# Maulana Abul Kalam Azad University of Technology, West Bengal

*(Formerly West Bengal University of Technology)*

**SYLLABUS FOR BACHELOR OF TECHNOLOGY IN ROBOTICS**

**(Effective from academic session 2020-21)**

| | |
|---|---|
| **Subject Code:** PC-CS601 | **Category:** Professional Core Courses |
| **Subject Name:** Artificial Intelligence (AI) & Machine Learning | **Semester:** Sixth |
| **L-T-P:** 3-0-2 | **Credit:** 3 |
| **Pre-Requisites:** Basic Programming in Python | |

**Course Objectives:**

This course will give an opportunity to gain expertise in one of the most fascinating and fastest growing areas of Computer Science through classroom program that covers fascinating and compelling topics related to human intelligence and its applications in industry, defense, healthcare, agriculture and many other areas. This course will give the students a rigorous, advanced and professional graduate-level foundation in Artificial Intelligence.
To introduce students to the basic concepts and techniques of Machine Learning. thorough understanding of the Supervised and Unsupervised learning techniques. To study the various probability based learning techniques, graphical models of machine learning algorithms.

**Course Content:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | **Introduction:** Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree | 3 |
| 2 | **Search Algorithms**: Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search. | 5 |
| 3 | **Probabilistic Reasoning:** Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, temporal model, hidden Markov model. | 8 |
| 4 | **Markov Decision process:** MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs. | 8 |
| 5 | **Reinforcement Learning:** Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning. | 7 |
| 6 | **Introduction: Learning**– Types of Machine Learning– Supervised Learning– The Brain and the Neuron– Design a Learning System– Perspectives and Issues in Machine Learning– Concept Learning Task– Concept Learning as Search– Finding a Maximally Specific Hypothesis– Version Spaces and the Candidate Elimination Algorithm– Linear Discriminants– Perceptron– Linear Separability– Linear Regression.. | 5 |

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|---|---|---|
| 7 | Linear Models: Multi-layer Perceptron– Going Forwards– Going Backwards: Back Propagation Error– Multilayer Perceptron in Practice– Examples of using the MLP | 5 |
| 8 | Tree and Probabilistic Models Learning with Trees– Decision Trees– Constructing Decision Trees– Classification and Regression Trees– Ensemble Learning– Boosting– Bagging– Different ways to Combine Classifiers– Probability and Learning– Data into Probabilities– Basic Statistics– Gaussian Mixture Models– Nearest Neighbor Methods– Unsupervised Learning– K means Algorithms– Vector Quantization– Self Organizing Feature Map | 5 |
| 9 | Graphical Models: Markov Chain Monte Carlo Methods– Sampling– Proposal Distribution– Markov Chain Monte Carlo– Graphical Models– Bayesian Networks– Markov Random Fields– Hidden Markov Models– Tracking Methods | 4 |

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Build intelligent agents for search and games.
2. Solve AI problems through programming with Python.
3. Learning optimization and inference algorithms for model learning.
4. Design and develop programs for an agent to learn and act in a structured environment.
5. Distinguish between, supervised, unsupervised and semi-supervised learning
6. Apply the appropriate machine learning strategy for any given problem
7. Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem
8. Design systems that uses the appropriate graph models of machine learning
9. Modify existing machine learning algorithms to improve classification efficiency

**Learning Resources:**

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall, 2009.
2. E. Rich, K. Knight and K. Knight, Artificial Intelligence, McGraw Hill, 1991.
3. M.C. Trivedi, A Classical Approach to Artifical Intelligence, Khanna Publishing House, New Delhi, 2018.
4. S. Kaushik, Artificial Intelligence, Cengage Learning India, 2011.
5. D. Poole and A. Mackworth, Artificial Intelligence: Foundations for Computational Agents, Cambridge University Press, 2010.
6. Websites for reference: https://nptel.ac.in/courses/106105077
7. Websites for reference: https://nptel.ac.in/courses/106106126
8. S. Marsland, Machine Learning– An Algorithmic Perspective, 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
9. T.M. Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.
10. P. Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, First Edition, Cambridge University Press, 2012.
11. J. Bell, Machine learning– Hands on for Developers and Technical Professionals, First Edition, Wiley, 2014.
12. E. Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning Series), 3rd Edition, MIT Press, 2014.

