M.Tech.: Industrial Automation & Robotics
(2014 - 15)

Scheme of Teaching and Examination & Syllabus

Department of Mechanical Engineering
The National Institute of Engineering, Mysore
BLUEPRINT OF SYLLABUS STRUCTURE AND QUESTION PAPER PATTERN

(To be effective from the odd semester of the academic year 2014-15 for all semester students)

Blue Print of Syllabus Structure

1. Complete syllabus is prescribed in SIX units as Unit 1, Unit 2, etc.
2. In each unit there is one topic under the heading “Self Learning Exercises” (SLE). These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which SLE components are to be studied. Thus there will be six topics in the complete syllabus which will carry questions with a weightage of 10% in SEE only. No questions will be asked on SLE components in CIE.

Blue Print of Question Paper

1. Question paper will have seven full questions.
2. One full question each of 15 marks (Question No 1, 2, 3, 4, 5 and 6) will be set from each unit of the syllabus. Out of these six questions, two questions will have internal choice from the same unit. The unit in which choice is to be given is left to the discretion of the course instructor.
3. Question No 7 will be set for 10 marks only on those topics prescribed as “Self Learning Exercises”.

Dr. B. K. Sridhara
Dean (Academic Affairs)
M.Tech: Industrial Automation and Robotics

Course Structure: I Semester

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Subject Code</th>
<th>Subject</th>
<th>Contact Hrs. / Week</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
</tr>
<tr>
<td>1</td>
<td>APM0401</td>
<td>Applied Mathematics</td>
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<tr>
<td>2</td>
<td>IAR0501</td>
<td>Industrial Automation</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>IAR0502</td>
<td>Robotics for Industrial Automation</td>
<td>4</td>
<td>2</td>
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<tr>
<td>4</td>
<td>IAR0503</td>
<td>Computer Aided Engineering</td>
<td>4</td>
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</tr>
<tr>
<td>5</td>
<td>IAR05XX</td>
<td>Elective–I</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>IAR05XX</td>
<td>Elective –II</td>
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</tr>
<tr>
<td>7</td>
<td>IAR0101</td>
<td>Seminar–I</td>
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<tr>
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<td></td>
<td><strong>Total number of Credits</strong></td>
<td><strong>29</strong></td>
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Elective – I

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
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</thead>
<tbody>
<tr>
<td>IAR0508</td>
<td>Modeling, Simulation and Analysis of Manufacturing Systems.</td>
</tr>
<tr>
<td>IAR0509</td>
<td>Finite Element Analysis</td>
</tr>
<tr>
<td>IAR0520</td>
<td>Automatic Control Systems</td>
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</table>

Elective – II

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<tr>
<th>Subject Code</th>
<th>Subject</th>
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<tbody>
<tr>
<td>IAR0403</td>
<td>Knowledge Based Design</td>
</tr>
<tr>
<td>IAR0404</td>
<td>Dynamics and Mechanisms Design</td>
</tr>
<tr>
<td>IAR0405</td>
<td>Product Design &amp; Development</td>
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</table>
## Course Structure: II Semester

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Subject Code</th>
<th>Subject</th>
<th>Contact Hrs. / Week</th>
<th>Credits</th>
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<tbody>
<tr>
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<tr>
<td>1</td>
<td>IAR0521</td>
<td>Computer Concepts for Automation</td>
<td>4</td>
<td>2</td>
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<tr>
<td>2</td>
<td>IAR0505</td>
<td>Drives and Control systems for Automation</td>
<td>4</td>
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<tr>
<td>3</td>
<td>IAR0506</td>
<td>Microprocessors and Micro Controllers</td>
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<td>IAR0406</td>
<td>Sensors Applications in Manufacturing</td>
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<td>5</td>
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<td>Elective - III</td>
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**Total number of Credits** 29

### Elective - III

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<tr>
<td>IAR0522</td>
<td>Computer Aided Production and Operation Management</td>
</tr>
<tr>
<td>IAR0523</td>
<td>Rapid-Prototyping</td>
</tr>
<tr>
<td>IAR0516</td>
<td>Mathematical Approach to Robotic Manipulators</td>
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### Elective - IV

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<tr>
<td>IAR0407</td>
<td>ANN &amp; Genetic Algorithms</td>
</tr>
<tr>
<td>IAR0408</td>
<td>Computer Vision and Image Processing</td>
</tr>
<tr>
<td>IAR0409</td>
<td>Artificial Intelligence and Expert Systems in Automation</td>
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### Course Structure: III Semester

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<tr>
<th>Sl. No.</th>
<th>Subject Code</th>
<th>Subject</th>
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<th>T</th>
<th>P</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>IAR0401</td>
<td>Industrial Training for 8 Weeks duration (At the end of the training, students are required to submit a report and present a seminar)</td>
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<tr>
<td>2</td>
<td>IAR0801</td>
<td>Project Work (preliminary) (Students have to initiate the project work and at the end of the semester should present a progress seminar)</td>
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<tr>
<td>3</td>
<td>IAR0201</td>
<td>Seminar</td>
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**Total number of credits** 14

### Course Structure: IV Semester

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<tr>
<th>Sl. No.</th>
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<th>Subject</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IAR2801</td>
<td>Project-Work (Students have to submit the final project report at the end of the semester which will be evaluated followed by a seminar presentation and viva-voce examination)</td>
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**Total number of credits** 28

### Credit Structure

<table>
<thead>
<tr>
<th></th>
<th>Credits</th>
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<tbody>
<tr>
<td>Core Courses</td>
<td>38</td>
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<tr>
<td>Elective Courses</td>
<td>20</td>
</tr>
<tr>
<td>Seminars/Ind Training/preliminary project</td>
<td>14</td>
</tr>
<tr>
<td>Major Project</td>
<td>28</td>
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<tr>
<td>TOTAL</td>
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</table>

