedded Product development life cycle, Program modeling concepts: DFG, FSM, Petri-net, UML 2	7
3	**Embedded system programming** Embedded C-programming concepts, Constants, Variables & Data Types, Operators, Functions, and Software's, interfacing of LED, LCD, motors, and switches. Serial Communication Programming: Introduction to Serial Communication, Types of Serial Communication, and Description of SFR associated with Serial Communication, Programming of UART, Interfacing of ADC, sensor interfacing, embedded networking	7
4	**Embedded Serial Communication** Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, 10 CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network	7
5	**Real Time Based Operating System(RTOS) & Linux Fundamentals & Device Driver Programming** POSIX Compliance , Need of RTOS in Embedded system software, Foreground/Background systems, multitasking, context switching, IPC, Scheduler policies, Architecture of kernel, task scheduler, ISR, Semaphores, mailbox, message queues, pipes, events, timers, memory management, RTOS services in contrast with traditional OS. Linux Fundamentals, Linux Commands, VI Editors, Introduction to Device Driver, The Role of Device Driver, Kernel Module Vs Application, Types of Device Driver, Character Driver, Block Driver & network Driver.	7

Course Mapping

Unit and Chapter	Bloom's Taxonomy Level	CO Mapped	PO Mapped	PSO Mapped
1	Understand, Apply	1,4	PO1, PO2, PO7, PO8	1,2
2	Understand, Analyze	1,2	PO1, PO2, PO3, PO5, PO12	1,2
3	Apply, Analyze	2,3	PO1, PO2, PO3, PO4, PO5, PO10, PO12	1,2
4	Understand, Evaluate	3,4	PO1, PO2, PO4, PO5, PO6	1,2
5	Analyse, Create	4	PO1, PO3, PO4, PO5, PO8, PO12	1,2

References Books

1. 1.K. V. Shibu, Introduction to Embedded Systems, TMH, ISBN: 978-9339219680
2. F. Vahid, Embedded System Design – A unified hardware and software introduction, John Wiley, ISBN: 978-0-471 38678-0

Text Books

1. 3. Rajkamal, Embedded Systems, TMH.
2. 4. L. B. Das, EMBEDDED SYSTEMS and Integrated approach, Pearson, ISBN: 978-81-317-8766-
3. 5. M. Mazidi, Pic Microcontroller and Embedded System

e Resources

Course Name	Instructor / Institute	Link
Embedded Systems Design	Prof. Santanu Chattopadhyay (IIT Kharagpur)	https://nptel.ac.in/courses/108/105/108105102
Embedded Systems	Prof. Dhananjay V. Gadre (NSUT Delhi)	https://nptel.ac.in/courses/117/102/117102095
Real-Time Systems	Prof. Rajib Mall (IIT Kharagpur)	https://nptel.ac.in/courses/106/105/106105156/

Useful websites / Video

Channel Name	Useful For	Link
Paul McWhorter	Arduino-based programming, sensor interfacing, real-time projects	Paul McWhorter Teaches Technology
FreeRTOS Tutorials by Dave Jones (EEVBlog)	RTOS concepts, multitasking, and embedded C	- YouTubeSimulator Software - Proteus
The Linux Foundation	Linux device drivers, kernel basics	YouTube
GreatScott!	Embedded design, SPI, I2C, UART, ADC interfacing	GreatScott! - YouTube

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• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low, 2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2	2	1	2	1	1	1	1	1	1	2	3	2
CO 2	3	3	3	2	3	1	1	1	2	2	2	3	3	3
CO 3	3	3	3	2	3	1	1	1	2	2	2	3	3	3
CO 4	3	3	3	2	3	1	1	1	2	2	2	3	3	3

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for CCE	Marks Allotted
1	Tests on each unit using LMS	10
2	Timely Assignment Submission	10
	Total	20

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairman**

Course Code	ROB224006						
Course Name	Elective 5 (A) Natural Language Processing						
Type of Course	DEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	2		-		-		2
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	-	-	-	-	20	30	50

Prerequisites for the Course: students are expected to have a good understanding of Data Analytics

The course aims to:

Course Objectives	Description
1	To be familiar with fundamental concepts and techniques of natural language processing (NLP)
2	To acquire the knowledge of various morphological, syntactic, and semantic NLP tasks
3	To develop the various language modeling techniques for NLP
4	To use appropriate tools and techniques for processing natural languages
5	To comprehend the advance real world applications in NLP domain

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Describe the fundamental concepts of NLP, challenges and issues in NLP	2
CO2	Describe the concepts of morphology, syntax, semantics of natural language	2
CO3	Illustrate various language modelling techniques	2
CO4	Integrate the NLP techniques for the information retrieval task	2
CO5	Demonstrate the use of NLP tools and techniques for text-based processing of natural languages	2

Course context, Relevance, Practical Significance: This course introduces core concepts and techniques of Natural Language Processing (NLP), covering text processing, syntax, semantics, language modeling, and real-world applications. With hands-on use of tools like NLTK and spaCy, it equips students to process and analyze human language, making it highly relevant for AI, search engines, chatbots, and other language-based technologies.