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|---|---|
| **Subject Code** : PC-ROB602 | **Category:** Professional Core Courses |
| **Subject Name** : Computer Vision | **Semester** : Sixth |
| **L-T-P : 3-1-0** | **Credit: 3** |
| **Pre-Requisites:** | |

| Unit | Content | Hrs/ Unit |
|---|---|---|
| 1 | **Introduction**<br><br>Background, Digital Image Representation, Fundamental steps in Image Processing, Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display. | 3 |
| 2 | **Digital Image Formation**<br>A Simple Image Model, Geometric Model- Basic Transformation (Translation, Scaling, Rotation), Perspective Projection, Sampling & Quantization - Uniform & Non uniform. | 4 |
| 3 | **Mathematical Preliminaries**<br>Neighbor of pixels, Connectivity, Relations, Equivalence & Transitive Closure; Distance Measures, Arithmetic/Logic Operations, Fourier Transformation, Properties of The Two Dimensional Fourier Transform, Discrete Fourier Transform, Discrete Cosine & Sine Transform. | 9 |
| 4. | **Image Enhancement**<br>Spatial Domain Method, Frequency Domain Method, Contrast Enhancement -Linear & Nonlinear Stretching, Histogram Processing; Smoothing - Image Averaging, Mean Filter, Low-pass Filtering; Image Sharpening. High- pass Filtering, High-boost Filtering, Derivative Filtering, Homomorphic Filtering; Enhancement in the frequency domain - Low pass filtering, High pass filtering. | 8 |
| 5 | **Image Restoration**<br>Degradation Model, Discrete Formulation, Algebraic Approach to Restoration - Unconstrained & Constrained; Constrained Least Square Restoration, Restoration by Homomorphic Filtering, Geometric Transformation - Spatial Transformation, Gray Level Interpolation. | 5 |

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| 6 | **Image Segmentation**<br>Point Detection, Line Detection, Edge detection, Combined detection, Edge Linking & Boundary Detection - Local Processing, Global Processing via The Hough Transform; Thresholding - Foundation, Simple Global Thresholding, Optimal Thresholding; Region Oriented Segmentation - Basic Formulation, Region Growing by Pixel Aggregation, Region Splitting & Merging. | 7 |

**Text book and Reference books:**

1. Hearn, Baker – "Computer Graphics (C version 2nd Ed.)" – Pearson education
2. Z. Xiang, R. Plastock – " Schaum's outlines Computer Graphics (2nd Ed.)" – TMH
3. D. F. Rogers, J. A. Adams – "Mathematical Elements for Computer Graphics (2nd Ed.)" – TMH

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|---|---|
| **Subject Code**: HM-HU601 | **Category:** Humanities and Social Sciences including Management Courses |
| **Subject Name**: Humanities II (Operations Research) | **Semester**: Sixth |
| **L-T-P**: **3-0-0** | **Credit: 3** |
| **Pre-Requisites:** | |

**Course Objectives:**

1. To study the various Operations Research tools,
2. To study to apply an appropriate model to the given situation.
3. To formulate the problem.
4. To solve and analyze the problems on Operations Research.

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | **Introduction to Operations Research:**<br>Introduction, Historical Background, Scope of Operations Research, Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools, Structure of the Mathematical Model, Limitations of Operations Research | 2 |
| 2 | **Linear Programming:**<br>Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Case Studies of LPP, Graphical Methods to Solve Linear Programming Problems, Applications, Advantages, Limitations.<br><br>Graphical Analysis of Linear Programming Problems: Introduction, Graphical Analysis, Some Basic Definitions, Graphical Methods to Solve LPP, Some Exceptional Cases, Important Geometric Properties of LPP.<br><br>Simplex Method: Introduction, Standard Form of LPP, Fundamental theorem of LPP, Solution of LPP - Simplex Method, The Simplex Algorithm, Penalty Cost Method or Big M-method, Two Phase Method, Solved Problems on Minimisation.<br><br>Duality in Linear Programming Problem: Introduction, Importance of Duality Concepts, Formulation of Dual Problem, Economic Interpretation of Duality, Sensitivity Analysis. | 8 |