**Legend:**
1) L – Lecturers Hrs/ Week
2) T – Tutorials Hrs/ Week
3) P – Practical Hrs/ Week
4) SLE – Self Learning Exercise
(Common to IAR, Machine Design, PEST, Nanotechnology)
APPLIED MATHEMATICS (4-0-0)

Sub Code: APM0401       CIE  : 50% Marks
Hrs/Week: 04        SEE  : 50% Marks
SEE Hrs: 3Hrs                             Max      :100 Marks

Course Outcome:
1. Obtain roots of algebraic and transcendental equations using various numerical methods.
2. Obtain complex roots of quadratic factors of the given polynomial using iterative methods.
3. Apply quadrature formulae to solve application problems.
4. Solve linear algebraic equations using direct and iterative methods.
5. Obtain Eigen values and Eigen vectors using iterative methods.
6. Establish the homomorphism between vector spaces using Linear transform and obtain orthonormal basis and solve some application problems using the definition of inner product space.

PART-A: Numerical Analysis

Unit I
9 Hrs

Unit II
9 Hrs

Unit III
8 Hrs
PART-B: Linear Algebra

Unit IV
Solution of system of linear algebraic equations, Triangularization method, Cholesky’s method, Partition method, Gauss Seidel iterative method.
(SLE: Gauss elimination method). 9 Hrs

Unit V
Eigen values & Eigen vectors, Bounds on eigen values, Given’s method, Jacobi’s method for diagonalisation of symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method.
(SLE: Analytical method to obtain eigen values and eigen vectors) 9 Hrs

Unit VI
(SLE: Applications) 8 Hrs

Books for Reference:
4. Linear Algebra – Larson & Falvo (Cengage learning)
INDUSTRIAL AUTOMATION (4-2-0)

Sub Code: IAR0501                                      CIE: 50%
Hrs/Week: 06                                             SEE: 50%
SEE Hrs: 3 Hrs                                           Max. Marks: 100

Course Outcome:

After the successful completion of this course, the student will be able:

1. To identify potential areas for automation and justify need for automation
2. To select suitable major control components required to automate a process or an activity
3. To translate and simulate a real time activity using modern tools and discuss the benefits of automation.
4. To identify suitable automation hardware for the given application.
5. To recommend appropriate modeling and simulation tool for the given manufacturing application.

Unit I

(SLE: Analysis of Transfer Lines) 8 Hrs

Unit II

(SLE: Material Identification Methods) 8 Hrs

Unit III

(SLE: Usage of SPC tools using excel or Minitab) 10 Hrs

Unit IV

(SLE: Sensors, Actuators and other Control System Components) 8 Hrs
Unit V

**Computer Based Industrial Control:** Introduction & Automatic Process Control,
**Building Blocks of Automation Systems:** LAN, Analog & Digital I/O Modules, SCADA Systems & RTU.
**Distributed Control System:** Functional Requirements, Configurations & some popular Distributed Control Systems.
(SLE: Display Systems in Process Control Environment.)  

8 Hrs

Unit VI

**Modeling and Simulation for Plant Automation:** Introduction, need for system modeling, Building Mathematical Model of a Plant, Modern Tools & Future Perspective.
**Industrial Control Applications:** Cement, Thermal, Water Treatment & Steel Plants.
(SLE: Cases Studies minimum one for Cement, Thermal, Water Treatment & Steel Plants applications)

10 Hrs

**Text Books:**


**References:**

2. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk
ROBOTICS FOR INDUSTRIAL AUTOMATION (4-2-0)

Sub Code: IAR0502 CIE: 50%
Hrs/Week:06 SEE: 50%
SEEHrs:3Hrs Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able:
1. To explain the basic principles of Robotic technology, configurations, control and programming of Robots.
2. Design an industrial robot which can meet kinematic and dynamic constraints.
3. To describe the concept of Robot kinematics and dynamics, latest algorithms & analytical approaches
4. To discuss and apply the concepts of dynamics for a typical Pick and Place robot.
5. To choose the appropriate Sensor and Machine vision system for a given application.
6. To explain the basic principles of programming and apply it for typical Pick & place, loading & unloading and palletizing applications.

Unit I


Unit II


Unit III

Trajectory Planning: Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories: 4-3-4 & 3-5-3 Trajectories. (SLE: Admissible Motion Trajectories) 8 Hrs
Unit IV


(SLE: Dynamic Equations of Motion for A General Six Axis Manipulator) 10 Hrs

Unit V

**Robot Teaching:** Introduction, Various Teaching Methods, Task Programming, Survey of Robot Level Programming Languages, A Robot Program as a Path in Space, Motion Interpolation, WAIT, SIGNAL & DELAY Commands, Branching, Robot Language Structure, various Textual Robot Languages Such as VAL II, RAIL and their Features, Typical Programming Examples such as Palletizing, Loading a Machine Etc.

(SLE: Survey of Robot level programming Languages ) 7 Hrs

Unit VI


**Industrial Applications:** Objectives, Automation in Manufacturing, Robot Application in Industry, Task Programming, Robot Intelligence and Task Planning, Modern Robots, Future Application and Challenges and Case Studies.

(SLE: Goals of AI Research, AI Techniques) 9 Hrs

**Text Books:**


**References:**

COMPUTER AIDED ENGINEERING (4-0-2)

SubCode: IAR0503                                                                                     CIE: 50%
Hrs/Week:06                                                                                                 SEE: 50%
SEE Hrs: 3Hrs                                                                                          Max.Marks:100

Course Outcomes:

After the successful completion of this course, the student will be able:

1. To design and do manufacturing planning of mechanical system using state of the art CAD/ CAM and CAE tools and integrated database.
2. To create and manipulate 2D and 3D objects on graphic work station
3. To explain surface modeling and solid modeling and the use of application software in designing mechanical systems
4. To use FEM in the design of mechanical system
5. To integrate technical skill with business activities of a company.