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Unit 1: Introduction to Natural Language Processing** **Introduction:** Natural Language Processing, Why NLP is hard? Programming languages Vs Natural Languages, Are	7	1

	natural languages regular? Finite automata for NLP, Stages of NLP, Challenges and Issues(Open Problems) in NLP **Basics of text processing:** Tokenization, Stemming, Lemmatization, Part of Speech Tagging		
2	**Unit 2: Language Syntax and Semantics:** **Morphological Analysis:**What is Morphology? Types of Morphemes, Inflectional morphology &Derivational morphology, Morphological parsing with Finite State Transducers (FST) **Syntactic Analysis:** Syntactic Representations of Natural Language, Parsing Algorithms, Probabilistic context-free grammars, and Statistical parsing **Semantic Analysis:** Lexical Semantic, Relations among lexemes & their senses – Homonymy,Polysemy, Synonymy, Hyponymy, WordNet, Word Sense Disambiguation (WSD), Dictionary based approach, Latent Semantic Analysis	7	2
3	**Unit III : Language Modelling:** Probabilistic language modeling, Markov models, Generative models of language, Log-Liner Models, Graph-based Models **N-gram models:** Simple n-gram models, Estimation parameters and smoothing, Evaluating language models, Word Embeddings/ Vector Semantics: Bag-of-words, TFIDF, word2vec, doc2vec, Contextualized representations (BERT) **Topic Modelling**: Latent Dirichlet Allocation (LDA), Latent Semantic Analysis, Non Negative Matrix Factorization	7	3
4	**Unit IV : Information Retrieval using NLP:** **Information Retrieval:** Introduction, Vector Space Model **Named Entity Recognition:** NER System Building Process, Evaluating NER System Entity Extraction, Relation Extraction, Reference Resolution, Coreference resolution, Cross Lingual Information Retrieva	7	4
5	**Unit V : NLP Tools and Techniques:** **Prominent NLP Libraries:** Natural Language Tool Kit (NLTK), spaCy, TextBlob, Gensim etc. **Linguistic Resources:** Lexical Knowledge Networks, WordNets, Indian Language WordNet (IndoWordnet), VerbNets, PropBank, Treebanks, Universal Dependency	7	5

	Treebanks Word Sense Disambiguation: Lesk Algorithm Walker's algorithm, WordNets for Word Sense Disambiguation		

References Books

1. Steven Bird, Ewan Klein, Edward Loper, "Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit", O'Reilly Publication
2. Dipanjan Sarkar , "Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data", Apress Publication ISBN: 9781484223871
3. Alexander Clark, Chris Fox, and Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", Wiley Blackwell Publications
4. Jacob Eisenstein, "Natural Language Processing", MIT Press
5. Jacob Eisenstein, "An Introduction to Information Retrieval", Cambridge University Press

Text Books

1. Jurafsky, David, and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing", Computational Linguistics and Speech Recognition‖, ,PEARSON Publication .
2. Manning, Christopher D., and nrich Schütze , "Foundations of Statistical Natural Language Processing", Cambridge, MA: MIT Press

e Resources

1. https://onlinecourses.nptel.ac.in/noc23_cs45/preview

Useful websites / Video

1. https://www.ibm.com/think/topics/natural-language-processing

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2	1	-	-	-	-	-	-	-	-	-	1	-
CO 2	2	2	2	2	2	-	-	-	-	-	-	1	1	-
CO 3	2	2	2	2	2	-	-	-	-	-	-	2	1	-
CO 4	2	2	2	2	2	-	2	2	-	-	-	3	1	-
CO 5	2	2	2	2	2							3	-	-

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	**ROB224006**						
Course Name	**Industry 4.0**						
Type of Course	DEC						
Teaching Scheme and Credits Weekly Working Hrs	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
	02		--		--		02
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total
	--	--	--	--	20	30	50

Prerequisites for the Course: Manufacturing Technology

The course aims to:

Course Objectives	Description
1	Understand the core concepts, technologies, and enablers of Industry 4.0.
2	Explore the role of IoT, cyber-physical systems, cloud computing, and data analytics in smart manufacturing.
3	Analyse how Industry 4.0 transforms conventional production systems into smart factories.
4	Familiarize with the standards, protocols, challenges, and applications of Industry 4.0 in the robotics and automation domain.