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| 3 | **Transportation Problem:**<br>Introduction, Formulation of Transportation Problem (TP), Transportation Algorithm (MODI Method), the Initial Basic Feasible Solution, Moving Towards Optimality. | 3 |
| 4 | **Assignment Problem:**<br>Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Travelling Salesman Problem | 3 |
| 5 | **Project Management Using CPM-PERT:**<br>Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT, Float calculation and its importance. Cost reduction by Crashing of activity | 5 |
| 6 | **Queuing Theory:**<br>Basis of Queuing theory, elements of queuing theory, Operating characteristics of a queuing system, Queue discipline, Service Mechanism, Classification of Queuing models, [M/M/1]:{//FCFS} Queue System, numerical | 3 |
| 7 | **Inventory Management:**<br>Inventory classification, Different costs associated to Inventory, Inventory models with deterministic demands (EOQ, EPQ and price discount models), inventory classification systems | 4 |
| 8 | **Job Sequencing:**<br>Introduction to sequencing and scheduling models: n job two machines problem, n job 3 machines problem | 2 |
| 9 | **Decision Theory:**<br>Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, Hurwicz criterion, Decision tree | 3 |
| 10 | **Replacement Theory:**<br>Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy. | 3 |

**Course Outcome:**

At the end of this course students will be able to

1. Apply forecasting methods for predicting demands.
2. Make decisions under certainty, uncertainty and conflicting situations.
3. Apply linear programming tools for optimal utilization of resources in various types of industries.
4. Solve transportation problems to minimize cost and understand the principles of assignment of jobs and recruitment polices.
5. Understand the basic elements of a Queuing model
6. Apply PERT/CPM for project scheduling and resource allocation in an optimal way.
7. Manage inventory with cost effectiveness.

**Learning Resources**

1. F.S. Hillier, G.J. Lieberman, B. Nag and P. Basu, Introduction to Operation Research, 10th Edition, McGraw Hill, 2017.
2. C. Mohan and K. Deep, Optimization Techniques, New Age, 2009.
3. N.D. Vohra, Quantitative Techniques in Management, 5th Edition, McGraw-Hill.
4. K.V. Mittal and C. Mohan, Optimization Methods in Operations Research and Systems Analysis, New Age, 2003.
5. H.A. Taha, Operations Research - An Introduction, 7th Edition, Prentice Hall, 2002.
6. A. Ravindran, D.T. Phillips and J.J. Solberg, Operations Research: Principles and Practice, 2nd Edition, John Willey and Sons, 2009.
7. K. Bedi, Production and Operations Management, Oxford University Press, 2004.
8. S.J. Chandra and A. Mehra, Numerical Optimization with Applications, Narosa, 2009.
9. J.K. Sharma, Operation Research: Theory and Applications, 5th Edition, Macmillan Pub., 2013.
10. L.W. Wayne, Operations Research Applications and Algorithms, 4th Edition, Brooks/Cole, USA.

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| **Subject Code** : MC601 | **Category:** Mandatory Courses |
| **Subject Name** : Constitution of India | **Semester** : Sixth |
| **L-T-P : 2-0-0** | **Credit: 0** |
| **Pre-Requisites:** | |

**Course Objectives:**

The objectives of this course help the students to
1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications.

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations. | 4 |
| 2 | Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India. | 5 |
| 3 | State Executives – Governor, Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments. | 5 |
| 4 | Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights-Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co - Operative Societies. | 5 |

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| 5 | Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co - Operative Societies. | 5 |

**Course Outcomes:**
On completion of the course student will

1. Have general knowledge and legal literacy and thereby to take up competitive examinations.
2. Understand state and central policies, fundamental duties.
3. Understand Electoral Process, special provisions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies,
5. Understand Engineering ethics and responsibilities of Engineers
6. Understand Engineering Integrity & Reliability

**Learning Resources:**
1. D.D. Basu, Introduction to the Constitution on India, 19th/ 20th Students Edition, Prentice Hall EEE, 2001.
2. C.E. Haries, M.S. Pritchard and M.J. Robins, Engineering Ethics, Thompson Asia, 2003.
3. M.V. Pylee, An Introduction to Constitution of India, Vikas Publishing, 2002.
4. M. Govindarajan, S. Natarajan and V.S. Senthilkumar, Engineering Ethics, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
5. B.K. Sharma, Introduction to the Constitution of India, PHI Learning, New Delhi, 2011.
6. Latest Publications, Indian Institute of Human Rights, New Delhi.