Unit I


Unit II

Transformation and Manipulation of Objects: Introduction, Homogeneous Co-ordinatesystem, 2D Transformation-Translation, Scaling, Rotation, Mirroring, Reflection, Concatenation, Manipulation of Simple Geometrical objects, Algorithms. (SLE: 3D Transformations) 8 Hrs

Unit III

Unit IV

**Finite Element Modeling and Analysis:** Introduction, Basic Concepts in FEM, Potential Energy Formulation and Closed form Solution, Galerkin Method, Bar element: Introduction, FE formulation, Properties of the Local Stiffness Matrix, Global Stiffness Matrix, Solution of the Truss Problem
(SLE: Weighted Residual Method.) 10 Hrs

Unit V

**One Dimensional Heat Transfer:** Introduction, Modes of Heat transfer, Governing equations, Finite element formulation, Conduction & Convection matrices & heat rate vectors. Heat transfer through Composite wall, Analysis of Fins. (SLE: Galerkin method) 9 Hrs

Unit VI

**Advances in CAD/CAM:** CIM, Architecture, Objectives, CIM Implementation, Agile Manufacturing, Reverse Engineering, Concurrent Engineering, Rapid Prototyping, Virtual Manufacturing & Prototyping and Factory of the Future. (SLE: The Enterprise and Product Modeling) 7 Hrs

Note: Laboratory classes are conducted for duration of 2 hours per week

Text Books:


References:

MODELING, SIMULATION AND ANALYSIS OF MANUFACTURING SYSTEMS
(4-2-0)

Sub Code: IAR0508 CIE: 50%
Hrs/Week: 06 SEE: 50%
SEE Hrs: 3Hrs Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able to:
1. Describe a model and document a problem in preparation for the application of simulation solution techniques
2. Recognize, model, and analyze typical queueing scenarios
3. Develop and apply appropriate random number and random variable generation techniques
4. Analyze, model, and select appropriate input distributions and to explain simulation time advance mechanisms
5. Apply appropriate simulation statistical output techniques
6. Use the Arena simulation language to model and analyze problems found in industrial engineering practice and to design and analyze a simulation experiment

Unit I

Principles of Modeling & Simulation: Basic Simulation Modeling, When simulation is appropriate, When simulation is not appropriate, Advantages and disadvantages and pitfalls of Simulation, Monte Carlo Simulation, Areas of Applications, Discrete and Continuous Systems, Modeling of a system, Types of Models, Discrete event simulation. (SLE: Steps in simulation study) 10 Hrs

Unit II

Modeling Approaches: Modeling Complex Systems, List processing in simulation, Simple simulation language, Single server queuing systems, Time shared computer model, Multiteller banking with jockeying, Job shop model. (SLE: Simulation Software) 8 Hrs

Unit III

Random Number Generation: Basic Probability and Statistics-Random variables and their properties, Properties of random numbers, generation of Pseudo random numbers, techniques for generating random numbers, Various tests for random numbers-frequency test, and test for Autocorrelation. (SLE: General procedure for hypothesis testing) 8Hrs
Unit IV

**Random Variate Generation:** Introduction, different techniques to generate random variate: Inverse transform technique, exponential, Normal, uniform, Weibull, direct transformation technique for normal and log normal distribution, convolution method and acceptance rejection techniques-Poission distribution.

**Output Data Analysis for a single system:** Types of simulation with respect to output analysis, transient and steady state behavior of a stochastic process.

\[ \text{(SLE: statistical analysis for terminating simulation)} \]  
\[ 10 \text{ Hrs} \]

Unit V

**Statistical Techniques:** Comparison of two system design, Comparison of several system design – Bonferroni approaches to multiple comparisons for selecting best fit, for screening, Variance reduction Techniques such as simple linear regression, multiple linear regression.

\[ \text{(SLE: Optimization via simulation)} \]  
\[ 8 \text{ Hrs} \]

Unit VI

**Simulation Studies:** Simulation of Inventory Problems,Discrete Event Simulation problems, Experimental Design and Optimization, $2^k$ factorial designs, Simulation of Manufacturing Systems.

\[ \text{(SLE:Case Studies)} \]  
\[ 8 \text{ Hrs} \]

**Text Books:**


**Reference Books:**

FINITE ELEMENT ANALYSIS (4-2-0)

Sub Code: IAR0509                                                                 CIE: 50%
Hrs/Week: 06                                                                                     SEE: 50%
SEE Hrs: 3Hrs                                                                                      Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able to:
1. Explain the concepts of Finite element analysis, matrix algebra and theory of elasticity.
2. Apply variational methods and solve problems in one dimensional and two dimensional analysis.
3. Apply various analytical methods such as Rayleigh-Ritz method, Galerkin method for solving cantilever beam problem and other structural problems.
4. Derive element stiffness matrix and apply the concept of numerical integration to solve different problems.
5. Solve problems in structural elements such as Trusses and Beams.
6. Undertake a project, create a mathematical model, analyze and address various issues pertaining to structures.