On completion of the course, learner will be able to–

Course Outcomes	Description
CO1	Explain the fundamental concepts, history, and scope of Industry 4.0
CO2	Illustrate the application of IoT, CPS, and smart sensors in manufacturing.
CO3	Analyse the role of big data, AI, cloud, and digital twin technologies in industrial automation.
CO4	Examine case studies and applications of Industry 4.0 in robotic and automation systems.

Course context, Relevance, Practical Significance:

The **Industry 4.0 course** provides an interdisciplinary foundation on the fourth industrial revolution driven by **digital transformation**, **cyber-physical systems**, **artificial intelligence**, **big data**, and **smart manufacturing**. It aims to equip students with knowledge of intelligent systems, interconnected devices, and data-driven decision-making, which are central to modern industrial environments.

Course Contents:

Unit and Chapter	Contents	Lecture Hours
1	**Introduction to Industry 4.0** Evolution of Industry: Industry 1.0 to Industry 4.0,Key technologies of Industry 4.0,Smart Factory and Smart Manufacturing, Need for Industry 4.0,Pillars of Industry 4.0.	5
2	**Cyber-Physical Systems and IoT in Industry 4.0** Concepts of CPS,Architecture and Components of CPS,Industrial Internet of Things (IIoT),Communication protocols (MQTT, OPC UA),Role of smart sensors and actuators.	5
3	**Big Data Analytics and Cloud Computing** Introduction to Industrial Big Data, Data acquisition and storage, Cloud platforms and computing models, Edge vs. Cloud Computing, Real-time analytics in manufacturing.	6
4	**Artificial Intelligence, Digital Twin, and Simulation** Machine learning and AI in manufacturing, Digital Twin: Architecture and applications, Simulation for virtual commissioning, Predictive maintenance and anomaly detection	6
5	**Introduction to Industry 5.0** Introduction**,** Key Features of Industry 5.0, Enabling Technologies, Applications, Case Studies, Challenges and Ethical Considerations.	6

Course Mapping

Unit and Chapter	Bloom's Taxonomy Level	CO Mapped	PO Mapped	PSO Mapped
1	Remember, Understand	CO1	PO1, PO6, PO12	PSO1
2	Understand ,Apply	CO2	PO1, PO2, PO3, PO5	PSO1, PSO2
3	Understand ,Apply	CO3	PO1, PO2, PO4, PO5	PSO2
4	Understand ,Apply	CO4	PO1, PO2, PO3, PO5, PO12	PSO1, PSO2
5	Understand ,Apply	CO5	PO6, PO7, PO8, PO11, PO12	PSO1, PSO2

References Books

1. **Alasdair Gilchrist**, *Industry 4.0: The Industrial Internet of Things*, Apress, 2016. ISBN: **9781484220467**
2. **Klaus Schwab**, *The Fourth Industrial Revolution*, World Economic Forum, 2017. ISBN: **9780241300756**

Text Books

1. **Olivier Hersent**, *The Internet of Things: Key Applications and Protocols*, Wiley, 2nd Edition, 2012.
   ISBN: **9781119966709**
2. **Ulrike Stopper**, *Industry 4.0: Managing the Digital Transformation*, Springer, 2017.
   ISBN: **9783319564234**
3. **Jay Lee et al.**, *Smart Manufacturing: Theoretical and Practical Examples*, Springer, 2020.
   ISBN: **9783030173130**

e Resources

2. https://nptel.ac.in/courses/106/105/106105195/
3. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-842-fundamentals-of-systems-engineering-fall-2015/
4. https://new.siemens.com/global/en/company/topic-areas/digital-twin.html

Useful websites / Video

2. https://www.youtube.com/watch?v=kpK0wJ6ccQU
3. https://www.youtube.com/watch?v=AEXzjzE99z8
4. https://www.youtube.com/watch?v=9CO6M2HsoIA
5. https://www.youtube.com/watch?v=Rp4g0a9Ev1o
6. https://www.youtube.com/watch?v=yGD7XQlwKJc

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	1	-	-	2	-	-	-	-	2	-	-	2	-
CO 2	3	3	2	1	3	-	-	-	2	2	-	1	3	3
CO 3	3	3	3	3	3	-	2	-	2	2	2	3	3	3
CO 4	3	3	3	3	3	2	2	2	2	3	3	3	3	3

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairman**

Course Code	ROB224006						
Course Name	Modelling & Simulation						
Type of Course	DEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	2 hrs/week		---		---		2
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	---	---	---	---	20	30	50

Prerequisites for the Course:

1. Applied Mathematics (ODEs, Laplace Transforms, Probability),
2. Engineering Physics, Programming Concepts
3. Mechatronics and Control Systems.