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| | |
|---|---|
| **Subject Code** : PC-ROB691 | **Category:** Professional Core Courses |
| **Subject Name** : Computer Vision Lab | **Semester** : Sixth |
| **L-T-P : 0-0-3** | **Credit: 1** |
| **Pre-Requisites:** | |

1. Simulation and Display of an Image, Negative of an Image (Binary & Gray Scale)
2. Implementation of Relationships between Pixels
3. Implementation of Transformations of an Image
4. Contrast stretching of a low contrast image, Histogram, and Histogram Equalization
5. Display of bit planes of an Image
6. Display of FFT (1-D & 2-D) of an image
7. Computation of Mean, Standard Deviation, Correlation coefficient of the given Image
8. Implementation of Image Smoothening Filters (Mean and Median filtering of an Image)
9. Implementation of image sharpening filters and Edge Detection using Gradient Filters 10. Image Compression by DCT, DPCM, HUFFMAN coding
11. Implementation of image restoring techniques
12. Implementation of Image Intensity slicing technique for image enhancement
13. Canny edge detection Algorithm

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| **Subject Code** : PC-CS691 | **Category:** Professional Core Courses |
| **Subject Name** : AI & ML Lab | **Semester** : Sixth |
| **L-T-P : 0-0-2** | **Credit: 1** |
| **Pre-Requisites:** | |

1. To learn the basics of Artificial Intelligence and various ways in which Artificial Intelligence is related to the real world.
2. To learn about Python basics and tools used to run the Python code.
3. To learn about installation of Pycharm and Python Interpreter.
4. To learn and discuss the COVID 19 case using Python programming.
5. To learn about Machine Learning using Google Colab software and analyse the data using Python Programming Language.
6. To learn Neural Network Architecture and various examples in which this can be used in Machine Learning.
7. To discuss brief of Image Processing, Lab View and Fuzzy Logic and their relevance in the field of Artificial Intelligence.
8. To learn practical of Machine Learning and Deep Learning with MATLAB

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|---|---|
| **Subject Code** : PW-ROB681 | **Category:** Project (Summer Internship) |
| **Subject Name** : Project-II | **Semester** : Sixth |
| **L-T-P** : **0-0-4** | **Credit: 2** |
| **Pre-Requisites:** | |

**Course Objectives:**

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

**Course Outcomes:**

Students will be able to understand the procedure to carry out practical projects related to any technical event/ competition to fabricate and demonstrate an innovative machine or product, etc.

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|---|---|
| **Subject Code:** PE-ROB601A | **Category:** Professional Elective Courses |
| **Subject Name:** Mechatronic Systems | **Semester:** Sixth |
| **L-T-P:** 3-0-0 | **Credit:** 3 |
| **Pre-Requisites:** NA | |

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modelling, Analysis and Simulation, Man- Machine Interface; Sensors and transducers: classification, Development in Transducer technology, Opto-electronics- Shaft encoders, CD Sensors, Vision System, etc. | 8 |
| 2 | Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems; | 8 |
| 3 | Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc. | 10 |
| 4 | Micromechatronic systems: Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology. | 8 |

**Text Books:**


1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3. A Textbook of Mechatronics, R.K.Rajput, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall


**Course Outcomes:**

Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.

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## (Effective from academic session 2020-21)

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|---|---|
| **Subject Code:** PE-ROB601B | **Category:** Professional Elective Courses |
| **Subject Name:** Digital Signal Processing | **Semester:** Sixth |
| **L-T-P:** 3-0-0 | **Credit:** 3 |
| **Pre-Requisites:** NA | |

| Unit | Content | Hrs/Unit |
|---|---|---|
| 1 | Module 1: Discrete-time signals and systems<br>Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate. | 6 |
| 2 | Module 2: Z-transform<br>z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z transform, Properties of z-transform for causal signals, Interpretation of stability in z- domain, Inverse z-transforms. | 6 |
| 3 | Module 2: Discrete Fourier Transform<br>Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems. | 10 |
| 4. | Module 3: Design of Digital filters<br>Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band stop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing. | 12 |
| 5 | Module 4: Applications of Digital Signal Processing<br>Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter. | 6 |