Unit I


Unit II

FEM Procedure: Derivation of FEM Equations by Variation Principle Polynomials, Concept of Shape Functions, and Derivation for Linear Simplex Element, Interpolation Polynomials in Global and Local Coordinates. (SLE: Need for Integral Forms) 7 Hrs

Unit III

Weighted Residual Methods: Concept of Weighted Residual Method, Derivation of FEM Equations by Galerkin’s Method, Solving Cantilever Beam Problem by Galerkin’s Approach, Derivation of Shape Functions for CST Triangular Elements, Shape Functions for Rectangular Elements, Shape Functions for Quadrilateral Elements. Higher Order Elements: Concept of Iso-Parametric Elements, Concept of Sub- Parametric and Super –Parametric Elements. (SLE: Concept of Jacobian Matrix.) 10 Hrs
Unit IV

**Numerical Integration:** Numerical Integration, One Point Formula and Two Point Formula for 2D, Different Problems of Numerical Integration Evaluation of Element Stiffness Matrix, (SLE: Automatic Mesh Generation Schemes)  

8 Hrs

Unit V

**Pascal’s Triangle Law** For 2D Shape Functions Polynomial, Pascal’s Triangle Law for 3D Shape Function Polynomials, Shape Function for Beam Elements, Hermitian Shape Functions.  
**Convergence:** Convergence Criteria, Compatibility Requirements, Geometric Isotropy, Invariance, Shape Functions for Iso-Parametric Elements, Direct Method for Deriving Shape Functions using Langrage’s Formula, Plane Stress Problems. (SLE: Special Characteristics of Stiffness Matrix)  

10 Hrs

Unit VI

**Analysis of Structures:** Truss Elements, Analysis of Truss Problems by Direct Stiffness Methods, Analysis of Frames and Different Problems. (SLE: Different Axi-Symmetric Truss Problems.)  

8 Hrs

Text Books:


References:

AUTOMATIC CONTROL SYSTEMS (4-2-0)

Sub Code: IAR0520                                      CIE: 50%
Hrs/Week: 06                                             SEE: 50%
SEE Hrs: 3Hrs                                            Max.Marks:100

**Course Outcome:**
After the successful completion of this course, the student will be able to:
1. An ability to apply knowledge of mathematics, science and engineering.
2. An ability to use the analysis and design tools of classical linear control.
3. An ability to use modern computer tools such as MatLab tools to solve control problems.
4. An ability to use appropriate method in various applications of control engineering aspects
5. An ability to understand various applications of control charts.

**Unit I**

Motivation for control. Review of differential equations, impulse response and Laplace
transformations, Introduction to state equations and transfer functions.
(SLE-linear systems, Definition of stability)  8 Hrs

**Unit II**

Interpretation of poles and zeros of transfer functions. Time domain response of second order
system. Command tracking and system type. Rough/Hurwitz test.
(SLE- Stability and performance specifications)  8 Hrs

**Unit III**

and gain margins. Bode phase formula.
(SLE- Lead/lag compensation)  8 Hrs
Unit IV


Unit V

Applications of Root locus, Sensitivity of roots of characteristics equation, Tool for design and analysis of control systems, Case studies using mat lab on Bode, Nyquist and Root locus. (SLE- Applications of root locus) 6 Hrs

Unit VI

State variable analysis and design, Introduction, Concepts of state variables for linear discrete time systems, Diagonalization solutions of state equations, Concepts of controllability and observability, Pole placement by state feedback, Observer systems, problems. (SLE-Introduction to multivariable control) 6 Hrs

Text Books:


Syllabus taken from the reference link:
http://www.aem.umn.edu/teaching/curriculum/syllabi/UGrad/AEM_4321_syllabus.shtml
KNOWLEDGE BASED DESIGN (4-0-0)

Sub Code: IAR0403                                                                 CIE: 50%
Hrs/Week: 04                                                                              SEE: 50%
SEE Hrs: 3Hrs                                                                            Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able:
1. To explain the concept of Artificial intelligence in CAD.
2. To apply the concept of knowledge representation and programming in an expert system.
3. To discuss the basic knowledge of decision support systems.
4. To apply the knowledge based design in a typical manufacturing system.
5. To develop problem solving skills through perceptron learning, competitive learning and to generate genetic algorithms through artificial life and society based learning.
6. To design an expert system through Fuzzy logic and neural networks.

Unit I


Unit II


Unit III

Unit IV


(SLE - Reasoning under Uncertainty)  
10 Hrs

Unit V

**Knowledge Based Design Aids**: Inference Process, Backward Chaining, Forward Chaining, Hybrid Chaining. Expert System Shells, Feature Based Modeling, Feature Recognition, Design by Features, Application of Feature Based Models.

(SLE - Role of AI in Manufacturing)  
8 Hrs

Unit VI


(SLE - Neural Networks)  
8 Hrs

**Text Books:**


**References:**

Course Outcome:

After the successful completion of this course, the student will be able:
1. To explain the basics of mechanisms related to velocity and acceleration.
2. To apply the fundamental laws of motion to analyze the response of linear systems.
3. To explain the ‘D’Alemberts principle and apply lagrange equations for conservative and non conservative systems.
4. To address the problems related to Holonomic and Non-Holonomic constraints.
5. To develop a mathematical program for intermittent rotary motion block synthesis and couplar curve synthesis using knowledge of complex algebra.
6. To discuss the special mechanisms applied to linkages.

