| Course Code | Course Name | Credits |
|---|---|---|
| **MEC604** | **Automation and Artificial Intelligence** | **03** |

**Objectives:**

1. To understand the need and justification of automation.
2. To study design of pneumatic and hydraulic circuits.
3. To study and understand electropneumatic circuits and PLC Design
4. To familiarize with robotic systems in automated manufacturing processes.
5. To study and understand AI and machine learning technologies for automation.

**Outcomes:**Learner will be able to…

1. Demonstrate understanding of fundamentals of industrial automation and AI.
2. Design & develop pneumatic / hydraulic circuits.
3. Design and develop electropneumatic circuits and PLC ladder logics.
4. Demonstrate understanding of robotic control systems and their applications.
5. Demonstrate understanding of various AI and machine learning technologies.

| Module | Details | Hrs |
|---|---|---|
| 1 | **1.1 Introduction to Automation**<br>Definition and fundamentals of automation, Elements of Automated system, Automation principles and strategies, Levels of automation, types of automation, Advanced automation functions<br>**1.2 Introduction to Artificial Intelligence**<br>Introduction, Historical development, Intelligent Systems, Types of Intelligent Agents, Components of AI, Foundations of AI, Scope of AI, Current trends in AI, Relevance to Mechanical Engineering | 04 |
| 2 | **2.1 Design of Pneumatic Circuits**<br>Design of Pneumatic sequencing circuits using Cascade method and Shift register method (up to 2 cylinders)<br>**2.2 Design of Hydraulic Circuits**<br>Basic Hydraulic Circuits: Meter in, meter out and Bleed off circuits; Intensifier circuits, Regenerative Circuit, Counter balance valve circuit and sequencing circuits. | 08 |
| 3 | **3.1 Electro-pneumatic Circuits**<br>Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping;<br>**3.2 PLC Discrete Control Systems**<br>Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching. | 08 |
| 4 | **Robots and their applications**: Introduction to Robots, Types, Classifications, Selection of Robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a Robot, Robot feedback controls: Point to point control and Continuous path control, Control system for Robot joint, Adaptive control, Drives and transmission systems, End effectors, Industrial robot applications, Nex-gen robots. | 07 |

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|---|---|---|
| **5** | (Concept and Algorithms, No programming or numericals)<br>**5.1 Problem Solving:**<br>　Tree and Graph Search, Uninformed v/s informed search, uninformed methods: depth first search, breadth first search, Informed search: heuristic search, Best first search, branch and bound<br>**5.2 Machine Learning:**<br>　Introduction, types of machine learning: supervised, unsupervised, reinforcement learning<br>**5.3 Learning with Decision Trees:**<br>　Introduction to Decision Trees, Classification and Regression Trees, K means clustering algorithm, K nearest neighbours algorithm, hierarchical clustering, Concept of ensemble methods: bagging, boosting, random forests | **06** |
| **6** | (Concept and Algorithms, No programming or numericals)<br>**6.1 Learning with regression:**<br>Linear regression, Logistic regression<br>**6.2 Artificial Neural Networks**<br>　Concept of ANN, Basic Models of Artificial Neural Networks Important Terminologies of ANNs McCulloch-Pitts Neuron, NN architecture, perceptron, delta learning rule, backpropagation algorithm, Gradient Descent algorithm, feed forward networks, activation functions<br>**6.3 Introduction to AI Technologies in the realm of Automation**<br>　Concept of Natural Language Processing, Machine Vision, Deep learning, Expert systems, Genetic Algorithms, Industry 4.0 | **06** |

**Assessment:**

**Internal Assessment for 20 marks:**

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**

2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**

3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

4. Only **Four questions need to be solved**

**Text/Reference Books:**

1. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
2. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
3. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson eduaction
4. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
5. Pneumatic Circuits and Low Cost Automation by Fawcett JR
6. Electromechanical Design Handbook , Walsh, McGraw-Hill
7. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
8. Industrial Hydraulics: Pippenger

9. Vickers Manual on Hydraulics
10. Hydraulic Valves and Controls: Pippenger
11. Fundamentals of pneumatics: Festo series
12. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
13. Mechatronics, HMT
14. M.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing",  Pearson Education,New Delhi
15. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, "Industrial Robotics Technology programming and Applications", McGraw-Hill,
16. Yoram Korean, "Robotics for engineers", McGrew Hill Co
17. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications", Prentice Hall.
18. Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition
19. Artificial Intelligence: A Modern Approach by Peter and Norvig ISBN-0-13103805-2,
20. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair ISBN-978-0-07008770-5, TMH,
21. Artificial Intelligence by Saroj KausikISBN:- 978-81-315-1099-5, Cengage Learning
22. Artificial Intelligence and Intelligent Systems by Padhy, Oxforfd University Press,
23. Artificial Intelligence & Machine Learning by Vinod Chandra .S.S.  Anand Harindran. S.  ( PHI )
24. A first course in Artificial Intelligence – By Deepak Khemani. Mc GrawHill

**Links for online NPTEL/SWAYAM courses:**

**https://nptel.ac.in/courses/112/103/112103174/**

**https://nptel.ac.in/courses/112/103/112103293/**

**https://nptel.ac.in/courses/112/102/112102011/**

**https://nptel.ac.in/courses/112/101/112101098/**

**https://nptel.ac.in/courses/112/103/112103280/**

**https://nptel.ac.in/courses/106/106/106106139/**