**Text book and Reference books:**


1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall, 1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

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|---|---|
| **Subject Code:** PE-ROB601C | **Category:** Professional Elective Courses |
| **Subject Name:** Human Computer Interaction | **Semester:** Sixth |
| **L-T-P:** 3-0-0 | **Credit:** 3 |
| **Pre-Requisites:** NA | |

**Objective:**

1 Learn the foundations of Human Computer Interaction
2 Be familiar with the design technologies for individuals and persons with disabilities
3 Be aware of mobile Human Computer interaction
4 Learn the guidelines for user interface.

| Unit | Content | Hrs/Unit |
|---|---|---|
| 1 | Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms. | 9 |
| 2 | Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle –usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design. | 11 |
| 3. | Cognitive models –Socio-Organizational issues and stake holder requirements –Communication and collaboration models-Hypertext, Multimedia and WWW. | 8 |
| 4. | Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools. | 8 |
| 5. | Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies. | 8 |
| 6. | Recent Trends: Speech Recognition and Translation, Multimodal System | 3 |

**Text book and Reference books:**

1. Theodor Richardson, Charles N Thies, Secure Software Design, Jones & Bartlett
2. Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software Security,Addison Wesley.

**Course Outcomes:**

On completion of the course students will be able to

1. Differentiate between various software vulnerabilities.
2. Software process vulnerabilities for an organization.
3. Monitor resources consumption in a software.

Interrelate security and software development process

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|---|---|
| **Subject Code:** PE-ROB601D | **Category:** Professional Elective Courses |
| **Subject Name:** Pattern Recognition | **Semester:** Sixth |
| **L-T-P:** 3-0-0 | **Credit:** 3 |
| **Pre-Requisites:** NA | |

| Unit | Content | Hrs/Unit |
|---|---|---|
| 1 | Basics of pattern recognition | 2 |
| 2 | **Bayesian decision theory 8L**<br>Classifiers, Discriminant functions, Decision surfaces<br>Normal density and discriminant functions Discrete features | 8 |
| 3 | **Parameter estimation methods 6L** Maximum-Likelihood estimation Gaussian mixture models Expectation-maximization method Bayesian estimation | 6 |
| 4. | **Hidden Markov models for sequential pattern classification 8L**<br>Discrete hidden Markov models Continuous density hidden Markov models | 8 |
| 5 | **Dimension reduction methods 3L**<br>5.1. Fisher discriminant analysis 5.2Principal component analysis.<br>Parzen-window method K-Nearest Neighbour method | 3 |
| 6 | Non-parametric estimation techniques for density | 2 |
| 7 | **Linear discriminant function based classifier 5L**<br>Perceptron<br>Support vector machines | 5 |
| 8 | **Non-metric methods for pattern classification 4L**<br>Non-numeric data or nominal data Decision trees | 4 |
| 9 | **Unsupervised learning and clustering 2L** Criterion functions for clustering Algorithms for clustering: K-means, Hierarchical and other methods | 2 |

**Text book and Reference books:**


1. R. O. Duda, P. E. Hart and D. G. Stork: Pattern Classification, John Wiley, 2001.
2. S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

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|---|---|
| **Subject Code:** PE-ROB602A | **Category:** Professional Elective Courses |
| **Subject Name:** Bio Medical Electronics | **Semester:** Sixth |
| **L-T-P:** 3-0-0 | **Credit:** 3 |
| **Pre-Requisites:** NA | |

1. Brief introduction to human physiology.
2. Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases. Bio-electrodes and bio-potential amplifiers for ECG, EMG, EEG, etc.
3. Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrasonic, X-ray and nuclear imaging.
4. Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects.

**Text/Reference Books:**

1. W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
2. J.G. Websster, ed., Medical Instrumentation, Houghton Mifflin, 1978.
3. A.M. Cook and J.G. Webster, eds., Therapeutic Medical Devices, Prentice-Hall, 1982.

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|---|---|
| **Subject Code**: PE-ROB602B | **Category:** Professional Elective Courses |
| **Subject Name**: Material Handling | **Semester**: Sixth |
| **L-T-P** : **3-0-0** | **Credit: 3** |
| **Pre-Requisites:** Kinematics and Theory of Machines | |

**Course Objective:**

1. To know about the material handling systems used in industry.
2. To learn about basic designing principles of some material handling systems.
3. To know about modern handling system using a robot.