Unit I

Geometry of Motion: Introduction, Analysis and Synthesis, Mechanism Terminology, Plane, Spherical and Spatial Mechanism, Mobility, Kinematic Inversion, Grashof’s Law, Mechanical Advantage, Couplar Curves, Velocity and Acceleration Analysis using Auxiliary Point Method, (SLE: Goodman Analysis) 8 Hrs

Unit II

System Dynamics: Motion of Gyroscopes, Mechanical Transients, Response of Linear Systems to Transient Forcing Functions Phase Plane Methods (SLE: Phase Plane Representation) 10 Hrs

Unit III

Unit IV

(SLE: Four Precision Points)  
10 Hrs

Unit V

**The Overlay Method:** Couplar Curve Synthesis using Complex Algebra, Freudenstein’s Equation, Synthesis of Dwell Mechanism Intermittent Rotary Motion Block Synthesis.
(SLE: Synthesis of Mechanical Error through Mathematical Programming.)  
8 Hrs

Unit VI

**Synthesis of Spatial Linkages:** Introduction to Spatial Linkage, Special Mechanisms, The Position Problem, Position Analysis of the Rggr Mechanism, the Eulerian Angles, A Theorem on Angular Velocities and Acceleration.
(SLE: Hook’s Universal Joint.)  
8 Hrs

**Text Books:**

**References:**
PRODUCT DESIGN AND DEVELOPMENT (4-0-0)

Sub Code: IAR0405                                                                 CIE: 50%
Hrs/Week: 04                                                                 SEE: 50%
SEE Hrs: 3Hrs                                                                 Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able:
1. To explain the design procedures involved in product development process.
2. To discuss the various methodologies involved in development of a product.
3. To implement the principles of product planning, identify the customer needs and to formulate a procedure to fulfill the customer specifications.
4. To identify the problem, develop a new concept to understand the various steps involved in concept testing such as survey population, measure customer response etc.
5. To define product architecture, analyze the implication of the architecture, identify the need for industrial design and discuss its implications.
6. To suggest the cost effective method for the estimation of manufacture cost, reduce the cost of components and also to create a prototype which meets the customer requirements.

Unit I

Introduction: Characteristics of successful product development, design and development of products, duration and cost of product development, the challenges of product development.

Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

(SLE: Product Development Practices followed by different companies.) 8 Hrs

Unit II

Product Planning: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

(SLE: Survey of FMCG products through questionnaire) 10 Hrs

Unit III

Concept Generation: The activity of concept generation clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process.

Concept Selection: Overview of methodology, concept screening, and concept scoring,
Concept Testing: Define the purpose of concept test, choose a survey population, choose asurvey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.  
(SLE: Pugh Selection for one problem solution)  
8 Hrs

Unit IV

Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.  
Industrial design: Assessing the need for industrial design, the impact of industrial design, industrial design, process, managing the industrial design process, assessing the quality of industrial design.  
(SLE: Hand sketching / CAD model creation of the concept.)  
10 Hrs

Unit V

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.  
Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes.  
(SLE: Group exercise of one FDM prototype, Advantages & Limitations of rapid prototyping)  
8 Hrs

Unit VI

Product Development Economics: Elements of economic analysis, base case financial mode,.Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.  
Managing Projects: Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.  
(SLE: Exercise of project planning and identification of critical path.)  
8 Hrs

Text books:


References:

Course Outcome:

After the successful completion of this course, the student will be able to:

1. Analyze several key technologies used in manipulating, storing, and analyzing big data.
2. Acquire clear understanding of processing data.
3. Acquire clear understanding of Hadoop map reduce.
5. Manage Big Data and analyze Big Data.
6. Apply tools and techniques to analyze Big Data.

Unit I

Introduction to big data:
(SLE: Predictive Analytics)  
9 hrs

Unit II

Processing big data:
Integrating disparate data stores - Mapping data to the programming framework Connecting and extracting data from storage - Transforming data for processing - Subdividing data in preparation for Hadoop Map Reduce.
(SLE: Data Preparation for Map Reduce)  
9 hrs

Unit III

Hadoopmapreduce:
Employing Hadoop Map Reduce - Creating the components of Hadoop Map Reduce jobs - Distributing data processing across server farms - Executing Hadoop Map Reduce jobs - Monitoring the progress of job flows - The Building Blocks of Hadoop Map Reduce - Distinguishing Hadoop daemons - Investigating the Hadoop Distributed File System Selecting appropriate execution modes: local, pseudo-distributed, fully distributed.
SLE: Applications of HadoopMapreduce 8hrs

Unit IV

Database Management System:
(SLE: Logical Database Design) 8 Hrs

Unit V

Data Base Models: DBMS Languages and Interfaces. Data Base Security and Authorization.
(SLE: Data Warehouse) 8 Hrs

Unit VI

Big data tools and techniques:
(SLE: Installing and Running Hive) 10 Hrs

Text Books:

References:
DRIVES AND CONTROL SYSTEMS FOR AUTOMATION (4-2-0)

Sub Code: IAR0505                                      CIE: 50%
Hrs/Week:06                                             SEE: 50%
SEE Hrs: 3Hrs                                           Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able:
1. To understand working principles of various types of motors, differences, characteristics and selection criteria.
2. To apply the knowledge in selection of motors, heating effects and braking concepts in various industrial applications.
3. To explain control methods of special drives.
4. To elucidate various linear and rotary motion principles and methods and use the same to application areas.
5. To carry out programming using PLC and use of various PLCs to Automation problems in industries.
6. To discuss supervisory control and data acquisition method and use the same in complex automation areas.
7. To understand and use logical elements and use of Human Machine Interfacing devices to enhance control & communication aspects of Automation.