The course aims to:

Course Objectives	Description
1	To introduce students to the fundamental principles of modeling physical systems.
2	To develop understanding of various simulation techniques for dynamic systems.
3	To apply mathematical models for analysis and prediction of system behavior.
4	To explore simulation tools used in robotics and automation systems.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Describe the principles and types of modeling and simulation of Physical systems.	2 –Understand
CO2	Develop mathematical models of mechanical, electrical, thermal, and fluid systems.	3 – Apply
CO3	Implement dynamic simulations of control systems using tools such as MATLAB/Simulink	3 – Apply
CO4	Analyze and evaluate simulation results for robotic and automation systems	4 – Analyse

Course Contents:

Unit	Contents	Lecture Hours	Cos Mapped
1	**Introduction to Modelling and Simulation:** Definition and scope of modeling and simulation; types of models – physical, mathematical, static, dynamic, deterministic, stochastic, discrete, and continuous; role of simulation in design and control; steps involved in modeling; simulation life cycle; overview of simulation tools and their applications in engineering.	**(7hrs)**	**CO1**

2	**Modelling of Physical Systems:** Mathematical modelling of mechanical, electrical, thermal, and fluid systems; representation of translational and rotational dynamics; analogies between physical domains and conversion techniques useful for unified modelling.	**(7hrs)**	**CO2**
3	**Dynamic System Modelling using State-Space and Transfer Functions:** Transfer function and state-space representations of dynamic systems; block diagram algebra and signal flow graphs; linearization of nonlinear systems; time-domain response and stability analysis; application of Laplace transforms in system analysis.	**(7hrs)**	**CO2**
4	**Simulation of Dynamic Systems:** Simulation of dynamic systems using MATLAB and Simulink; modeling of mechanical and electrical subsystems; simulation of robotic arms, control loops, and joint behavior; introduction to offline and real-time simulation with comparison of features and use-cases.	**(7hrs)**	**CO3**
5	**Simulation Software and Applications in Robotics** Simulation environments such as Simulink, Simscape, Gazebo, and RobotStudio; implementation of offline simulation for industrial robots; case studies including mobile robot navigation, manipulator path planning, and automated system performance analysis; model verification and validation techniques.	**(7hrs)**	**CO3**

References Books

1. Katsuhiko Ogata, *System Dynamics*, Pearson Education.
2. William J. Palm III, *System Dynamics*, McGraw-Hill.

Text Books

1. W. Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, Pearson.
2. Robert L. Norton, *Design of Machinery*, McGraw-Hill.
3. Nise, Norman S., *Control Systems Engineering*, Wiley.

e Resources

1. NPTEL – Modelling and Simulation of Dynamic Systems

Useful websites / Video

1. https://www.geeksforgeeks.org/introduction-to-modeling-and-simulation/
2. https://www.tutorialspoint.com/discrete_event_simulation/index.htm

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	--NA--	---
2	--NA--	---
	Total	**---**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	ROB224006D						
Course Name	Hybrid Vehicle						
Type of Course	DEC						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	02		--		--		02
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	--	--	--	--	20	30	50

Prerequisites for the Course:
1. Mathematics, Physics, Chemistry
2. Systems in Mechanical Engineering, Basic Electrical Engineering
3. Electrical and Electronics Engineering, Computer Aided Engineering

The course aims to:

Course Objectives	Description
1	Introduce the concepts of electric vehicle and allied technologies.
2	Learn the concept and types of hybrid electric vehicle.
3	Identify and Judge application specific selection of Prime Movers, Energy Storage and Controllers required for e-vehicles.
4	Recognize the e-Vehicle Configurations and Understand the Mechanics of vehicle movement.
5	Design and Select the body frame with relevant suspension system and testing of e-Vehicle as per Regulation/Licensing/Approval Organizations.
6	Understand the Battery Charging techniques and management.

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understand the basics related to Hybrid Vehicle.	2-Understand
CO2	Classify the different hybrid vehicles.	3-Apply
CO3	Identify and evaluate the prime movers, energy storage and controllers.	3-Apply
CO4	Discover and categorize the electric vehicle configuration with respect to propulsion, power distribution and drive-train topologies.	4-Analyze
CO5	classify and evaluate battery charging techniques and management.	4-Analyze

Course context, Relevance, Practical Significance:
The Hybrid Vehicle course focuses on the design, operation, and integration of hybrid powertrains, which combine internal combustion engines (ICEs) with electric motors to improve fuel efficiency and reduce emissions. The course is highly relevant today due to the global shift toward sustainable transportation and efforts to combat climate change. Understanding hybrid systems enables engineers to: Design more efficient vehicles, Optimize

energy management and battery usage.