**Course Content:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | **Introduction:** Definition, importance and scope of material handling (MH); classification of materials; codification of bulk materials; utility of following principles of MH– (i) materials flow, (ii) simplification, (iii) gravity, (iv) space utilization, (v) unit size, (vi) safety, (vii) standardization, (viii) dead-weight, (ix) idle time,(x) motion. | 4 |

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| 2 | **Unit load**: Definition; advantages & disadvantages of unitization; unitization by use of platform, container, rack, sheet, bag and self-contained unit load; descriptive specification and use of pallets, skids, containers, boxes, crates and cartons; shrink and stretch wrapping.<br>**Classification of MH Equipment**: Types of equipment– (i) industrial trucks & vehicles, (ii) conveyors, (iii) hoisting equipment, (iv) robotic handling system and (v) auxiliary equipment; Independent equipment wise sub classification of each of above type of equipment. | 6 |
| 3 | **Industrial trucks & vehicles**: Constructional features and use of the following equipment – (i) wheeled hand truck, (ii) hand pallet truck, (iii) fork lift truck; Major specifications, capacity rating and attachments of fork lift truck. | 5 |
| 4 | **Conveyors:** Use and characteristics of belt conveyor, constructional features of flat and troughed belt conveyor; Use and constructional features of chain conveyors– (i) apron, car and trolley type; Construction of link-plate chains; Dynamic phenomena in chain drive; Use and constructional features of roller conveyors; Gravity and powered roller conveyor; Pneumatic conveyor-use and advantages; Positive, negative and combination system of pneumatic conveyors; constructional feature, application and conveying capacity of screw conveyor. | 8 |
| 5 | **Hoisting Equipment**: Advantage of using steel wire rope over chain; constructional features of wire ropes; Rope drum design; Pulley system-simple vs. multiple pulley; Load handling attachments: hooks, grabs, tongs, grab bucket; Arrangement of hook suspension with cross piece and pulleys (sheaves); Use and constructional features of (i) hand operated trolley hoist, (ii) winch; (iii) bucket elevator, (iv) Jib crane, (v) overhead traveling crane and (vi) wharf crane; Level luffing system of a wharf crane; Utility of truck mounted and crawler crane. | 8 |
| 6 | **Robotic handling**: Materials handling at workplace; Major components of a robot; Applications of robotic handling. | 2 |
| 7 | **Auxiliary Equipment:** Descriptive specification and use of (i) Slide and trough gates, (ii) belt, screw and vibratory feeders, (iii) Chutes, (iv) positioners like elevating platform, ramps, universal vice; (v) ball table. | 3 |

**Course Outcomes:**

After completing this course, the students will

1. Know about constructional features, working principle and specific applications of each of the material handling system.
2. Learn about unit load calculation and selecting specification of some material handling system.

**Learning Resources:**

1. S. Ray, Introduction to Materials Handling, New Age International Pub., 2017.
2. T.K. Ray, Mechanical Handling of Materials, Asian Books Pvt. Ltd., 2005.
3. T.H. Allegri, Materials Handling: Principles and Practices, CBS Publishers and Distributors, 2018.
4. J.M. Apple, Material Handling System Design, John Wiley & Sons, 1972.

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| **Subject Code:** PE-ROB602C | **Category:** Professional Elective Courses |
| **Subject Name:** 3D Printing and Design | **Semester:** Sixth |
| **L-T-P:** 3-0-0 | **Credit:**3 |
| **Pre-Requisites:** Computer Aided Design, Engineering Materials | |

**Objectives:**

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | **3D Printing (Additive Manufacturing):** Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications. | 2 |
| 2 | **CAD for Additive Manufacturing**: CAD Data formats, Data translation, Data loss, STL format. | 3 |
| 3 | **Additive Manufacturing Techniques:** Stereo-Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. Process, Process parameter, Process Selection for various applications. Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defense, Automotive, Construction, Food Processing, Machine Tools | 10 |
| 4 | **Materials:** Polymers, Metals, Non-Metals, Ceramics Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials | 7 |
| 5 | **Additive Manufacturing Equipment:** Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting Process Design | 8 |
| 6 | **Post Processing:** Requirement and Techniques | 3 |
| 7 | **Product Quality:** Inspection and testing ,Defects and their causes | 3 |

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Develop CAD models for 3D printing, import and export CAD data to generate. stl file.
2. Select a specific material for the given application.
3. Select a 3D printing process for an application.
4. Produce a product using 3D Printing or Additive Manufacturing.