Unit I

(SLE: Current control (sensor less vector control))  8 Hrs

Unit II

Industrials Drives: DC and AC motors operation and selection, method of control and application of brushless DC motor, PMSM, stepper motor, A.C servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects, electric braking, rheostatic and regenerative braking principles in power converters.
(SLE: The Hydraulic Motor)  10 Hrs
Unit III

Motion laws for rotary and linear systems: converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, Selection of converting systems, Dynamic response gearing, and control approaches of Robots, Control loops using Current amplifier. (SLE: control loops Using Voltage Amplifier.) 8 Hrs

Unit IV

Introduction to Programmable Logic Controllers: Definitions of PLC, basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing’s, types of variables, definition of firmware, software, programming software tool and interfacing with PC (RS232 & TCP-IP), methods of PLC programming (LD, ST, FBD & SFC), function blocks logical / mathematical operators & data types, array & data structure, PID, types of tasks and configuration, difference between relay logic and PLC, selection of PLC controller (case study) Centralized concept. (SLE: types of field bus systems) 8 Hrs

Unit V

Logic, instructions & Application of PLC: What is logic, Conventional Ladder v/s PLC ladder, series and parallel function of OR, AND, NOT logic, Ex Or logic, Analysis of rung. Timer and Counter Instructions; on delay and Off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers, Comparison and data handling instructions, Sequencer instruction, Visualization Systems, Types of visualization system, PC based Controller, Applications of HMI’s, and Interfacing of HMI with controllers. (SLE: Programming of HMI and its implementation) 10 Hrs

Unit VI

Supervisory control & data Acquisitions: Introduction to Supervisory control & data Acquisitions, distributed Control System (DCS): computer networks and communication in DCS. different BUS configurations used for industrial automation – GPIB, HART and OLE protocol, Industrial field bus – FIP (Factory Instrumentation Protocol), PROFIBUS (Process field bus), Bit bus. Interfacing of SCADA with controllers, Basic programming of SCADA, SCADA in PC based Controller / HMI, (SLE: Case study & implementation for different examples.) 8 Hrs
Lab Exercises:

**PLC Programming exercises on PLC/ Drives & Control/ SCADA**

1. Star-Delta - starting up
2. Road works traffic lights
3. Automatic tablet filler
4. Changing floor
5. Drilling tool
6. Pressing unit
7. Testing unit
8. Development & realization of SCADA programs

**Text Books:**

2. Andrew Parr, Industrial drives, Butterworth – Heineamann
4. Programmable Logic Controllers by W.Bolton

**References:**

2. Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania
5. Programmable Logic Controllers by Hugh Jack.
MICROPROCESSORS AND MICRO CONTROLLERS (4-0-2)

Sub Code: IAR0506  CIE: 50%
Hrs/Week: 06  SEE: 50%
SEE Hrs: 3Hrs  Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able:
1. To explain the internal organization of some popular microprocessors/microcontrollers.
2. To analyze the instruction set of microprocessors/microcontrollers
3. To discuss hardware and software interaction and integration.
4. To explain the design of microprocessors/microcontrollers-based systems for industrial automation systems.
5. To demonstrate interfacing examples using 8051 microcontroller
6. To develop assembly language source code for applications that use I/O ports, timer and Single/multiple interrupts

Unit I

Introduction to Microprocessors: Introduction to Microprocessors, Microprocessor based Computer Systems, Architecture of 8085, 8086 and Segmentation. (SLE: Memory Addressing.)  7 Hrs

Unit II


Unit III

Interrupt Systems, Memory and I/O Interfacing In Microprocessors: Introduction to Interrupts, Interrupt related Instructions, Interrupt Processing, Memory Devices, Address Decoding, 8/16-Bit Memory Interfacing, DRAM Memory Systems, Introduction to I/O Interfacing, Memory Mapped and I/O Mapped I/O; Application examples related to Stepper Motor. (SLE: Temperature Control and Robot Control)  8 Hrs
Unit IV


11 Hrs

Unit V


8 Hrs

Unit VI

Micro Controller Applications: Introduction, Key Boards, Displays, Pulse Measurement, D/A and A/D Conversions, Multiple Interrupts. (SLE: Programming the 8255)

7 Hrs

Note: Laboratory classes are conducted for duration of 2 hours per week

Text Books:


References:

SENSORS APPLICATIONS IN MANUFACTURING (4-0-0)

Sub Code: IAR0406                                                                 CIE: 50%
Hrs/Week: 04                                                                 SEE: 50%
SEE Hrs: 3Hrs                                                                 Max.Marks:100

Course outcome:

After the successful completion of this course, the student will be able to:
1. To explain various signal condition devices used in electronic devises and use of appropriate method in signal conditions in various applications
2. Analyse and choose appropriate sensors in different industrial applications.
3. To describe the impact of an RFID system on manufacturing, defense, distribution, retail and health sectors
4. To describe the methods to abstract (“filter”) information in RFID and other sensor networks
5. To integrate various sensors in developing Flexible Manufacturing Systems.
6. To describe the future advances to the quality and integrity of Manufacturing and related sectors resulting from the use of RFID and other sensor technologies

Unit I

(SLE: multiplexers and data acquisition systems)  8 Hrs

Unit II

Sensors and their applications: Inductive, capacitive, magnetic, various types of photo sensors, detection methods, through-beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors.
(SLE: limit switches)  8 Hrs

Unit III

Advanced Sensor Technologies: Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID (Radio Frequency Identification), electro-magnetic identifier, optical encoders ,color sensors, sensing principles, color theory, unit color measurement, colour comparator, color sensing algorithm, fuzzy logic color sensor. fuzzy logic for opt-electronic colour sensor in manufacturing.
(SLE: advantages and disadvantages of optical encoders)  10 Hrs
Unit IV

Sensors in Flexible Manufacturing Systems: Vision sensors, image transformations, robot visual sensing tasks, detecting partially visible objects, sensors in flexible manufacturing system cell.  
(SLE: edge detection and extraction.)  
8 Hrs

Unit V

Sensors for Special Applications: A multi objective approach for selection of sensors in manufacturing, cryogenic manufacturing applications, semiconductor absorption sensors, semiconductor temperature detector using photoluminescence temperature detectors using point-contact, sensors in process manufacturing plants, measurement of high temperature, robot control through sensors, other sensors, collection and generation of process signals in decentralized manufacturing system.  
(SLE: noncontact Sensors (pyrometers) multi sensor applications)  
10 Hrs

Unit VI

Networking: Networking of sensors, control of manufacturing process, tracking- the mean time between operations interventions, tracking the yield and mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing.  
(SLE: acoustic sensing)  
8 Hrs

Note: Lab Exercises on Inductive, Capacitive, Magnetic, Photo& Ultrasonic Sensors in order to understand their characteristics.