Course Contents:

Unit	Contents	Lecture Hours	COs Mapped
1	**Introduction to Electric and Hybrid Vehicle:** History and evolution of Electric Vehicles, Comparison of Electric with Internal Combustion Engine Vehicles, Limitations of IC Engine Vehicles (ICEV), Exhaust Emission and Global warming, Environmental importance of Hybrid and Electric Vehicles, Overview of EV Challenges, Classification, Overview of EV Technologies, Advantages and Disadvantages	08	CO1
2	**Hybrid Electric Vehicle:** Classification of HEV: Architecture, Construction, Working, Advantages and Limitations of Conventional and Gridable HEV, Classification of Conventional HEV, Types of Gridable HEV, Tractive force, Power and Energy requirements for standard drive cycles of HEV Hybrid Electric Drive-Trains: Basic concept of Hybrid Traction, introduction to various hybrid Drive-Train Topologies	07	CO2
3	**Prime Movers, Energy Storage:** Brief introduction to Motors: Classification, Construction, Working, Control, Design criteria, Application and Design Examples, Selection of Motor, Structural Configuration of Motor Layout Brief introduction to Energy Storage Systems: Classification - Types and Packs, Construction, Working, Comparison and Selection, Principle of Operation, Units of Battery/Fuel Cell Energy Storage, Battery Performance Parameters Estimation, Battery/Cell Modeling	07	CO3
4	**Controllers:** Configuration based on power electronics, Torque/Speed Coupling, Speed and Torque Controllers, BCU, MCU, Speed Control for Constant Torque/Power Operation of all electric motors, Control Method	07	CO4
5	**EV Charging Infrastructure Management:** Battery Charging: Basic Requirements for Charging System, Charging Methods and Standards, Converters, Charger Architectures, Grid Voltages, Frequencies and Wiring, Charger Functions, Real Power, Apparent Power, and Power Factor, Boost Converter for Power Factor Correction, Examples, Vehicle to Grid operation of EV's Battery Management Systems: Necessity of Battery Management Systems, Typical Structure of BMSs, Representative Products, Key points of BMSs in Future Generation, Hazard/Safety Management	08	CO5

	Safety Guidelines for EV: Charging Safety, Battery Safety, Emergency Response, Maintenance Safety, Driving in Wet Conditions		

References Books

1. Mehrdad Ehsani, Yimi Gao, Sefano Longo, Kambiz Ebrahimi, (2019), "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design," CRC Press, ISBN: 9780367137465
2. Tariq Muneer, Mohan Kolhe, Aisling Doyle, (2017), "Electric Vehicles: Prospects and Challenges", ISBN: 9780128030219
3. Sandeep Dhameja, (2001), "Electric Vehicle Battery Systems", Newnes, ISBN: 9780750699167
4. Bruno Scrosati, Jürgen Garche, Werner Tillmetz, (2015), "Advances in Battery Technologies for Electric Vehicles," Woodhead Publishing, ISBN: 9781782423775
5. Shunli Wang, Carlos Fernandez, Yu Chunmei, Yongcun Fan, Cao Wen, Daniel-Ioan Stroe, Zonghai Chen, (2021), "Battery System Modeling," Elsevier, ISBN: 9780323904728
6. Andrea, Davide, (2010), "Battery management systems for large lithium battery packs," Artech House Publishers, ISBN: 9781608071043

Text Books

1. Iqbal Hussein, (2021), "Electric and Hybrid Vehicles: Design Fundamentals," CRC Press, ISBN: 9780367693930
2. Denton, Tom, (2020), "Electric and Hybrid Vehicles," 2nd Ed., Routledge, ISBN:9780367273248
3. John Lowry, James Larminie, (2012), "Electric Vehicle Technology Explained," Wiley, ISBN: 9781119942733
4. Knowles, Don, (2011), "Automotive Suspension & Steering Systems," Cengage learning, ISBN: 9781435481152
5. Malen, Donald E., (2011), "Fundamentals of Automobile Body Structure Design," SAE International, ISBN: 9780768021691
6. R. Krishnan, (2001), "Electric Motor Drives: Modeling, Analysis, and Control," Pearson, ISBN: 9780130910141
7. Mohammad Saad Alam, Reji Kumar Pillai, N. Murugesan, (2021), "Developing Charging Infrastructure and Technologies for Electric Vehicles," IGI Global/ Business Science Reference, ISBN: 9781799868583

e Resources

1. https://archive.nptel.ac.in/courses/108/103/108103009/

Useful websites / Video

1. https://www.youtube.com/watch?v=403xVzVHgEQ&t=1244s
2. https://www.youtube.com/watch?v=bHrWjMVOpag&t=134s

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1														
CO 2														
CO 3														
CO 4														
CO 5														

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	--NA--	--
2	--NA--	--
	Total	**--**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	ROB224007						
Course Name	Innovation, Entrepreneurship & IPR						
Type of Course	ASM (Additional Specialized / MOOCs)						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	3		-		-		3
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	20	-	-	-	20	60	100

Prerequisites for the Course:
No pre-requisite

The course aims to:

Course Objectives	Description
1	Identify and evaluate innovative ideas.
2	Develop prototypes and test their feasibility.
3	Understand the different types of innovation and their potential impact
4	Develop entrepreneurial skills and mindset

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Understand the different types of innovation and their potential impact.	Understand
CO2	Protect their intellectual property.	Understand
CO3	Think creatively and come up with innovative ideas.	Apply
CO4	Develop prototypes and test their feasibility.	Apply
CO5	Apply entrepreneurial principles to solve real-world problems.	Apply

Course context, Relevance, Practical Significance:
This course prepares students to become innovative entrepreneurs capable of navigating uncertainty, solving complex problems, and creating sustainable value. It covers a wide range of topics including idea generation, prototyping, technological and non-technological innovation, entrepreneurship, social innovation, intellectual property rights, commercialization, and startup development. By exploring the innovation ecosystem, pre-incubation and incubation stages, and various entrepreneurial opportunities, students gain the knowledge, skills, and mindset needed to launch impactful ventures and drive positive change in society.

Course Contents:

Unit	Contents	Lecture Hours	COs Mapped
1	**Introduction to Innovation and Entrepreneurship:** Defining innovation, Types of innovation: incremental, radical, disruptive, The innovation process, Factors that drive innovation, Defining entrepreneurship, The entrepreneurial process, Characteristics of successful entrepreneurs, Brainstorming, Design thinking process.	7	CO1

2	**Idea Generation and Prototyping:** Techniques for brainstorming and generating ideas - Criteria for evaluating innovative ideas, Market research and feasibility analysis, Identifying potential customers and partners. Developing and Testing Prototypes - The purpose and importance of prototyping, Different prototyping methods and tools, Creating low-fidelity and high-fidelity prototypes, User testing and feedback collection, Iterating and refining prototypes based on feedback.	7	CO3, CO4
3	**Entering into market and Understanding the process:** Attaining Market-Product Fit: Prototype Designing Process and Tools for Development of Minimum Viable Product (MVP), Application of Design Thinking Tools and Approach for Right Problem Identification and Solution Development. Understanding Technology Readiness Level (TRL), Manufacturing Readiness Level (MRL) and Investment Readiness Level (IRL) Stages & Implications in Innovation Development, Innovation Management Process, Types of IPR, Patents, patent requirements, what is not patentable, general procedure for filing patents in India, KAPILA scheme.	7	CO2, CO3
4	**Business plans and execution:** Business Plan Development: Components and Stages in Business Plan Development, Validation of Business Opportunity: Application of Market Research Tools at the Early Stage of Startup. Generation and Management of IP at the Early Stage of Innovation and Startup Development, Legal Structures and Ethical Steps in Establishing Startups. Social Entrepreneurship, Blue Ocean Strategy-I, Blue Ocean Strategy-II	7	CO2, CO3
5	**Start-up and its working:** Start-ups, Definition, requirements, company act, opportunities and schemes, benefits of start-up formation, start-up registration process., funding opportunities, incubators and accelerators- roles, responsibilities and partnership, infrastructure. Funding, government schemes, Investments – need, sources, VC, angel investments. Start-up life cycle., documentation and recording., NISP and its features.	7	CO5

References Books

1. Innovation and Entrepreneurship, Peter F. Drucker, Harper Business; Reprint, 2006, ISBN: 9780060851132.
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Crown Currency; Illustrated, 2011. ISBN: 9780307887894.

3. Innovator's DNA, Updated, with a New Preface: Mastering the Five Skills of Disruptive Innovators, Harvard Business Review Press; Revised, 2019. ISBN: 1633697207.
4. Wiley Innovation Black Book Enterprise 4.0, 2020.
5. Problem-Solving", Penguin Random House India Pvt. Ltd. 2020, ISBN: 9780670094097
6. HBS series on Innovation and Entrepreneurship.

Text Books

1. 8 Steps To Innovation: Going From Jugaad To Excellence, Collins India, 2013. ISBN: 9789350293584
2. Pavan Soni, "Design Your Thinking - The Mindsets, Toolsets and Skill Sets For Creative Problem Solving", Penguin Random House India Pvt. Ltd. 2020, ISBN: 9780670094097..

e Resources

1. Innovation, Business Models and Entrepreneurship, By Prof . Rajat Agrawal and Prof. Vinay Sharma | IIT Roorkee nptel.ac.in/courses/110107094
2. Design Thinking - A Primer, By Prof. Ashwin Mahalingam & Prof. Bala Ramadurai | IIT Madras, nptel.ac.in/courses/110106124
3. Innovation and Start-up Policy By Prof. Rahul K. Mishra | IILM Institute for Higher Education https://onlinecourses.swayam2.ac.in/imb20_mg22/preview
4. Introduction to Intellectual Property By KAPILA IPR committee | IIT Kharagpur, https://onlinecourses.swayam2.ac.in/aic21_ge20/preview