**Learning Resources:**

1. L. Gibson, D.W. Rosen and B. Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. A. Gebhardt, Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing, Hanser Publisher, 2011.
3. C.K. Chua and K.F. Leong, 3D Printing and Rapid Prototyping- Principles and Applications, World Scientific, 2017.
4. J.D. Majumdar and I. Manna, Laser-Assisted Fabrication of Materials, Springer Series in Material Science, 2013.
5. L. Lu, J. Fuh and Y.S. Wong, Laser-Induced Materials and Processes for Rapid Prototyping, Kulwer Academic Press, 2001.
6. Z. Fan and F. Liou, Numerical Modelling of the Additive Manufacturing (AM)Processes of Titanium Alloy, InTech, 2012.

# Maulana Abul Kalam Azad University of Technology, West Bengal

*(Formerly West Bengal University of Technology)*

**SYLLABUS FOR BACHELOR OF TECHNOLOGY IN ROBOTICS**

**(Effective from academic session 2020-21)**

| | |
|---|---|
| **Subject Code:** PE –ROB602D | **Category:** Professional Elective Courses |
| **Subject Name:** CAD/CAM | **Semester:** Sixth |
| **L-T-P:** 3-0-0 | **Credit:** 3 |
| **Pre-Requisites:** Manufacturing Technology, Elements of Mechanical Design, Mathematics | |

**Course Objective:**

To impart knowledge about computer aided design- geometric modeling, stress analysis.
To give an idea about computer aided manufacturing system, its components including application of robot.

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | Fundamentals of CAD- Design process, benefits of computer aided design, graphics standards. | 3 |
| 2 | Geometric modeling- wire-frame, surface and solid modeling<br>Transformation- translation and rotation exercise problems and programming.<br>Stress analysis- basics of FEM, formation of stiffness matrix for two elements. | 6 |
| 3 | Introduction to computer aided manufacturing (CAM) systems, basic building blocks of computer integrated manufacturing (CIM). | 4 |
| 4 | Tooling's of CNC machines, tool and work handling systems involving robot, AGV, RTV, AS/RS, ATC, APC. | 3 |
| 5 | Robotics; types, anatomy, drives and applications. | 3 |
| 6 | Computer aided production planning and control, Manufacturing from product design- CADCAM interface, concept of group technology (GT), CAPP. | 6 |
| 7 | Control systems, Process monitoring, Adaptive control systems, etc. | 2 |
| 8 | Automatic inspection systems, use of CMM, Reverse Engineering. | 1 |

**Course Outcome:**

1. To familiarize the basics of computer aided design- geometric modeling, stress analysis.
2. To familiarize the basics of computer aided manufacturing.
3. To familiarize the components of computer aided manufacturing system including application of robot and control systems.

**Learning Resources:**


1. P.N. Rao, N.K. Tewari and T.K. Kundra, Computer Aided Manufacturing, McGraw-Hill Publication, 2017.
2. M.P. Groover and E.W. Zimmers Jr., CAD/CAM, Prentice Hall of India, 1983.
3. P. Radhakrishnan, S. Subramanyan and V. Raju, CAD/CAM/CIM, New Age International

Publishers, 2007.
4. P.N. Rao, CAD/CAM, McGraw Hill Publication, 2010.
5. M.P. Groover, Automation, Production Systems, and Computer- Integrated Manufacturing, Prentice Hall of India, 2016.
6. I. Zeid, CAD/CAM- Theory and Practice, McGraw-Hill Publishing Co. Ltd., New Delhi, 1991.
7. S.R. Deb and S. Deb, Robotics Technology and Flexible Automation, McGraw-Hill Publication, 2010.
8. S.K. Saha, Introduction to Robotics, McGraw-Hill Publication, 2008.
9. P.B. Mahapatra, Computer-Aided Production Management, Prentice Hall of India, 2010