Text Books:
2. Mechatronics by W,Bolton,

References:
1. Sensor Technology Handbook by Jon S. Wilson 
2. N.L.Buck&T.G.Buckwith, Mechanical measurement. 
3. Sensors and Transducers by Ian Sinclair
COMPUTER AIDED PRODUCTION AND OPERATION MANAGEMENT (4-2-0)

Sub Code: IAR0522
Hrs/Week: 06
SEE Hrs: 3Hrs

Course Outcomes:

After the successful completion of this course, the student will be able:
1. To explain production systems and their management
2. To solve inventory related problems in a manufacturing setup and suggest on controlling costs.
3. To map various process and production and product information and formulate a Master Production schedule using Computers.
4. To identify areas of improvement and implement JIT in a Manufacturing setup.

Unit I

Management of Production Systems: Production system and its management, Classical, Behavioural & quantitative management, Introduction to CAP-OM.
(SLE: Tasks of a Production Manager) 6 Hrs

Unit II

(SLE: Transportation and Assignment models) 10 Hrs

Unit III

Forecasting and Capacity Planning: Forecasting and analysis, spreadsheet models, time series analysis, simple moving average, weighted moving average, simple exponential smoothing, exponential smoothing and correction, linear regression, regression analysis and Delphi method. Capacity analysis basics, introduction to capacity planning methods, linear programming for aggregate planning, basics of facility layout methods. Introduction to Line Balancing, precedence requirements of operations, methods of solution, real life problem.
(SLE: accuracy of forecasting) 10 Hrs
Unit IV

**Inventory systems**: Basic inventory systems, parameters of an inventory policy, costs associated with inventory policy, deterministic inventory models, simple EOQ model.
(SLE: model for finite production rate)  
10 Hrs

Unit V

**MRP system**: Master Production Schedule, Production scheduling and sequencing, MRP System, Computation in a MRP system, Information provided by the MRP system, ERP system.
(SLE: Modules in an ERP system)  
8 Hrs.

Unit VI

**Just in time manufacturing**: Kanban system, Dual card Kanban, Number of Kanbans Implementation of a JIT system.
(SLE: Purchasing under JIT.)  
8 Hrs

Text Books:

1. Operations Management: A Quantitative Approach, P. B. Mahapatra, Published 2010 by PHI Learning

References:

RAPID PROTOTYPING (4-2-0)

Sub Code: IAR0523 CIE: 50%
Hrs/Week: 06 SEE: 50%
SEE Hrs: 3Hrs Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able:
1. To explain the various techniques of Rapid-prototyping.
2. To elucidate all phases of prototyping including modeling, tooling and process optimization.
3. To describe the principles of Solid ground curing & LOM for a suitable operation.
4. To automate, optimize the process and enhance the performance of the system through Concept modelers, Rapid tooling and Optimization skills.
5. To take up a project work, analyze, and identify the proper RP technique which meets the requirements of the problem.
6. To apply the concept of Rapid-prototyping in fast growing industrial applications such as automobile industry, aircraft industry, etc.

Unit I

Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems
Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details,
(SLE: Application.) 7 Hrs

Unit II

(SLE: Path generation, Applications) 11 Hrs

Unit III

(SLE: LOM materials) 8 Hrs
Unit IV

**Concepts Modelers:** Principle, Thermal jet printer, Sander's model market. GenisysXs printer HP system 5, object Quadra systems. (SLE: 3-D printer)  
7 Hrs

Unit V

**Rapid Tooling:** Indirect Rapid tooling -Silicone rubber tooling –Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, etc Direct Rapid Tooling., AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling.  
(SLE: Soft Tooling v/s hard tooling)  
11 Hrs

Unit VI

**RP Process Optimization:** Factors influencing accuracy. Data preparation errors, Partbuilding errors, Error in finishing.  
(SLE: Influence of build orientation.)  
8 Hrs

**Text books:**


**References:**

MATHEMATICAL APPROACH TO ROBOTIC MANIPULATORS (4-2-0)

Sub Code: IAR0516
Hrs/Week: 06
SEE Hrs: 3 Hrs

Course Outcome:

After the successful completion of this course, the student will be able:
1. To explain the concepts of multifingered hands and dexterous manipulation.
2. To apply the rigid body transformations and lay basics of kinematics for redundant and parallel manipulators.
3. To explain the concepts of the open chain manipulators using Lagrange’s equations.
4. To address the issues regarding grasping using grasp planning and force closure analysis.
5. To solve simple problems on redundant and non manipulable systems using Kinematics and statics of Tendon actuation.
6. To describe the structure of non holonomic systems and understand the applications of robots in Hazardous environments and in medical applications.