Useful websites / Video

1. https://www.startupindia.gov.in/
2. https://kapila.mic.gov.in

Strength of CO - PO/PSO Mapping (Sample): Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped
• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1-Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	2	2	1	1	1	2	2	1	1	1	2	2	2	2
CO 2	2	1	1	1	1	3	1	3	1	1	2	2	2	2
CO 3	2	2	3	2	2	2	2	2	2	2	2	3	2	2
CO 4	2	3	3	3	3	2	1	2	2	2	3	2	2	2
CO 5	2	3	3	2	2	3	2	2	3	3	3	3	2	2

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Test on each unit using LMS	10
2	Assignment on each unit	10
	Total	**20**

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**

Course Code	**ROB224008**						
Course Name	**Supply Chain Management**						
Type of Course	LHSM						
Teaching Scheme and Credits Weekly Working Hrs	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
	02		--		--		02
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
	50	--	--	--	--	--	50

Prerequisites for the Course: Manufacturing Technology

The course aims to:

Course Objectives	Description
1	Understand the fundamental concepts and strategies of supply chain management.
2	Learn how SCM integrates with manufacturing, automation, and robotics in industries.
3	Analyse the role of logistics, inventory, and information systems in supply chains.
4	Gain insights into modern technologies like IoT, AI, and automation in SCM.
5	Understand optimization and risk management within supply chains.

On completion of the course, learner will be able to–

Course Outcomes	Description
CO1	Explain the structure and components of a supply chain.
CO2	Analyze supply chain strategies and performance metrics.
CO3	Apply forecasting, inventory, and logistics planning in SCM.
CO4	Evaluate the role of IT, AI, and automation in modern supply chains.
CO5	Assess supply chain risks and propose mitigation strategies.

Course context, Relevance, Practical Significance:

This course introduces students to the fundamental and advanced concepts of supply chain management with a strong focus on how automation, robotics, and emerging technologies are transforming supply chains globally. It covers design, forecasting, logistics, inventory, digital technologies, and sustainability — all tailored to the applications and needs of robotics and automation engineers.

Course Contents:

Unit and Chapter	Contents	Lecture Hours
1	**Introduction to Supply Chain Management** Definition and Importance of SCM, Supply Chain Drivers and Metrics, Process View of Supply Chains, Decision Phases in Supply Chains, Strategic Fit and Scope, SCM in the context of Robotics and Automation	5
2	**Supply Chain Network Design** Network Design in the Supply Chain, Facility Location and Capacity Planning, Role of Robotics in Warehouse Automation, Global Supply Chain Networks, and Case Studies: Amazon Robotics, Flipkart Warehouse Automation.	5
3	**Demand Forecasting and Inventory Management** Forecasting Methods (Qualitative and Quantitative), Role of Forecasting in Supply Chain, Inventory Management Techniques (EOQ, JIT, Safety Stock), Push vs Pull Strategies, Vendor-Managed Inventory (VMI)	6
4	**Logistics, Transportation, and Warehousing** Modes of Transportation and Optimization, Distribution Network Design, Role of AGVs and Drones in Logistics, Cross-Docking and Last-Mile Delivery, Packaging and Material Handling Automation	6
5	**Digital Supply Chain and Risk Management** Role of IoT, AI, and Blockchain in SCM, Supply Chain Visibility and Analytics, ERP and SCM Software (SAP, Oracle SCM Cloud), Risk Identification and Mitigation Strategies, Sustainable and Green Supply Chains.	6

Course Mapping

Unit and Chapter	Bloom's Taxonomy Level	CO Mapped	PO Mapped	PSO Mapped
1	Understand, Apply	CO1	PO1, PO2, PO10	PSO1, PSO2
2	Analyse, Apply	CO1,CO2	PO2, PO3, PO5	PSO1, PSO2
3	Apply, analyse	CO2,CO3	PO4, PO5, PO11	PSO1, PSO2
4	Apply, Evaluate	CO3,CO4	PO3, PO5, PO9, PO12	PSO1, PSO2
5	Evaluate, Create	CO4,CO5	PO6, PO7, PO12	PSO1, PSO2

References Books

- **"Supply Chain Management: Strategy, Planning, and Operation"** – Sunil Chopra ISBN: 9780134731889

Text Books

1. **"Logistics and Supply Chain Management"** – Martin Christopher ISBN: 9781292083797
2. **"Designing and Managing the Supply Chain"** – David Simchi-Levi ISBN: 9780073341521

e Resources

1. https://www.youtube.com/playlist?list=PLUl4u3cNGP63EdVPNLG3ToM6LaEUuStEY
2. https://www.youtube.com/watch?v=77rgtVhHT50
3. https://www.youtube.com/watch?v=elK8bspXK4o

Useful websites / Video

1) https://www.youtube.com/watch?v=Rh1EC7FfD4E
2) https://www.youtube.com/watch?v=dLIabZc0O4c

Strength of CO - PO/PSO Mapping (Sample):

Attainment of a PO/PSO depends both on the attainment levels of associated COs of courses and the strengths to which it is mapped

• Each Course Outcome addresses a sub-set of POs and PSOs to varying levels (strengths: 1- Low,2 – Medium, 3 - Strong).

Strength of CO-PO/PSO Mapping														
Strength of COs	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	-	-	-	-	-	-	-	-	-	2	2	2	2
CO 2	3	3	-	2	-	-	-	-	-	-	2	2	2	2
CO 3	3	2	3	-	2	-	-	-	-	-	3	2	3	3
CO 4	3	2	3	2	3	-	-	-	-	-	3	3	3	3
CO5	3	2	3	2	2	2	2	-	-	2	3	3	3	3

Guidelines for Continuous Comprehensive Evaluation of Theory Course

Sr. No.	Components for CCE	Marks Allotted
1	Tests on each unit using LMS	20
2	Timely Assignment Submission	30
	Total	20

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairman**

Course Code	ROB224009						
Course Name	Project Stage						
Type of Course	PSI						
Teaching Scheme and Credits	TH(Hrs.)		TU(Hrs.)		PR(Hrs.)		Total Credits
Weekly Working Hrs	-		-		8		4
Assessment Scheme	CCE	TW	PR	OR	ISE	ESE	Total (Marks)
(Marks)	-	100	50	-	-	-	150

Pre-requisite:

1. Students are required to undergo 3 to 4 weeks industrial training / implant training /in-house project based learning/project related skill development course/ industrial survey report before Commencement of first semester of Final year.
2. Submit detailed report of 10-15 pages of the same.
3. Project registration will be based on completion of above activities.

The course aims to:

Course Objectives	Description
1	To Apply the knowledge for solving realistic problem
2	To develop problem solving ability
3	To Organize, sustain and report on a substantial piece of team work over a period of several months
4	To Evaluate alternative approaches, and justify the use of selected tools and methods
5	To Reflect upon the experience gained and lessons learned
6	To Consider relevant social, ethical and legal issues
7	To find information for yourself from appropriate sources such as manuals, books, research journals and from other sources, and in turn increase analytical skills.
8	To Work in Team and learn professionalism

On completion of the course, learner will be able to–

Course Outcomes	Description	Bloom's Level
CO1	Solve real life problems by applying knowledge.	
CO2	Analyze alternative approaches, apply and use most appropriate one for feasible solution.	
CO3	Write precise reports and technical documents in a nutshell.	
CO4	Participate effectively in multi-disciplinary and heterogeneous teams exhibiting team work	
CO5	Inter-personal relationships, conflict management and leadership quality.	

The student shall take up a suitable project, the scope of the project shall be such as to complete it within the time schedule, and the term work shall consist of:

Fabrication of models, machines, prototypes based on new ideas, robots and machine based on hi-tech systems and automation, experimental set-up, fabrication of testing equipment, renovation of machines, etc. Students shall submit the project phase –II plan. Above work shall be taken up individually or in groups. The group shall not be more than 4 students, (If project work is more than group members may be increased by permission of guide)

OR

Extensive analysis of some problems done with the help of a computer individually or in a group not exceeding two students.
A detailed report on the work done shall include project specification, design procedure, drawings, process sheets, assembly procedure and test results etc. Project may be of the following types:

(i) Manufacturing / Fabrication of a prototype machine' including selection, concept, design, material, manufacturing the components, assembly of components, testing and performance evaluation
(ii) Improvement of existing machine / equipment / process.
(iii) Design and fabrication of robots for specialized applications,
(iv) Computer aided design, analysis of components such as stress analysis.
(v) Problems related to Automated Storage and retrieval system
(vi) Design of a test rig for performance evaluation of machine devices.
(vii) Design and development. of non-standard robots
(viii) Analysis, evaluation and experimental verification of any engineering problem
(ix) Design and development of service robots
(x) Hardware system development to ingrate robotics operations
(xi) Low cost automation, Computer Aided Automation in Manufacturing.
(xii) Development of prototypes for new concepts in robotics such as biological robots, swarm robotics, drones, humanoids
(xiii) Development of artificial intelligence systems for humanoids and robots
OR
Computer based design / analysis or modelling / simulation of robot(s), mechanism(s) or system (s) and its validation or comparison with available benchmarks / results. When a group of students is doing a project, names of all the students shall be included on every certified report copy. Two copies of project Report shall be submitted to the college. The students shall present and submit their Project Phase-I report to the internal and external examiner from college/Industry.

Name and Sign of Academic Coordinator **Name and Sign of BoS Chairperson**