Unit I

Introduction: Brief History, Multi-fingered Hands and Dexterous Manipulation.
(SLE: Applications) 6 Hrs

Unit II

Rigid Body Motion: Rigid Body Transformations, Rotational Motion in $\mathbb{R}^3$, Rigid Motion in $\mathbb{R}^3$, and Velocity of a Rigid Body, Wrenches and Reciprocal Screws.
Manipulator Kinematics: Introduction, Forward Kinematics, Inverse Kinematics, the Manipulator Jacobian.
(SLE: Redundant and Parallel Manipulators.) 10 Hrs

Unit III

Robot Dynamics and Control: Introduction, Lagrange’s Equations, and Dynamics of Open-Chain Manipulators, Lyapunov Stability Theory, Control of Constrained Manipulators.
(SLE: Position Control and Trajectory Tracking) 10 Hrs
Unit IV

(SLE: Rolling Contact Kinematics.) 8 Hrs

Unit V

Hand Dynamics and Control: Lagrange’s Equations with Constraints, Robot Hand Dynamics, Redundant and Nonmanipulable Robot Systems, Kinematics and Statics of Tendon Actuation,  
(SLE: Control of Robot Hands.) 9 Hrs

Unit VI

Future Prospects: Robots in Hazardous Environments, Medical Applications for Multifingered Hands, Robots on a Small Scale:  
(SLE: Microrobotics) 9 Hrs

Text books:


References:

ARTIFICIAL NEURAL NETWORKS & GENETIC ALGORITHMS (4-0-0)

Sub Code: IAR0407                                                                 CIE: 50%
Hrs/Week: 04                                                                 SEE: 50%
SEE Hrs: 3Hrs                                                                 Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able:
1. To address the optimization issues in Image processing
2. To explain the application of computers for the generation of genetic Algorithm
3. To analyse performance of multilayer network
4. To explain how (recurrent) networks behave.
5. To Find a way to teach networks to do a certain computation (e.g. ICA)
6. To implement various application of artificial neural network and apply in desired application by computer Implantation of a generic.

Unit I

Hopfield model: Associative memory problem, capacity of stochastic n/w.
(SLE: Model, stochastic networks) 8 Hrs

Unit II

Optimization problems: Weighted matching problem, Traveling salesman problem,
Graph bipartitioning, optimization problems in image processing Simple perceptrons: feed forward n/w, Threshold units, linear units, nonlinear units, stochastic units.
(SLE: capacity of simple perceptron.) 11 Hrs

Unit III

(SLE: Kohoanenself organizing network) 7 Hrs
Unit IV

**Recurrent Network:** Boltzmann network, Recurrent Back-propagation, Learning timesequence, Reinforcement learning.– Supervised, Unsupervised (Hebbian/Competitive), Adaptive resonance theory.
(SLE: Travelling salesman problem.)  
11 Hrs

Unit V

Neural Network: Application of Artificial Neural Network.

**Genetic Algorithms:** Mathematical Foundations.
(SLE: Introduction)  
8 Hrs

Unit VI

**Computer Implementation of a Genetic Algorithm:** Data Structures, Reproduction, Crossover and Mutation, Mapping objective functions to fitness form, Codings, Discretization, Constraints.
(SLE: Fitness scaling)  
7 Hrs

Text Books:


References:

COMPUTER VISION & IMAGE PROCESSING (4-0-0)

Sub Code: IAR0408  CIE: 50%
Hrs/Week: 04  SEE: 50%
SEE Hrs: 3Hrs  Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able:
1. Explain the applications of computer vision in automation.
2. Select the appropriate image processing technique for application.
3. Select the appropriate segmentation technique for the application.
4. Explain the importance of 3D reconstruction.
5. Explain the method of feature detection.

Unit I

Introduction: What is computer vision? A brief history, Image formation, Geometric primitives and transformations, Photometric image formation, The digital camera. (SLE: Image compression) 8 Hrs

Unit II

Image processing: Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Geometric transformations, Global optimization. (SLE: Image restoration) 8 Hrs

Unit III

Feature detection and matching: Points and patches, Feature detectors, Feature matching, Feature tracking, Edge detection, Edge linking, Lines, Successive approximation, Vanishing points. (SLE: Rectangle detection) 8 Hrs
Unit IV

Segmentation: Active contours, Split and merge, Mean shift and mode finding, K-means and mixtures of Gaussians, Normalized cuts, Graph cuts and energy-based methods.
(SLE: Medical image segmentation) 8 Hrs

Unit V

Stereo correspondence: Epipolar geometry, Sparse correspondence, Dense correspondence, Local methods, Global optimization, Multi-view stereo
(SLE: Volumetric and 3D surface reconstruction) 8 Hrs

Unit VI

3D reconstruction: Shape, Active rangefinding, Surface representations, Volumetric representations, Model-based reconstruction, Recovering texture maps.
(SLE: 3D photography) 8 Hrs

Text Books:


Reference Books:

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS IN AUTOMATION
(4-0-0)

Sub Code: IAR0409 CIE: 50%
Hrs/Week: 04 SEE: 50%
SEE Hrs: 3Hrs Max.Marks:100

Course Outcome:

After the successful completion of this course, the student will be able:
1. Explain the applications of AI.
2. Select search strategies based on application requirement.
3. Explain the knowledge representation methods.
4. Discuss the applications of uncertain knowledge and reasoning.
5. Discuss the architecture of expert systems.

Unit I

Artificial Intelligence: What is AI?, The Foundations of Artificial Intelligence, The History of Artificial Intelligence,
(SLE: State of the Art of AI applications) 8 Hrs

Unit II

(SLE: Comparing uninformed search strategies) 8 Hrs

Unit III

(SLE: Simulated annealing) 8 Hrs
Unit IV

**Knowledge Representation**: Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Semantic networks, Description logics, Reasoning with Default Information, Truth maintenance systems. (SLE: The Internet Shopping World) 8 Hrs

Unit V

**Uncertain knowledge and reasoning**: Quantifying Uncertainty, Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Bayes' Rule and Its Use, Probabilistic Reasoning, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, Inference by Markov chain simulation, Relational and First-Order Probability Models. (SLE: Other Approaches to Uncertain Reasoning) 8 Hrs

Unit VI


Text Books:


References: