2020

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (MS)

Deen Dayal Upadhyay KAUSHAL Kendra

Course Structure and Curriculum

Master of Vocation

(M.Voc)

In

Industrial Automation

Choice Based Credit System

& Outcome Based Curriculum

(Effective from July 2020 onwards)

Structure and Curriculum for Master of Vocation (M. Voc) in Industrial Automation

(Choice Based Credit System)

This M.Voc (Industrial Automation) program is divided in four semesters having 120 credits.

Preamble:

Dr. Babasaheb Ambedkar Marathwada University (BAMU) is offering a two-year Master program in vocation (M. Voc.). The curriculum design of this program is undertaken in the following framework (assumptions).

a) Although there has been remarkable progress in all sectors of education in last couple of decades, the less regulated area of the education sector-vocational training—seems to have lost its significance/importance. This has led to the widening gap between the supply and demand for skilled manpower across various industries and R&D organizations. This shortage of skills has translated directly into unemployment among an increasing number of graduates who pass-out every year and are forced to bare- trained in order to become market table.

This program is designed to produce a skilled manpower in Industrial Automation to improve the opportunities for the unemployed youths in the country in both the private and public sectors.

b) According to a study conducted by the Associated Chambers of Commerce and Industry of India (ASSOCHAM), there should be a deficit of 40 million working professionals by the year 2020 and the employers would face the difficulty of filling positions because of the dearth of suitable talent and skilled person all in their industry. This program aims to provide some solution for this problem and this would facilitate to improve:

- **(i) Quality of training**
- **(ii) High drop-out rates**
- **(iii) Linkages with Universities and industry**
- **(iv) Inadequacy of resources.**

c) This program is intended to offer practical training and skills needed to pursue an occupation straight away. It will provide options to the students to select the courses of their choice which are directly aligned to land a job in a chosen profession or a skilled trade.

d) This program is intended to offer students with life-long independent and reflective learning skills in their career.

Program Educational Objectives:

The objectives of M.Voc (Industrial Automation) program are to produce graduates who -

1. **Are equipped with time advanced knowledge of mechatronics and electronics to address multi-disciplinary demand of automated manufacturing, and process in modern industries in capacity of productive Senior System Developers, Senior System Integrators and Plant Supervisors.**
2. **Have an acute knowledge base to practice industrial automation in the areas of robotics, manufacturing, and process control in industry and Government settings meeting the growth expectations of stakeholders.**
3. **Have an ability to pursue higher studies and succeed in academic and professional careers.**
4. **Have the ability to address professional demands individually and as a team member communicating effectively in technical environment using modern tools.**
5. **Recognize the need for and possess the ability to engage in lifelong learning.**
6. **Should be sensitive to consequences of their work both ethically and professionally for productive professional career.**

Program Outcomes (PO):

Vocational Education is education that prepares the students for specific trades, crafts and career sat various levels and scopes. It trains the students from a trade/ craft, technician or professional position in R & D organizations.

The Program Outcomes are the skills and knowledge which the students have at each exit level/at the time of graduation. These Outcomes are generic and are common to all exit levels mentioned in the program structure. Graduates of the M.Voc program are expected to -

PO1. Domain knowledge: Apply advanced knowledge of the specific skill based trade for the solution of target skill sector.

PO2. Problem Analysis: Identify industry domain related problems at varied complexity and analyze the same to formulate/ develop substantiated conclusion using first principles of domain sectors and technical literature.

PO3. Design Development of solutions : Design / develop solutions for specific

critical problems in the target skill based trade to address changing challenges put forward by market demand/ stakeholder

PO4. Conduct Investigation of complex problems: Design and conduct technology enabled experiments, analyze the resulting data and interpret the same to provide valid conclusions

PO5. Modern tools: Use the techniques, skills and modern tools necessary skill-based trade to practice with clear understanding of limitations.

PO6. The citizenship and society: Apply sound understanding of ethical and professional skill-based trade practice in the context of global, economic, environmental and societal realities while encompassing relevant contemporary issues.

PO7. Environment and sustainability: Apply sound understanding of impact of skill-based trade in a global, economic, environmental and societal context.

PO8. Ethics: Apply ability to develop practical solutions for skill trade problems within positive professional and ethical boundaries.

PO9. Individual and team work: Function effectively as a leader and as well as team member in diverse/ multidisciplinary environments.

PO10. Communication: Communicate effectively in oral and written format addressing specific professional/ social demands.

PO11. Project management and finance: Demonstrate knowledge and understanding of the first principles of skill trade and apply these to one's own work as a member and leader in a team, to complete project in any environment.

PO12. Life-long learning: Recognize the need for and have the ability to address to the changing technological demands of the target skill trade.

<u>Program Specific Outcomes (PSO):</u>

Graduates of the M.Voc (Industrial Automation) program are expected to -

1. Apply advance knowledge of electronics, electrical, mechatronics fundamentals and Industrial automation specialization for the solution of automated manufacturing and process related problems.

2. Identify complex industrial automation related problems at varied complexity and analyze the same to formulate/ develop substantiated conclusion using advance

concepts of electronics, electrical and mechatronics and technical literature.

3. Design and conduct technology enabled experiments, analyze the resulting data and interpret the same to provide valid conclusions.

4. Use the techniques, skills and modern tools necessary for industrial automation practice with clear understanding of limitations.

Eligibility:

Those who have completed B.Voc (Industrial Automation)/ B. Sc with Physics / B. Sc. with Electronics/ B. E./ B. Tech (Electronics/ Electronics and Telecommunication/ Instrumentation/ Electrical/ Mechanical/ Mechatronics/Industrial Automation) from any recognized Board/ Institution are eligible for registration/ admission.

AND

Students having B. Sc degree with Physics or Electronics will have to complete at least 4 credits in terms of one theory courses namely – (i) Fundamentals of Hydraulics and Pneumatics during First year of M.VOC apart from courses being taught in course of regular academic session.

Admission / Promotion Process:

In response to the advertisement for registration, interested students will have to register themselves. Admission should be done on the basis of performance of students at Common Entrance Test (CET). The CET will be conducted in the month of June every year.

There is Full Carry on for M.Voc i.e. irrespective of individual performance in first year; a student should be promoted to Second Year. However, for obtaining M. Voc. Degree, a student will have to complete all semesters successfully within 4 years/ 08 semesters.

Choice Based Credit System (CBCS):

Choice-based credit system is going to be adopted by this Centre. This provides flexibility to make the system more responsive to the changing needs of our students, the professionals and society. It gives greater freedom to students to determine their own pace of study. The credit-based system also facilitates the transfer of credits. Students will have to earn 102 credits for the award of two years Master of Vocation (M. Voc)

Credit-to-contact hour Mapping:

(a) One Credit would mean equivalent of 15 periods of 60 minutes each for theory lecture.

(b) For lab course/ workshops/internship/field work/project, the credit weightage for equivalent hours shall be 50% that for lectures /workshop

(c) For self- learning, based on e-content or otherwise, the credit weightage for equivalent hours of study should be 50% or less of that for lectures/workshops.

Attendance:

Students must have 75 % of attendance in each course for appearing examination, otherwise he / she should be strictly not allowed for appearing the semester examination of each course. Frequent absence from regular lecture/practical course may lead to disqualification from CIA process in respective subject.

Departmental Committee:

The Departmental Committee (DC) of the Centre will monitor smooth functioning of the program.

Results Grievances / Redressal Committee

Grievances / redressal committee should be constituted in the department to resolve all grievances relating to the evaluation. The committee shall consist of Head of the department, the concerned teacher of a particular course and senior faculty member of Department of Committee. The decision of Grievances / redressal committee will have to be approved by Department committee.

Evaluation Methods:

- **The assessment will be based on 20: 80 ratio of continuous internal assessment (CIA) and semester end examination (SEE). Performance will be decided after combining performance in CIA and SEE. In case of failure in SEE in particular course(s), exam will be conducted in immediate subsequent semester. However, if a student fails in CIA (considering independent CIA score), he/she may appear for the same CIA, at his/her own responsibility in the next academic year, when the same course is offered during regular academic session.**

- **In case a student fails in certain course(s) in a particular semester and the same course(s) are modified/ revised/ removed from the curriculum in due course, the student will have to appear as per the newly framed curriculum and/or pattern in subsequent semester, at his/her own responsibility.**

Continuous Internal Assessment (CIA):

For 4 credit courses-

- **There will be 20 marks for Continuous Internal Assessment. Two internal tests (of 20 marks each) will be conducted, after completion of 40% and 80% of the curriculum respectively. Average performance of the two sets will be considered for final marks-memo preparation. The setting of question papers and the assessment will be done by concerned teacher.**

Semester End Examination (SEE):

- **The semester end theory examination for each theory course of 4 credits will be of 80 marks. Therefore, the total marks shall be 100 for 4 credit theory course (80 marks semester end exam + 20 marks CIA).**

- **Semester end examination (SEE) time table will be declared by the departmental committee (as per the university annual calendar). The paper setting and assessment of theory courses, laboratory courses and project will be done by external (50 %) and internal (50%) examiners. However, in case of non-availability of external examiner for either paper setting or assessment or both, department committee will be empowered to take appropriate decision.**

- **Pattern of semester end question paper will be as below:**

For 4 credit courses-

  - **The semester end examination of theory course will have two parts (20+60 = 80 Marks)**

  - **Part A will be consisting of 10 questions having 2 marks each (multiple choice questions / fill in the blanks/ answer in one sentence) as compulsory questions and it should cover entire syllabus**

  - **Part B will contain 05 questions of 12 marks each with equal weightage on every unit. Each of these questions will have two options, from which students will have to attempt anyone.**

  - **20 to 30% weightage can be given to problems/ numerical (wherever applicable) wherein use of non-programmable scientific calculator may be allowed.**

  - **Number of sub questions (with allotment of marks) in a question may be decided by the examiner.**

- **Assessment of laboratory courses and project will be carried out at the end of semester. Student must perform at least eight experiments from each laboratory course. The semester end practical examination will be conducted at the end of each semester along with the theory examination.**

- **Every student will have privilege for going through the assessed answer sheets (both CIA and SEE). Grievance, if any, should be immediately communicated to the Director, through concerned subject teacher.**

- **Grievance Applications received will be discussed by the Departmental committee and grievance redressal committee will be appointed accordingly.**

  The decisions of redressal committee will be discussed by the Departmental committee for necessary approval(s).

- **At the end of each semester, the Departmental Committee will assign grades to the students.**

- **The Director of the Centre shall send all results to the Director, Board of Assessment and evaluation for further processing**

Earning Credits:

- **At the end of every semester, a letter grade should be awarded in each course for which a student had registered. A student's performance should be measured by the number of credits that he/she earned by the weighted Grade Point Average (GPA). The SGPA (Semester Grade Point Average) should be awarded after completion of respective semester and the CGPA (Cumulative Grade Point Average) should be awarded at the final exit.**

Grading System:

- **The grading reflects a student-own proficiency in the course. A ten point rating scale shall be used for the evaluation of the performance of the students to provide letter grade for each course and overall grade for the Master Programme. Grade points are based on the total number of marks obtained by him / her in all heads of the examination of the course. The grade points and their equivalent range of marks are shown in Table-I**

Table – I : Ten point grade and grade description

Marks Obtained (%)	Grade Point	Letter Grade	Description
90-100	9.00- 10	O	Outstanding
80-89	8.00-8.99	A^{++}	Exceptional
70-79	7.00-7.99	A^{+}	Excellent
60-69	6.00-6.99	A	Very Good
55-59	5.50-5.99	B^{+}	Good
50-54	5.00-5.49	B	Fair
45-49	4.50-4.99	C^{++}	Average (Above)
41-44	4.01-4.49	C	Average
40	4.0	P	Pass
< 40	0.0	F	Fail (Unsatisfactory)
	0.0	AB	Absent

- **Non-appearance in any examination / assessment shall be treated as the students have secured zero marks in that subject examination / assessment.**
- **Minimum P grade (4.00 grade points) shall be the limit to clear / pass the course / subject. A student with F grade should be considered as "failed" in the concerned course and he / she has to clear the course by appearing in the next successive semester examinations. There should be no revaluation or recounting under this system.**
- **Every student shall be awarded grade points out of maximum 10 points in each subject (based on 10 point scale). Based on the grade points obtained in each subject, Semester Grade Point Average (SGPA) and then Cumulative Grade Point Average (CGPA) shall be computed. Results should be announced at the end of each semester and CGPA should be given at final exit.**

<u>Computation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average)</u>

Grade in each subject / course should be calculated based on the summation of marks obtained in all five units.

The computation of SGPA and CGPA should be as below

- **Semester Grade Point Average (SGPA) is the weighted average points obtained by the students in a semester and should be computed as follows –**

$$\text{SGPA} = \frac{\text{Sum (Course Credits) X Number of Grade Points in concerned Course Gained by the Student}}{\text{Sum (Course Credits)}}$$

The SGPA should be mentioned on the grade card at the end of every semester.

- **The Cumulative Grade Point Average (CGPA) should be used to describe the overall performance of a student in all semester of the course and should be computed as under.**

$$\text{CGPA} = \frac{\text{Sum (All six CGPA Semester SGPA)}}{\text{Total Number of Semesters}}$$

The SGPA and CGPA shall be rounded off to the second place of decimal.

<u>Grade Card</u>

Results should be declared by the Centre and the grade card (containing the grades obtained by the student along with SGPA) should be issued by the university after completion of every semester. The grade card should be consisting of following details.

- **Title of the courses along with code opted by the student.**
- **Credits associated with the course.**
- **Grades and grade points secured by the student.**
- **Total credits earned by the student in a particular semester.**
- **Total credits earned by the students till that semester.**
- **SGPA of the student.**
- **CGPA of the student (at final exit).**

<u>Cumulative Grade Card</u>

The grade card showing details grades secured by the student in each subject in all semesters along with overall CGPA should be issued by the University at final exit.

Course Structure
M.VOC Industrial Automation Program (Pattern 2020)

Sr. No.	Course Code	Name of the Course	Contact Hours Per Week			Evaluation Scheme		Credit
			L	T	P	CIA	SEE	
SEMESTER – I								
1	CC100	Constitution of India	2	0	0	10	40	2
2	IAMVOC111	Industrial Instrumentation	3	1	0	20	80	4
3	IAMVOC112	Programmable Logic Controllers	3	1	0	20	80	4
4A	IAMVOC113A	Kinematics and Dynamics of Robot	3	1	0	20	80	4
		OR						
4B	IAMVOC113B	Advance Process Control						
5A	IAMVOC114A	ARM Microcontroller	3	1	0	20	80	4
		OR						
5B	IAMVOC114B	8086 Microprocessor						
6	IAMVOC115	Project Management	3	1	0	20	80	4
7	IAMVOC116	Lab-Course	0	0	6	00	100	3
8	IAMVOC 117	Industrial Project – Phase I	100 hours (through semester)			-	150	5
Students have to choose any one subject from Sr. No. 4A and 4B and any one subject from Sr. No. 5A and 5B						Total Credits		30
SEMESTER – II								
1	IAMVOC211	Electrical Vehicles	3	1	0	20	80	4
2	IAMVOC212	Industrial Networking	3	1	0	20	80	4
3	IAMVOC213	Advance Hydraulics and Pneumatics	3	1	0	20	80	4
4	IAMVOC214	Advance IOT Applications	3	1	0	20	80	4
5A	IAMVOC215A	Cognitive Robotics	3	1	0	20	80	4
		OR						
5B	IAMVOC215B	Advance Manufacturing						
6	IAMVOC216	Mini Project	-----	0	----	00	150	5
7	IAMVOC217	Industrial Project – Phase II	100 hours (through semester)			-	150	5
Students have to choose any one subject from Sr. No. 5A and 5B						Total Credits		30
SEMESTER – III								
1	IAMVOC311	Computer Integrated Manufacturing (Self Study Mode)	4		0	20	80	4
2	IAMVOC312	Mini Project with specific Integrated Machineries in Lab	----		----	00	200	6
3	IAMVOC313	Industrial Project – Phase III	400 hrs (through semester)			-	600	20
						Total Credits		30
SEMESTER – IV								
1	IAMVOC411	Intellectual Property Rights (Self Study Mode)	4		0	20	80	4
2	IAMVOC412	Case Study Report of Any Existing Industrial Project	----		-----	00	200	6
3	IAMVOC413	Industrial Project – Phase IV	400 hrs (through semester)			-	600	20
							Total Credits	30
							Total Credits for Four Semesters	120

IAMVOC 111
Industrial Instrumentation

(04 credits – 100 marks)

Learning Objectives-

1. To introduce students to the multifaceted challenges in industrial process measurements
2. To provide insight on field instrumentation in process industries
3. Orient students with the advanced instrumentation trends

Learning Outcomes-

After completion of the course, students should be able to –

1. Explain basic building block of instrumentation systems
2. Recognize challenges in process variable monitoring and measurements
3. Describe operation of application specific instrumentation for temperature, flow and level measurement
4. Evaluate the importance of advanced sensor designs for challenging real time demands

---

Course Contents

Unit 1 **(10 Hrs)**

Introductory Concepts – Introduction to Instrumentation; Function Units; Classification; **Performance Characteristics -** Static and Dynamic Characteristics; **Errors in Measurement** - Gross Errors; Systematic Errors; Error Analysis; **Calibration and Standards –** Process of Calibration; Classification of Standards; Standards for Calibration; **Flowsheet Symbols –** Instrument Symbols; Tagging the Instruments; Functional Symbols; Control Loop; Control System

Unit 2 **(10 Hrs)**

Temperature Measurement Basics – Definitions and Standards; Techniques and Classification; **Electrical Type Temperature Sensors –** Resistance Temperature Detectors; Thermistors; IC Temperature Sensors; Thermo-emf thermometry; **Radiation Thermometry –** Total Radiation Pyrometry, Optical Pyrometer, Ratio thermometer; **Calibrators and Simulators**

Unit 3 **(10 Hrs)**

Flow Measurement Basics – Definitions and Standards; Techniques and Classification; **Head Types –** Orifice, Venturi, Flow Nozzle, Pitot Tube; Target Flowmeter; **Area Flowmeters -** Rotameters; Inductance Bridge type flow transmitter; Magnetic coupling type rotameter transmitter; **Mass Flowmeters –** Turbine Mass Flowmeter; Liquid Bridge Mass Flowmeter; Coriolis Force Flowmeter; Electrical Type Flowmeters – Turbomagnetic Flowmeters, Electromagnetic Flowmeters, Ultrasonic Flowmeters; Hot Wire Anemometer; **Solid Flow Measurement**

Unit 4 **(10 Hrs)**

Level Measurement Basics – Introduction; Techniques and Classification; **Float Types –** Float and Shaft Mechanism; Magnetic Float Type level gauging; Differential Bellows Element; **Displacer Types-** Torque Tube Assembly, Torque Tube and Flapper Nozzle Assembly; **Hydrostatic Types –** Pressure Gauge System; Purge method; Diaphragm box type; **Electrical Methods** - Resistance Switching type, Conductance Probe Method; Inductance/ Capacitance type gauging; Capacitive type gauging for conducting and non-conducting liquids; **Ultrasonic method**

Unit 5 **(10 Hrs)**

Advance Sensor Applications – Introduction; **Semiconductor Sensors –** Basics; Materials and Techniques; **Smart Sensors –** Definition; Configuration; **Microsensors –** Introduction; Inertial Sensors; Hall Effect Sensors; Polymer sensors; **Chemical Sensors –** Introduction; Semiconductive Gas Detectors; Ion Selective Electrodes; Conductometric Sensors; Mass Sensors; **Sensors in Robotics –** Status Sensors; Environment Sensors; Quality Control Sensors; Safety Sensors; Workcell Control Sensors

Unit 6 **(10 Hrs)**

Tutorials and Assignments based on Unit 1 to 5

REFERENCES

TEXT-

1. Principles of Industrial Instrumentation (Third Edition)- D. Patranobis (Mc Graw Hill)
2. Transducers and Instrumentation – D.V. Murty; Newnes (Elsevier)
3. Robotics and Control – R. K. Mittal, I. J. Nagrath (Mc Graw Hill)

SUGGESTED READING-

1. Process Measurement and Analysis – B. G. Liptak (Elsevier)
2. Industrial Instrumentation and Control (Third Edition) – S. K. Singh (Mc Graw Hill)
3. Modern Electronic Instrumentation and Measurement Techniques – A. D. Helfrick; W. D. Cooper (Prentice Hall of India)

WEB:

1. https://nptel.ac.in/courses/108/105/108105064/

IAMVOC 112
Programmable Logic Controllers

(04 credits – 100 marks)

Learning Objectives-

1. To introduce students to general hardware specifications of Programmable Logic Controllers and I/O devices
2. To develop concepts for creating ladder diagram from process control description
3. To equip students with basic to advanced level software tools for application of PLC in real-time operating conditions

Learning Outcomes-

After completion of the course, students should be able to –

1. Create Ladder Diagram from Process Control Descriptions
2. Apply PLC Timer and Counter Functions in real time applications
3. Apply PLC for Analog Signal Processing and Data Handling
4. Implement PID function with PLCs in process control applications

---

Course Contents

Unit 1 **(10 Hrs)**

Introductory Concepts - Introduction to Programmable Logic Controllers; Hardware considerations; Factors to consider in selecting a PLC; Input Devices; Output Actuators; I/O Processing (I/O Address, Signal Conditioning); PLC **Programming Basics -** General PLC Programming Procedure; Basic I/O Programming; Internal Relays; Creating Ladder Diagram from Process Control Descriptions

Unit 2 **(10 Hrs)**

Register Basics - Introduction to Registers; General Characteristics of Registers; Module Addressing; Holding Registers; Input Registers (Single and Group); Output Registers (Single and Group); **PLC Timer Functions –** Introduction to PLC Timers; PLC Timer Functions; Examples of Timer Function in Industrial Applications; Industrial Process Timing Applications; **PLC Counter Functions –** Introduction to PLC Counters; PLC Counter Functions; Examples of Counter Function in Industrial Applications; Industrial Process Counting Applications

Unit 3 **(10 Hrs)**

Arithmetic Functions – Introduction; PLC Addition and Subtraction; PLC Repititive Clock; PLC Multiplication, Division and Square Root; PLC Trigonometric and Log Functions; Other PLC Arithmetic Functions; **Number Comparison Functions –** Introduction, PLC basic Comparison Functions; Application of Comparison Functions; Advanced Comparison Functions; **SKIP and MASTER CONTROL RELAY Functions –** Introduction, SKIP Function and Applications, MASTER CONTROL RELAY Function and Applications

Unit 4 **(10 Hrs)**

Jump Functions – Introduction; Jump with Nonreturn; Jump with Return; **Data Move Systems –** Introduction; PLC MOVE Function and Applications Functions; Moving Large Blocks of PLC Data; PLC Table and Register Moves; Special MOVE Functions**; Data Handling Functions –** Introduction; PLC FIFO Function; FAL Function; One Shot (ONS) Function; Clear

(CLR) Function; SWEEP Function; **Digital Bit Functions and Applications –** Introduction; Bit Patterns in a Register; Changing a Register Bit Status; Shift Register Functions

Unit 5 **(10 Hrs)**

Analog PLC Operation – Introduction; Types of PLC Analog Modules and Systems; PLC Analog Signal Processing; BCD or Multibit Data Processing; PLC Analog Output Applications; **PID Control of Continuous Processes –** Introduction; PID Principles; Typical Continuous Process Control Curves; PID Modules; PID Tuning; Typical PID Functions; **Industry Applications Examples**

Unit 6 **(10 Hrs)**

Tutorials and Assignments based on Unit 1 to 5

REFERENCES

TEXT-

1. Programmable Logic Controllers: Principles and Applications (Fifth Edition)- J.W. Webb, R. A. Reiss; Prentice Hall of India
2. Programmable Logic Controllers (Fourth Edition) – W. Bolton; Newnes (Elsevier)

SUGGESTED READING-

1. Programmable Controllers: Theory and Implementation (Second Edition) - L. A. Bryan, E. A. Bryan (An Industrial Text Company Publication)
2. Programmable Logic Controllers (Second Edition) – J. A. Rehg, G. J. Sartori (Pearson)
3. Programmable Logic Controllers (Fifth Edition) – F. Petruzella (Mc Graw Hill Publishing Company)
4. Programmable Logic Controllers and Industrial Automation: An Introduction - M. Mitra, S. Sen Gupta (Penram International (India) Pvt. Ltd.)

IAMVOC 113A
Kinematics and Dynamics of Robotics

(04 credits – 100 marks)

Learning Objectives-

1. To introduce students with mathematical description of motion in robotics
2. To equip students with concept of kinematics and dynamics of Robot
3. To develop concepts among students in trajectory planning of a Robot

Learning Outcomes-

After completion of the course, students should be able to –

1. Describe Co-ordinate Frames, Mapping and Transforms of Robotic system
2. Explain DH parameters and jacobian computation in static analysis
3. Relate kinematics and dynamics of Robot
4. Assess and modify trajectory planning of a Robot

Course Contents

Unit 1 **(10 Hrs)**

Introduction to Robot: Industrial Robot Anatomy: links, joints and joint notation scheme, degree of freedom(DOF) in a manipulator, required DOF in a manipulator, arm configuration, wrist configuration, the end effector; **Co-ordinate Frames, mapping and transforms:** co-ordinate frames: mapping, mapping between rotated frames, mapping between translated frames, mapping between rotated and translated frames, Objects in a space, transformation of vectors: rotation of vectors, translation of vectors, combined rotation and translation of vectors, composite transformation, inverting a homogenous transform, fundamental rotation matrices : principal rotation matrices, principal axes rotation, fixed angle representation, euler angle representation, equivalent angle axis representation

Unit 2 **(10 Hrs)**

Symbolic Modeling of Robots- Direct Kinematic Model: mechanical structure and notations, description of links and joints, kinematic modelling of manipulator, Denavit-Hartenberg Notation, Kinematic Relationship between adjacent links, manipulator transformation matrix

Unit 3 **(10 Hrs)**

The Inverse Kinematics: Manipulator Workspace, solvability of inverse kinematic model: existence of solutions, multiple solutions,Solution Techniques, Closed from solution: guidelines to obtain cosed from solution,

Unit 4 **(10 Hrs)**

Dynamic Modelling: Lagrangian mechanics, two degree of freedom manipulator-dynamic model, Lagrange-Euler Formulation,: velocity of point on the manipulator, inertia tensor, kinetic energy, potential energy, equations of motion, the LE Dynamic model algorithm, Newton-Euler formulation, Newtons Equation, Eulers equation, Kinematics of links: link acceleration, recursive NE formulation, forward iteration, background iteration, Comparision of Lagrange Euler and Newton Euler formulation, Inverse Dynamics

Unit 5 **(10 Hrs)**

Trajectory Planning: Definition and planning tasks:terminology, steps in trajectory planning; Joint space technique:use of a p-degree polynomial as interpolation function, cubical polynomial trajectories, linear function and trajectory blends; cartesian space techniques: parametric description of a path, a straight line path, a circular path, position planning, orientation planning; Joint space versus cartesian space: Trajectory planning

Unit 6 **(10 Hrs)**

Tutorials and Assignments based on Unit 1 to 5

REFERENCES:

TEXT:

1. S.K. Saha, 'Introduction to Robotics', Second Edition, McGraw Hill Education Pvt. Ltd. 2015, ISBN-13:978-93-329-0280-0 and ISBN-10: 93-329-0280-1
2. R. K. Mittal and I. J. Nagrath, 'Robotics and Control', McGraw Hill Education Pvt. Ltd. 2013, ISBN-13: 978-0-07-048293-7 and ISBN-10: 0-07-048293-4

SUGGESTED READINGS:

1. S. R. Deb and S. Deb, 'Robotics Technology and Flexible Automation', Tata McGraw Hill Education Pvt. Ltd, 2016. ISBN-13: 978-0-07-007791-1, ISBN-10:0-07-007791-6
2. Dr. K.C. Jain and Dr. L. N. Aggarwal, 'ROBOTICS Principles and Practice', Khanna Publishers, 2005, ISBN No.: 81-7409-157-2
3. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics : Control, Sensing, Vision and Intelligence", McGraw Hill Education Pvt. Ltd, 2013, ISBN: 978-0-07-026510-3 and ISBN: 0-07-026510-0
4. Er. R. K. Rajput 'Robotics and Industrial Automation', S. Chand and Company, 2016, ISBN: 978-81-219-2997-4
5. YASNAC MRC Operator's Manual by YASKAWA Robotics

WEB:

1. https://nptel.ac.in/courses/112101098/24
2. https://onlinecourses.nptel.ac.in/noc18_me

MVOC 113B
Advanced Process Control

(04 Credits:100Marks)

Learning Objectives-

1. To introduce students with fundamental concepts of advanced process control technology
2. To develop concepts modelling for plant automation
3. To equip students with Advanced Process Control for application in real-time operating conditions

Learning Outcomes-

After completion of the course, students should be able to –

1. Discuss basic Control Loop Characteristics.
2. Identify the requirement of distributed control system.
3. Understand the modelling and simulation for plant Automation.
4. Understand the Intelligent Controllers.

Course Contents:

Unit 1 **(10 Hrs)**

Basic Control Theory: Control basics, control modes: PID controllers, PID variations, closed loop response, Control: cascade loops, feedback and feedforward control, interaction and decoupling, nonlinear and adaptive control, process gains, time lags, reaction curves, ratio control

Unit 2 **(10 Hrs)**

Control Loop Characteristics: Introduction, Control system configurations-single variable, cascade control, Multivariable control systems-analog control, supervisory and direct digital control, Control system quality-definition of quality, measure of quality, Stability-transfer function frequency dependence, stability criteria, Process Loop Tuning-open loop transient response method, Ziegler-Nichols method, Frequency response methods.

Unit 3 **(10 Hrs)**

Distributed Digital Control: Introduction, history, functional requirements of (Distributed) Process Control System, System Architecture, Distributed control systems

Unit 4 **(10 Hrs)**

Modelling and simulation for plant Automation: Introduction, definition of terms, Need of system modelling, uses of systems simulation, building a mathematical model for plant, model evaluvation and improvement, modern tools for modelling and simulation systems, application examples, **Case-studies**

Unit 5 **(10 Hrs)**

Intelligent Controllers: Introduction, model based controllers, predictive control, artificial intelligence based systems, expert controller, fuzzy logic system, fuzzy controller, fuzzy logic

tools, artificial neural networks, neural controllers, VLSI implementation of Neural Networks, Neuro-fuzzy control system.

Unit 6 **(10 Hrs)**

Tutorials and Assignments based on Unit 1 to 5

REFERENCES:

TEXT:

1. Krishna Kant; 2017; Computer–based industrial control(Second edition); PHI Learning PVT LTD; New Delhi (India).
2. Curtis D. Johnson; 2012 ; Process Control Instrumentation Technology (EIGHTH EDITION); PHI Learning PVT LTD; New Delhi (India).

SUGGESTED READING:

1. Surekha Bhanot; 2017 ; Process Control principles & applications (EIGHTH EDITION); Oxford university press; New Delhi (India).
2. N. P. Lieberman, E. P Lieberman; 2014; A Working Guide to Process Equipment (Fourth Edition), Mcgraw-Hill Book CoMyke King; 2010; Process Control: A Practical Approach; Wiley International
3. William Dunn; 2005; Fundamentals of Industrial Instrumentation and Process Control; McGraw-Hill; USA

WEB:

1. https://nptel.ac.in/courses/108105062/2
2.https://nptel.ac.in/courses/108105063/pdf/L 01(SM)(IA&C)%20((EE)NPTEL).pdf

IAMVOC 114A

ARM Microcontroller

(04 credits – 100 marks)

Learning Objectives-

1. To make students understand organization and instruction sets of ARM controller & ARM cortex controller
2. To make students able to interface peripheral devices with ARM controller

Learning Outcomes-

On completion of the course; students should be able to-

1. Illustrate ARM architecture and architectural support for system development & operating system.
2. Classify the addressing modes and different instruction set of ARM.
3. Understand an embedded hardware using ARM cortex microcontroller.
4. Design program & hardware for interfacing different peripheral devices with ARM.

Course Contents

Unit 1 **(10 Hrs)**

An Introduction to Processor Design - Processor architecture and organization; Abstraction in hardware design; MU0-A simple processor; Instruction set design; Processor design tradeoffs; The Reduced Instruction Set Computer; Design for low power; **The ARM Architecture -** The Acorn RISC Machine; Architectural inheritance; The ARM programming's Model; ARM development tools; ARM architecture variants; **ARM Assembly Language Programming -** Data processing instructions; Data transfer instructions; Control flow instructions

Unit 2 **(10 Hrs)**

ARM Organization and Instruction Set - 3-stage pipeline ARM organization; 5-stage pipeline ARM organization; ARM instruction execution; ARM implementation; The ARM coprocessor interface; **ARM instruction set** – Exceptions; Conditional Execution; Branch; branch with link(B;BL);branch; branch with link and exchange(BX; BLX); software interrupt (SWI); data processing instructions; multiply instructions; multiple register transfer instructions; Co-processor instructions; Breakpoint instructions; **Thumb Instruction set-** The Thumb bit in the CPSR; The Thumb programmer's model; Thumb branch instructions; Thumb software interrupt instruction; Thumb data processing instructions; Thumb single register data transfer instructions; Thumb multiple register data transfer instructions; Thumb breakpoint instruction; Thumb implementation; Thumb application

Unit 3 **(10 Hrs)**

Architectural Support for High level Language - Data types; floating point data types; ARM Floating point Architecture; Expressions; Conditional statements; Loops; Functions and Procedure; Use of memory; Run time environment; The ARM memory interface; The Advanced Microcontroller Bus Architecture (AMBA); The ARM reference peripheral specification

Hardware system prototyping tools; The ARMulator; The JTAG boundary scan test architecture; The ARM debug architecture

Unit 4 **(10 Hrs)**

System Development and operating system - An introduction to operating systems; The ARM system control coprocessor; CP15 protection Module registers; ARM protection Module;CP15 MMU registers; ARM-MMU architecture; Synchronization; Context switching; Input/output; ARM processor Cores ARM7TDMI; ARM8

Unit 5 **(10 Hrs)**

Memory hierarchy - Memory size and speed; ON-Chip memory; Caches; Cache design; Memory management; **ARM CORTEX Microcontroller -** Cortex -M Architecture; Registers; Reset; Memory; Operating Modes; The Software Development Process ARM Cortex-M Assembly Language; Syntax; Addressing Modes and Operands; Memory Access Instructions; Logical Operations; Shift Operations; Arithmetic Operations; Stack; Functions and Control Flow; Assembler Directives; Simplified Machine Language Execution; I/O Programming and the Direction Register; Switch Inputs and LED Outputs; Interrupt Programming and Real-time Systems; Analog I/O Interfacing

Unit 6 **(10 Hrs)**

Tutorials and Assignments based on Unit 1 to 5

REFERENCES

TEXT-

1. ARM System on chip Architecture (Second Edition) - Prof. Steve Furber; Pearson
2. Embedded Systems: Introduction to Arm(r) Cortex(tm)-M Microcontrollers (Fifth Edition) - Jonathan Valvano

SUGGESTED READING-

1. Arm System Developers Guide: Designing and Optimizing System Software (First Edition) – S. Andrew and D. Symes; Elsevier Science
2. ARM Assembly for Embedded Applications (Fifth Edition) – D. W. Lewis

WEB:

1. https://nptel.ac.in/courses/117106111/
2. https://nptel.ac.in/courses/108102045/5

IAMVOC 114B
8086 Microprocessor

(04 Credits:100Marks)

Learning Objectives-

1. To make students understand organization and instruction sets 8086 microprocessor
2. To make students able to interface peripheral devices with 8086 microprocessor

Learning Outcomes-

After completion of the course, students should be able to –

1. Illustrate 8086 architecture and architectural support for system development & operating system.
2. Classify the addressing modes and different instruction set of 8086 microprocessor.
3. Understand an embedded hardware using 8086 microprocessor.
4. Design program & hardware for interfacing different peripheral devices with 8086 microprocessor.

Course Contents:

Unit 1 **(10 Hrs)**

Introduction : Overview of Microcomputer structure and operation, memory, input / output, CPU, address bus, data bus, control bus, 8086 microprocessor family overview, 8086 internal architecture: execution unit, (flag register, general purpose register, ALU), Bus interface unit, segment register, stack pointer register, pointer and index register [Refer Douglas and Hall book for above articles], Pin out and pin functions of 8086 : The pin out, power supply requirements, DC characteristics, input characteristics, out put characteristics, pin connections (common pins, maximum mode pins and minimum mode pins) **Addressing Modes:** Data addressing modes: Register addressing, Immediate addressing, Direct addressing, register indirect addressing, base plus index addressing, register relative addressing, base relative plus index addressing, Programme memory addressing modes: Direct program memory addressing, relative program memory addressing, indirect program memory addressing; stack memory addressing modes.

Unit 2 **(10 Hrs)**

Data Movement Instructions: MOV revised: machine language, the opcode, MOD field, register assignments, R/M memory addressing, special addressing, PUSH/POP : PUSH, POP, initializing the stack; Miscellaneous data transfer instructions: XCHG, IN and OUT, **Arithmetic and Logic Instructions:** Addition, subtraction and comparison: Addition: Register addition, immediate addition, memory to register addition, array addition, increment addition, addition with carry; Subtraction: Register subtraction, immediate subtraction, decrement subtraction, subtraction with barrow; Comparison, Multiplication and division: Multiplication: 8 bit multiplication, 16 bit multiplication; Division: 8 bit division, 16 bit division; **Basic Logic Instructions:** AND, OR, Ex-OR, TEST, NOT, NEG; Shift and Rotate: Shift: left shift, right shift; Rotate: Rotate left, rotate right

Unit 3 **(10 Hrs)**

Program Control Instructions: The Jump Group: Unconditional jump: short jump, near jump, far jump, indirect jumps using an index; Conditional Jumps: LOOP, conditional LOOPs; Procedures: CALL, near CALL, far CALL, indirect memory address, RET; **Machine Control and Miscellaneous Instructions:** Controlling the carry flag bit, wait, HLT, NOP ; Assembly Language Programming: **Assembler directives:** ASSUME, DB, DD, DQ, DT, DW, END, ENDP, ENDS, EQU, EVEN, EXTRN, GLOBAL, GROUP, INCLUDE, LABEL, LENGTH, NAME, OFFSET, ORG, PROC, PTR, PUBLIC, SEGMENT, SHORT, TYPE [Refer Douglas and Hall book for above articles Assembly Language Programming: Sum of an array, factorial, largest / smallest from given array, sorting of numeric array, square root

Unit 4 **(10 Hrs)**

Memory Interfacing (with reference to 8086 Microprocessor): Memory devices: Memory pin connections, ROM memory, static RAM devices, Dynamic RAM memory, Address Decoding: simple NAND gate decoder, the 3 to 8 line decoder, the dual 2 to 4 line decoder, PROM decoder, 8086 memory interface

Unit 5 **(10 Hrs)**

Input / Out Interfacing(with reference to 8086 Microprocessor): Introduction to I/O interface, I/O instructions, isolated and memory mapped I/O, basic input and output interfaces, handshaking, I/O port address decoding: decoding of 8-bit I/O addresses, decoding of 16 – bit I/O address; **The programmable peripheral interface:** basic description of 8255, programming the 8255, mode 0 operation, an LCD display interfaced to 8255, a stepper motor interfaced to 8255, Mode 1 strobed input, mode1 strobed output , Mode 2 bisectional operation

Unit 6 **(10 Hrs)**

Tutorials and Assignments based on Unit 1 to 5

REFERENCES:

TEXT:

1. The Intel Microprocessors, Architecture Programming and interfacing, Barry B Brey ; Sixth Edition ; PHI
2. Microprocessors and Interfacing : Programming and Hardware, Douglas V Hall : II Edition ; Tata McGraw-Hill

SUGGESTED READING:

1. Microcomputer Systems : The 8086 / 8088 Family; Architecture, Programming and Design, Yu-Cheng Liu and Glenn A. Gibson ; PHI

2. The 8086/8088 Family:Design, Programming and Interfacing, John Uffenbeck, PHI

IAMVOC 115
Project Management

(04 credits –100 marks)

Learning Objectives-

To introduce students to project management and use this skill-set in relevant fields.

Learning Outcomes-

After completion of the course, students should be able to –

1. Apply Project management in essential skill-set for many careers and day to day problems
2. Apply Project Management to manage projects at work

Course Contents

Unit 1 **(10 Hrs)**

Introduction of Project Management, Project Success, Types of Structure Organizations, Project Management Office, Stakeholders Management

Unit 2 **(10 Hrs)**

Types of Projects and Project Life Cycle, Project Life Cycle Phases & Project Appraisal, Methods of Project Selection, Market and Demand Analysis

Unit 3 **(10 Hrs)**

Financial Analysis, Capital Budgeting Techniques, Risk Management, Stand Alone Risk Analysis, Hillier Model, Simulation Analysis, Product Mix and Plant Capacity Analysis

Unit 4 **(10 Hrs)**

Project team building, conflict, negotiation, HRM Issues and time Management, Project Time Management- Introduction, Project Time Management (Project Scheduling), Project Time Management- PERT Networks, Project Time Management- CPM, probability models in networks

Unit 5 **(10 Hrs)**

Time and Cost Relationship, Crashing of Networks, Introduction to Project Cost Management, Cost Control (Tools and Techniques), Cost Estimation, Introduction to Quality Management, Cost of Quality, Quality Management (Six Sigma Tools), Procurement Management

Unit 6 **(10 Hrs)**

Tutorials and Assignments based on Unit 1 to 5

REFERENCES:

TEXT:

1. The certified six sigma Green Belt Handbook,by Roderick A. Munro and Govindarajan Ramu and Daniel J. Zrymiak,; ASQ Quality Press and Infotech Standards India Pvt. Ltd. , ISBN-978087389891:
2. The Certified Six Sigma Black Belt Handbook by T. M. Kubiak and Donald W. Benbow; Pearson Publication, ISBN- 9788131728697

SUGGESTED READING:

1. Fundamentals of Quality Control and Improvement by Mitra, Amitava; Wiley India Pvt Ltd, ISBN- 9781118491645

WEB

1. https://www.youtube.com/channel/UC35NsIdqUF3RPCM_J7djCYg
2. https://www.youtube.com/channel/UCixCsqrW8tcoZMn_24f9wGA
3. https://onlinecourses.nptel.ac.in/noc19_mg30/preview
4. https://onlinecourses.nptel.ac.in/noc19_mg31/preview

IAMVOC 116
Lab-course

(03 credits: 100 marks)

1. Students have to perform at least 04 experiments from each section.
2. Students have to choose any one section each from Section C and Section D according to the optional subject they have chosen as theory

Section A

1 Study of RTD Characteristics and Implementation in a Closed Loop Circuit
2 Study of Thermocouple Characteristics and Implementation in a Closed Loop Circuit
3 Study of Temperature Transmitter Characteristics and Implementation in a Closed Loop Circuit
4 Study of Capacitive Level Transmitter Characteristics and Implementation in a Closed Loop Circuit
5 Calibration of a semiconductor LPG Sensor/ Ultrasonic Depth Sensor
6 To obtain the coefficient of discharge from experimental data by utilizing venturi meter and orifice meter

Section B

1 Implementation of Various Logic Gates in PLC Ladder Diagram (Software and Hardware)
2 Implementation of Different Timers and Counters in PLC Ladder Diagram (Software and Hardware)
3 Implementation of Memory Bit, Pulse Memory Bit and PWM Instruction in PLC Ladder Diagram (Software and Hardware)
4 Implementation of MOVE and Addition Instruction in PLC Ladder Diagram (Software and Hardware)
5 Implementation of JUMP and LABEL Instruction; use of Subroutine in PLC Ladder Diagram (Software and Hardware)
6 Implementation of PID Instruction in PLC Ladder Diagram (Software and Hardware)

Section C (A)

1 Determination of D-H Parameters of Industrial Robot
2 Calculation of Joint Accelerations of Industrial Robot while Robot Geometric, Inertial Parameters, Joint Torque and Forces are given (Study of FD)
3 Calculation of Joint Torque and Forces of Industrial Robot while Robot Geometric, Inertial Parameters, Joint Motions are given (Study of ID)
4 Determination of End -Effector's Configuration/ Transformation Consisting of its orientation and Position (Study of FK)
5 Determination of Joint Variables Corresponding to a given End -Effector's Orientation and Position (Study of IK)
6 Study of Motion Planning for an Industrial Robot

Section C (B)

1 Study of Controller Calibration
2 Study of Proportional Control
3 Study of Proportional Integral Control
4 Study of Proportional Integral Derivative Control
5 Study on PID Design by Process Reaction Curve Method
6 Study of Ratio Control

7 Study of Feedforward Control
8 Study of Cascade Control

Section D (A)

1 Study of interfacing of Switches with ARM – LPC2148
2 Study of interfacing of 16× 2 LCD with ARM – LPC2148
3 Study of interfacing of Multiplexed Seven segment display with ARM – LPC2148
4 Study of interfacing of ADC with ARM – LPC2148
5 Study of interfacing of DAC with ARM – LPC2148
6 Study of interfacing Stepper Motor with ARM – LPC2148
7 Study of Interfacing DC Motor with ARM – LPC2148

Section D (B)

1 Data transfer, addition, subtraction, multiplication, division and sum of series using 8086 microprocessor
2 Sorting of data (ascending/descending), square root of a number using 8086 microprocessor
3 Interfacing of SPDT switches and 7 segment display as a position encoder/decoder with 8086 microprocessor
4 Interfacing of stepper motor with 8086 microprocessor
5 Interfacing of DC motor with 8086 microprocessor
6 Interfacing of DAC to generate ramp wave, triangular wave and square wave with 8086 microprocessor
7 Interfacing of 8 bit ADC with 8086 microprocessor
8 Interfacing of LCD display with 8086 microprocessor

IAMVOC 117
Industrial Project- Phase I

(05 credits – 150 marks)

(Review of Literature / Industrial Process, Formulation of Topic, Experimental Plan)

Students are expected to go through review of literature on a particular technical aspect and/or pay industrial visit to identify a point of further study and investigation. The student (or group of students), thereafter, would propose a subject on basis of literature review and/or industrial orientations and will have to present a short seminar on his/her proposal to the board of examiners constituted by faculties of the department. If approved, he/she will be allowed to work on that particular project. Within a week after this approval, the student(s) will have to finalize their topic/subject of project and duly officiate it.

During phase – I of Industrial Project, it is expected that the student(s) will–

i. Build up a concrete fundamental of the concept on which they are going to work

ii. Carry out thorough literature survey to find out scope of work in the particular field

iii. Thereby, finalizing the topic of further study/investigation and finally, draft a systematic experimental plan to achieve projected goal

iv. Deliver regular presentations

v. Systematically document the above activities in bound volume and submit one copy to the department, one copy to concerned faculty and retain one copy with him/her.

NAAC Reaccredited Grade A CGPA – 3.22; 2019

Dr. Babasaheb Ambedkar Marathwada University,
Aurangabad (MS)

Deen Dayal Upadhyay KAUSHAL Kendra

MASTER OF VOCATION

SYLLABUS

Pattern

2020

INDUSTRIAL AUTOMATION

Semester –II, III and IV

Director, Deen Dayal Upadhyay KAUSHAL Kendra
director.ddukk@bamu.ac.in

M.VOC Industrial Automation
Semester II: Course Structure and Syllabus

Sr. No.	Course Code	Name of the Course	Contact Hours Per Week			Evaluation Scheme		Credit
			L	T	P	CIA	SEE	
1	IAMVOC211	Electrical Vehicles	3	1	0	20	80	4
2	IAMVOC212	Industrial Networking	3	1	0	20	80	4
3	IAMVOC213	Advance Hydraulics and Pneumatics	3	1	0	20	80	4
4	IAMVOC214	Advance IOT Applications	3	1	0	20	80	4
5A	IAMVOC215A	Cognitive Robotics	3	1	0	20	80	4
OR								
5B	IAMVOC215B	Advance Manufacturing						
6	IAMVOC216	Mini Project	---	0	---	00	150	5
7	IAMVOC217	Industrial Project – Phase II	100 hours (through semester)			00	150	5
Students have to choose any one course from Sr. No. 5A and 5B			Total Credits					30

IAMVOC211 Electrical Vehicles

(4 Credits 100 Marks)

Learning Objectives

1. To provide students with consideration aspects of Drive train in Electric Vehicles
2. To provide students with basic knowledge of propulsion unit in Electric Vehicles
3. To provide students with fundamental energy storage in Electric Vehicles
4. To introduce students with energy management strategies in Electric Vehicles

Course Outcomes

On completion of the Course, students should be able to-

1. Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
2. Explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles.
3. Analyze various electric drives suitable for hybrid electric vehicles.
4. Discuss different energy storage technologies used for hybrid electric vehicles and their control.
5. Demonstrate different configurations of electric vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components and design optimization and energy management.

Contents :

Unit 1 : Introduction to Hybrid Electric Vehicles (9 Hours)

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Unit 2 : Hybrid Electric Drive-trains (9 Hours)

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Unit 3 : Electric Propulsion unit (9 Hours)

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit 4 : Energy Storage: (9 Hours)

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor

based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Unit 5 : Energy Management Strategies: : (9 Hours)

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Unit :6 : (15 Hours)

Tutorials, Assignments, Demonstrations and Presentation based on Unit 1 to 5

REFERENCES:

TEXT:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003 ISBN 0203009398, 9780203009390.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004, ISBN 0-8493-3154-4.

SUGGESTED READING:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003, ISBN: 978-1-119-94273-3.

WEB:

1. https://nptel.ac.in/courses/108/106/108106170/
2. https://nptel.ac.in/courses/108/103/108103009/

IAMVOC212: Industrial Networking

(4 Credits: 100 Marks)

Learning Objectives

1. To introduce students with basics of various industrial networking protocols
2. To provide students with knowledge of different industrial networking protocols
3. To provide students with basic traits of installation practices in industrial networking

Course Outcomes

On completion of the Course, students should be able to-

1. Recognize the role of different network protocols in process automation
2. Explain basic traits of HART, Foundation Fieldbus, MODBUS, CAN Bus, Device Net and PROFIBUS
3. Apply concepts of installation basics in practical networking requirements

Course Contents:

Unit 1: Networks in Process Automation and Fieldbus (09 Hrs)

Networks in Process Automation – Introduction, Communication hierarchy in Factory Automation, I/O Bus Networks – Types, Network and Protocol Standards, OSI Reference Model – Networking at I/O and field levels, Networking at I/O and Field Levels, Networking at Control Level, Networking at Enterprise/ Management Level; Field bus- Concept, Evolution and Progress, Types, Expanded Network View; Topologies- Point-to-Point, Bus with Spurs, Tree, Daisy Chain, Mixed Topology; Terminators; Benefits of Fieldbus

Unit 2: Highway Addressable Remote Transducer (HART) (09 Hrs)

HART- Introduction, Evolution and adaptation of HART Protocol, HART and Smart Devices, HART Encoding and Waveform, HART Character, Addressing, Arbitration, Communication Modes, HART Networks, Field Device Calibration; HART Communication Layers – Physical, Datalink, Application; Installation and Guidelines for HART Networks; Device Descriptions, Applications in Control Systems and SCADA, Benefits

Unit 3: Foundation Fieldbus (09 Hrs)

Introduction, Definition and Features, Foundation Fieldbus Data Types, Architecture, Standards, H1 Benefits, HSE Benefits; Communication Process, Data Link Layer, Application Layer, Technology of Functional Fieldbus, Linking and Scheduling of Blocks, Device Information System Configuration

Unit 4: MODBUS, CAN Bus and Device Net (09 Hrs)

MODBUS-Introduction, Communication Stack, Network Architecture, Communication Transactions (Master- Slave and Broadcast Communications, Query Response Cycle), Protocol Description (PDU & ADU), Transmission Modes (ASCII Mode, RTU Mode) Message Framing (ASCII Framing, RTU Framing), MODBUS TCP/IP; CAN Bus – Introduction, Features, Types, CAN Frames, CAN Frames, CAN Data frame, CAN Arbitration, CAN Communication; Device

Net- Introduction, Features, Object Model, Protocol Layers, Physical Layer, Data Link Layer, Application Layer, Power Supply and Cables, Error States

Unit 5: PROFIBUS and Installation Practice (10 Hrs)

Profibus - Introduction, PROFIBUS Family, Transmission Technology, Communication Protocols, Device Classes, PROFIBUS in Automation, OSI Model of PROFIBUS Protocol Stack, PROFIBUS – DP Characteristics; Installation Practice – Introduction, HART Wiring, Building a Fieldbus Network, Powering Fieldbus Devices, Shielding, Cables, Number of Spurs and Devices per Segment, Polarity, Segment Voltage and Current Calculations, Linking Device, Device Coupler, Communication Signals, Device Commissioning, Foundation Fieldbus Device Commissioning; PROFIBUS-PA Fieldbus Device, Commissioning, Host Commissioning, Wiring and Addressing via Ethernet and IP, Ethernet, IEEE Ethernet Standards, Topologies, IP Basics, IP Commissioning, Subnet, Manual / Automatic IP Configuration

Unit 6: (14 hrs)

Tutorials, Assignments, Demonstrations and Presentation based on Unit 1 to 5

REFERENCES:

TEXT:

1. Sunit Kumar Sen, 'Fieldbus and Networking in Process Automation', CRC Press, Taylor and Francis Group, ISBN-13 : 978-1-4665-8677-2
2. Gary D Anderson, 'Industrial Network Basics: Practical Guides for the Industrial Technician', Volume 3, ISBN-13: 978-1500930936
3. Maglaras, Leandros A., Janicke, Helge, Jones, Kevin (Eds.), 'Industrial Networks and Intelligent Systems', Springer, ISBN-978-3-319-52568-6

SUGGESTED READING:

1. Lawrence (Larry) M. Thompson and Tim Shaw, 'Industrial Data Communications', International Society of Automation, ISBN: 978-0-87664-095-1
2. Dick Caro, 'Automation Network Selection: A Reference Manual', ISBN: 978-1-941546-80-2

WEB:

1. https://nptel.ac.in/courses/106105195/
2. https://nptel.ac.in/courses/108105088/48
3. https://nptel.ac.in/courses/106105166/5

IAMVOC213: Advanced Hydraulics and Pneumatics

(4 Credits: 100 Marks)

Learning Objectives

1. To provide students with consideration aspects in hydraulic circuit components
2. To provide students with basic tools for designing hydraulic circuits
3. To provide students with fundamental traits of pneumatic circuit design
4. To introduce students with advance trends and maintenance practices in hydraulics and pneumatics

Course Outcomes

On completion of the Course, students should be able to-

1. Implement selection consideration of primary hydraulic components
2. Explain basic aspects of hydraulic circuit design
3. Implement basic principles for designing pneumatic circuits
4. Recognize advance trends in hydraulic and pneumatic technology
5. State and Implement key rules of maintenance practice in hydraulics and pneumatics

Course Contents:

Unit 1: Selection Considerations of Hydraulic Circuit Components (09Hrs)

Recapitulation of basic hydraulic components, Hydraulic Pumps - Selection and sizing of hydraulic pump; Oil compatibility; Linear actuators- Cylinder force, flow velocity, cylinder efficiency, sizing, piston rod; Cylinder mounting; DCVs - Size and capacity ratings; General Guidelines for seal selection; Hydraulic pipes hoses and fittings- Pipe specification, Pipe Fittings- Selection of fittings and connectors, Energy Loss, Estimation of line diameter, Synthetic hydraulic hoses, Hose selection criteria, End fittings, Quick Coupling

Numerical on design considerations of various hydraulic components

Unit 2: Design of Hydraulic Circuits (09Hrs)

Basic Hydraulic circuits, Manual/Automatic Hydraulic Systems, Regenerative Circuits, Use of Check Valves, Standards in circuit diagram representation, Speed variation in cylinder motion, Functional Diagram and application, Electrical Control of hydraulic systems

Unit 3: Principles of Pneumatic Circuit Design (09 Hrs)

Basic standards of Pneumatic circuits- Functional Diagram in Pneumatic circuit design, sequential operations, movement diagram, cascade system of pneumatic circuit design, logics in pneumatic circuit design, Binary Arithmetic, Logic and Boolean Algebra, De Morgan's Theorem, Control equation, Application of K-V map for pneumatic circuit design, K-V diagram, Control problems; Electrical controls in pneumatic circuits

Basic Control problems

Unit 4: Advanced Trends in Hydraulics and Pneumatics (09 Hrs)

Advanced trends in Hydraulics- Electrohydraulic Servo System, Feedback consideration, Mechanical feedback; Servo valves; Torque Motors; Terminologies in Servo Technology; Advanced trends in Pneumatics- Introduction, Hydro pneumatics, Types of Hydro pneumatic system, hydro pneumatic cylinders, check units, Integral type cylinders; Fluidics- Elementary concepts, Low pressure pneumatics, Basic application, Pneumatic sensors

Unit 5: Maintenance Practice in Hydraulics and Pneumatics (09 Hrs)

Maintenance Practice in Hydraulics- Common faults, Repair procedure, failure due to contamination; Pump maintenance; Filter maintenance; Hydraulic system maintenance; Estimation of seal failure; faulty fitting of seals in cylinders; Fault Diagnosis, Standard Inspection Format, General Safety Measures

Maintenance Practice in Pneumatics- Maintenance needs, commonly encountered problem in pneumatics, Maintenance schedule of pneumatic system, Pressure Loss in Pneumatic Line, Seal failure, Troubleshooting standards; Maintenance of Air compressor.

Unit 6: (15 hrs)

Tutorials, Assignments, Demonstrations and Presentation based on Unit 1 to 5

REFERENCES:

TEXT:

1. S. R. Majumdar – Oil Hydraulic Systems: Principles and Maintenance, Tata McGraw Hill Education Pvt. Ltd., ISBN – 0-07-463-748-7
2. S R Majumdar - Pneumatic Systems: Principal and maintenance); Tata McGraw Hill Education Pvt. Ltd., ISBN 0-07-460-231-7

SUGGESTED READING:

1. W. Bolton – Pneumatic and Hydraulic Systems, Butterworth Heinemann, ISBN – 0-07-506-383-62
2. Anthony Esposito- Fluid Power with Application, Seventh Edition, Pearson Publication, ISBN- 97801351136904.
3. Parr – Hydraulics and Pneumatics: A Technician‘s and Engineer‘s Guide, Butterworth Heinemann, ISBN – 0-08-096-674-8

WEB

https://nptel.ac.in/courses/112105046/
https://nptel.ac.in/courses/105103021/

IAMVOC214: Advanced IOT Applications

(4 Credits: 100 Marks)

Learning Objectives:

1. To introduce students with basics of Industrial IoT.
2. To provide students with knowledge of connectivity technologies employed across Industry IOT domain
3. To acquaint students with traits of Industrial IOT based system design
4. To provide students with application of IOT in industries and other sectors

Course Outcomes:

On completion of the course, students should be able to –

1. Describe the connectivity technologies in IOT
2. Describe various Industrial processes
3. Explain role of IOT in industry, agriculture and other sectors
4. Recognize the role of IOT in industrial framework and other sectors

Course Contents:

Unit 1: Basics of Industrial IoT (09 hrs)

Introduction; IIoT vs Automation; Challenges in IIoT; Applications of IIoT: Healthcare industry, Mining industry, Manufacturing industry, Transportation & logistics, Firefighting; Industrial Internet System: Introduction; Three Waves of Innovation: The Industrial Revolution, The Internet Revolution, The Industrial Internet; Three Key Elements: Intelligent Machines, Advanced Analytics, People at Work; Applications of Industrial internet

Unit 2: Industrial Sensing & Actuation: (09 hrs)

Introduction, Need of Sensing for Industry; Requirements for Industrial Standard; Industrial Sensing; Smart Sensor; Configurations involved in Smart Sensors; Smart Sensor Functions; Examples of Industrial sensors; Electro-hydrostatic Actuation System; Electro-pneumatic systems

Unit 3: Industrial Processes (09 hrs)

Challenges for Industrial Processes in Industry 4.0; Design Philosophy: IIoT for Industrial Processes; Expected Features of Industrial Processes with Industry 4.0; Futuristic Industrial Plant; Futuristic Industrial Plant: 5C Architecture for Cyber Physical Systems; Industrial Processes Enablers; Smart Factory of Future; Functional Viewpoint of Industrial Processes; Industry 4.0 – Different Sectors

Unit 4: Industrial Communication (09 hrs)

Industrial Ethernet: ModBus-TCP, EtherCat, EtherNet/IP, Profinet, TSN, Fieldbus: Modbus-RTU, Profibus, Interbus, CC-Link, DeviceNet, Communication Infrastructure: Wired Connectivity, Wireless Connectivity

IIoT with AI; Applications of IIoT with Machine Learning, Cloud computing in IIOT, IIOT Application case studies

Unit 6: **(15 hrs)**

Tutorials, Assignments, Demonstrations and Presentation based on Unit 1 to 5

REFERENCES:

TEXT:

1. Giacomo Veneri and Antonio Capasso- Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry; Packt Publishing; 1st edition (29 November 2018); ISBN : 1789537223
2. Ismail Butun; Industrial IoT: Challenges, Design Principles, Applications, and Security; Springer 2020; ISBN 10: 3030424995
3. A. Suresh, Malarvizhi Nandagopal, Pethuru Raj, E. A. Neeba, Jenn-Wei Lin; Industrial IoT Application Architectures and Use Cases; Auerbach Publications (2020); ISBN 10: 0367343088

SUGGESTED READING:

1. Arshdeep Bahga and Vijay Madisetti; Internet of Things: A Hands-on Approach; Universities Press; ISBN- 9788173719547
2. Adrian Mcewen and Hakin Cassimally; Designing The Internet of Things; Willey; ISBN-10: 8126556862
3. Pethuru Raj, Anupama C. Raman; The Internet of Things: Enabling Technologies, Platforms, and Use Cases; Auerbach Publications; ISBN 9781498761284
4. Marco Schwartz; Internet of Things with ESP8266; Packt Publishing; ISBN 9781786468024
5. Pethuru Raj and Anupama C. Raman; The Internet of Things, Enabling Technologies, Platforms, and Use Cases; CRC Press; ISBN 9781498761284

WEB:

1. https://nptel.ac.in/courses/106/105/106105195/
2. https://nptel.ac.in/courses/106/105/106105166/
3. https://nptel.ac.in/courses/108/106/108106022/

IAMVOC215A: Cognitive Robotics

(4 Credits: 100 Marks)

Learning Objectives:

1. To provide students with foundational concepts of Cognitive Robotics
2. To acquaint students with Cognitive Robot Paradigms and Architecture
3. To provide students basic concepts on ethical, social and cultural aspects of cognitive robotics

Course Outcomes:

On completion of the Course, students should be able to-

1. Discuss foundational aspects of cognitive robotics
2. Describe cognitive robot paradigms and control architecture
3. Recognize role of sensors in cognitive robotics relam
4. Conceptualize cognitive humanoids
5. Explain ethical, cultural and social aspects of cognitive robots

Course Contents

Unit-1: Foundation Elements (08 hrs)

Introduction to Cognitive Robotics, Artificial Intelligence, Machine Learning and Robotics; How can a machine be intelligent; Social implications of robotics; Areas of Artificial Intelligence in Robotics; Animal Behaviour, Reflexive Behaviour; Coordination and Control of Behaviours; Perception in behaviours; Schema Theory; Principles and Issues in Transferring Insights to Robots

Unit-2: Basic Robot Paradigms and Control Architecture (10 hrs)

History of Cognitive Psychology, The Computer Analogy, Early Cognitive Robots; Action Control - Feedforward and Feedback Control in Humans, Feedforward and Feedback Control in Robots, Robotic Action Planning, Acquisition of Action Control; Hierarchical Paradigm - Attributes of the Hierarchical Paradigm, Representative Architectures, Advantages and Disadvantages; Reactive Paradigm - Attributes of Reactive Paradigm; Characteristics and connotations of reactive behaviours, Advantages of programming by behaviour, Representative architectures

Unit-3: Sensing Techniques and Hybrid Paradigm (10 hrs)

Sensing Techniques - Overview, Logical sensors, Behavioural Sensor Fusion, designing a Sensor Suite, Proprioceptive Sensors, Proximity Sensors, Computer Vision, Range from Vision; Hybrid Deliberative/Reactive Paradigm – Overview, Attributes, Characteristics and connotation of reactive behaviors in hybrids, Architectural Aspects, Managerial Architectures, Different Robots in hybrid paradigm, Other Robots in the Hybrid Paradigm, Evaluation of Hybrid Architectures, Interleaving Deliberation and Reactive Control

Unit-4: Bottom-Up Integration towards Cognitive Humanoids (09 hrs)

Robot Learning - A Cognitive Robotics Approach, Perceiving the Environment- Object Detection: icVision & CGP-IP, Interacting with the Environment- Collision Avoidance and World Model: MoBeE, Action Repertoire: TRM & LEOGrasper, Integration - Closing the Action-Perception Loop; Avoiding a Moving Obstacle, Reaching and Grasping Objects; Smart materials for Cognitive Robotics

Unit-5: Ethical, Cultural & Social Aspects of Cognitive Robotics (08 hrs)

Introduction, Blaming a Robot - The Robot as a Quasi-Person, The Robot as a Quasi-Animal, The Robot as a Manmade Object, Punishing the Robot; Blaming Homo Sapiens; Negligence And Product Liability Laws- The First Robot Fatality, Robots and the Laws of Negligence, Robots and the Laws of Product Liability, When Robots Are Modified or Misused, Other Considerations of Legal Responsibility, Summary of Legal Consideration; Effects Of Cultural Context, Social Robots, Effects of Robots' Social Role on Decision Making; A Cognitive Model For Determining Human Willingness to Engage with Collaborative Robots

Unit-6: (15 hrs)

Tutorials, Assignments, Demonstrations and Presentation Based On Unit 1 to Unit 5

REFERENCES:

TEXT:

1. Hooman Samani (ed.), 'Cognitive Robotics', First Edition, CRC Press, ISBN: 978-1-4822-4457-1
2. Robin R, Murphy, 'Introduction to AI Robotics', Third Edition, The MIT Press, ISBN: 0-262-13383-0

WEB:

1. https://nptel.ac.in/courses/112/104/112104293/

IAMVOC215B: Advance Manufacturing

(4 Credits: 100 Marks)

Learning Objectives:

1. To introduce students with basic aspects of production system
2. To provide students with knowledge of management issues that must be addressed in implementation of manufacturing systems
3. To acquaint students with various mathematical models of production performance and manufacturing
4. To provide insight of role of automation in manufacturing industry

Course Outcomes

On completion of the Course, students should be able to-

1. Explain basic dimensions of modern production systems
2. Describe mathematical models of production performance and manufacturing costs
3. Discuss role of automation and material handling technologies to create manufacturing systems and address automated assembly as a distinct field of automation
4. Construct a profile of what the future automated manufacturing will probably be like

Course Contents

Unit-1: Production systems (09 hrs)

Production systems, automation in production systems, automation principle and strategies, manufacturing industries and products, manufacturing operations, production facilities

Unit-2: Mathematical models of Production performance (09 hrs)

Mathematical models of Production performance: production rate, production capacity, utilization and availability, manufacturing lead time, work in process, manufacturing costs.

Unit-3: Introduction to manufacturing systems (09 hrs)

Components of manufacturing systems: production machines, material handling systems, computer handling system, human resources; Classification Scheme for Manufacturing Systems: types of operations performed, number of workstations, system layout, automation and manning levels, part or product variety; Overview of classification scheme: single station cells, multi-station systems with fixed routing, multi-station systems with variable routing

Unit-4: Single station manufacturing cells & automated production lines (09 hrs)

Single station manufacturing cells: Single station manned workstations, single station automated cells: enablers for unattended cell operation, parts storage subsystem and automatic parts transfer

Application of single station cells, analysis of single-station systems: number of workstations required, machine clusters

Automated production lines: Fundamentals of automated production lines: system configurations, work part transfer mechanism, storage buffers control of production line, application

Unit-5: Automated Assembly systems and inspection technology (09 hrs)

Fundamentals of Automated assembly systems: system configurations, parts delivery at workstations, application; Quantitative analysis of assembly stations: parts delivery system at workstations, multistation assembly system, single-station automatic assembly system; Inspection technology – CMM, Vision based inspection

Unit-6: (15 hrs)

Tutorials, Assignments, Demonstrations and Presentation Based on Unit 1 to Unit 5

REFERENCES:

TEXT:

1. Mikell P Groover, 'Automated Production Systems, and computer integrated manufacturing', Third Edition, Pearson Education, Inc. 2016, ISBN-978-93-325-4981-4
2. Kapil Gupta, 'Advanced Manufacturing Technologies- Modern Machining, Advanced Joining, Sustainable Manufacturing', Springer. 2017, ISBN 9783319560984; 9783319560991
3. Tien-chien Chang, Richard A Wysk, Hsu-Pin Wang, 'Computer aided manufacturing", Third Edition, Pearson Education, Inc. 2019 ISBN: 978-81-317-2164-3
4. A.Alavudeen, N. Venkateshwaran 'Computer aided manufacturing', PHI Learning Private Limited, 2008. ISBN: 978-81-203-3345-1

SUGGESTED READING:

1. K.K. Shivanand, M.M.Benal,V.Koti, 'Flexible Manufacturing System', New age Publishers, ISBN-10 : 8122418708, ISBN-13 : 978-8122418705
2. Mikell P Groover, 'Fundamentals of Modern Manufacturing:Materials, processes and systems', Fifth Edition, Wiley. 2012, ISBN-978-11-183-9367-3
3. Er. R. K. Rajput 'Robotics and Industrial Automation', S. Chand and Company, 2016, ISBN: 978-81-219-2997-4
4. P.N.Rao, N.K.Tewari, T.K.Kundra 'Computer aided manufacturing', Tata McGraw Hill Education Pvt. Ltd, 2017, ISBN-13: 978-0-07-463103-4 and ISBN-10:0-07-463103-9
5. S. Kant Vajpayee, ' Principles of Computer-Integrated Manufacturing', PHI Learning Private Limited, 2015, ISBN-978-81-203-1476-4

WEB:

1. https://nptel.ac.in/courses/112107077/
2. https://nptel.ac.in/courses/112104028/3
3. https://nptel.ac.in/courses/112107078/

IAMVOC216: Mini Project

(5 Credits: 150 Marks)

Course Outcomes:

On completion of this course, students should gain-

- Critical thinking in problem solving
- Presentation and communication skills
- Report organization and writing skills
- Independent learning and information integration skills
- Project management skill
- Work as an individual, with support from a supervisor, formulating solutions to day-to-day problems by integrating knowledge and experience gained on the course and outside the course.

Activity

Students or group of students (max.03) have to prepare a comprehensive project proposal based on theory and laboratory courses they have covered in Semester – I and will be covering under Semester – II during the semester under supervision of project guide. After approval of the proposal by the Director, students will be allowed to work on the project. Working Model/ Demonstration model of the project along with the project report have to be submitted to the project guide before the semester end examination. Final evaluation of Mini Project coursework will be based on power-point presentation, demonstration and viva-voce examination.

IAMVOC217: Industrial Project – Phase III

(5 Credits: 150 Marks)

Experimental work to be continued with the approved project. Final evaluation will be based on power-point presentation, demonstration and viva-voce examination.

M.VOC Industrial Automation
Semester III: Course Structure and Syllabus

Sr. No.	Course Code	Name of the Course	Contact Hours Per Week			Evaluation Scheme		Credit
			L	T	P	CIA	SEE	
1	IAMVOC311	Computer Integrated Manufacturing (Self-Study Mode)	0	4	0	20	80	4
2	IAMVOC312	Mini Project with specific Integrated Machineries in Lab	-----	----	00	00	200	6
3	IAMVOC313	Industrial Project – Phase III	400 hours (through semester)			---	600	20
							Total Credits	30

IAMVOC311: Computer Integrated Manufacturing
(Self- Study Mode)

(4 Credits: 100 Marks)

Learning Objectives

1. To introduce students with basic traits of Computer Integrated Manufacturing
2. To provide students introductory concepts of computer graphics and computer geometric modelling
3. To provide students with fundamental concepts of working and programming of NC and CNC machines
4. To acquaint students with diversified spectrum of Computer Aided Manufacturing

Course Outcomes

On completion of the Course, students should be able to-

1. Recognize the diversified role of computers in modern manufacturing fabric
2. Describe basic traits of computer-based design related to manufacturing industries
3. Explain operation of NC and CNC machines
4. Discuss different horizon of computer aided modern manufacturing

Course Contents:

Unit 1: Introduction to Computer Integrated Manufacturing (CIM) (12 Hrs)

Introduction to CIM, Data flow in CIM, CIM wheel, Processes involved in CIM, Necessity of CIM, Advantages, CIM integration, Applications of CIM, Challenges, Subsystems in CIM, Present industry scenario; Computers and Manufacturing System – Production system overview, Facilities, Manufacturing systems, Manufacturing support system, Sequence of information processing activities; Automation in production systems, Computerized manufacturing support systems, Reasons for automation; Manual labour in production systems, Automation principles and strategies, Automation migration strategy; Computer aided technologies, Terminologies

Unit 2: Computers and Manufacturing System (12 Hrs)

Computers in manufacturing industries – Concepts of Industry 4.0, Artificial Intelligence, Machine learning, Deep learning, Digital learning, Smart manufacturing, IOT, Cloud based manufacturing; Future Prospects; Computer Graphics – Concept of design, Coordinate systems in CAD, Transformation of geometry, Colour models; Computer Geometric Modelling – modelling – Steps, Requirements, Functions, Geometric models, Comparison of different geometric models

Unit 3: Computer Numerical Control (12 Hrs)

Concepts of Numerical Control (NC) and Computer Numerical Control (CNC), Difference between NC and CNC, Types of CNC machines, Elements of CNC system; CNC Machining; CNC Tooling; CNC Part Programming – Types, Preparatory and Miscellaneous codes, Manual part programming, Computer assisted programming, Part programming using APT; Concept of CAD/CAM programming, Overview of CAM software

Unit 4: Computer Aided Manufacturing – I **(12 Hrs)**

Introduction to group technology, Benefits, Part Family, Coding systems, Limitations of GT; Process planning details, Stages of computer aided process planning stages, Framework, Approaches; CAD/CAM integration; Advance manufacturing planning; Flexible Manufacturing System – Introduction, FMC/FMS components, FMS applications consideration, Analysis of FMS, Alternative approaches to FMS; Automatic Identification Methods – Concept, Requirement, Bar-code, RFID, AIDC Technologies

Unit 5: Computer Aided Manufacturing - II **(12 Hrs)**

Computer Aided Quality Control – Introduction, Inspection methodology, Types of inspection techniques, Coordinate metrology, Coordinate Measuring Machine, CMM controls, DCC, CMM software overview, Machine Vision; Rapid Manufacturing (RM) – Introduction, Steps involved in RM, Classification of RM processes, Rapid Tooling, Geometrical freedom, Application of RM, Disadvantages; Material Handling – Material transport systems, Material handling, Logistics, Flowrate, Routing scheduling, Plant layout, Unit load principle, Material transport equipment, Vehicle management, Conveyors

Unit 6:

Tutorials, Assignments, Demonstrations and Presentation based on Unit 1 to 5

REFERENCES:

WEB SUPPORT:

1. Lectures of Professor J. Ramkumar (Department of Mechanical Engineering, IIT, Kanpur) on 'Computer Integrated Manufacturing' available with NPTEL ; https://nptel.ac.in/courses/112/104/112104289/

SUGGESTED READING:

1. Mikell P Groover, 'Automated Production Systems, and computer integrated manufacturing', Third Edition, Pearson Education, Inc.; ISBN: 978-93-325-4981-4
2. P N Rao, N K Tewari, T K Kundra, 'Computer Aided Manufacturing', Mc Graw Hill; ISBN: 978-00-074-6310-3
3. Tien-chien Chang, Richard A Wysk, Hsu-Pin Wang, 'Computer aided manufacturing', Third Edition, Pearson Education, Inc.; ISBN: 978-81-317-2164-3
4. A.Alavudeen, N. Venkateshwaran 'Computer aided manufacturing', PHI Learning Private Limited, 2008. ISBN: 978-81-203-3345-1
5. K.K. Shivanand, M.M.Benal, V.Koti, 'Flexible Manufacturing System', New age Publishers; ISBN-13 : 978-8122418705
6. S. Kant Vajpayee, ' Principles of Computer-Integrated Manufacturing', PHI Learning Private Limited, 2015, ISBN-978-81-203-1476-4

IAMVOC312: Mini Project with specific Integrated Machineries in Lab

(6 Credits: 200 Marks)

Course Outcomes:

On completion of this course, students should be able to –

1. Recognize elements of a modular FMS in CIM lab
2. Recognize elements of unit manufacturing cell in CIM lab
3. Conceptualize role of computer in modern manufacturing
4. Develop program for controlling operations of modular FMS/unit manufacturing cell in CIM Lab
5. Apply programming logic in complex industrial operations

Activity

Group of students (max.03) have to undertake project on part of modular FMS / unit manufacturing cell in CIM lab. Each group should decide a specific task on the unit and get it approved by the faculty – in – charge. Flowchart and program should be developed by the group thereafter to accomplish the said task. Demonstration of the program along with the project report have to be submitted to the project guide before the semester end examination. Final evaluation of Mini Project coursework will be based on power-point presentation, demonstration and viva-voce examination.

IAMVOC313: Industrial Project – Phase II

(20 Credits: 600 Marks)

Experimental work to be continued with the approved project. Final evaluation of Industrial Project -Phase III coursework will be based on power-point presentation, demonstration (if the experimental work is at requisite matured stage) and viva-voce examination.

M.VOC Industrial Automation
Semester IV: Course Structure and Syllabus

Sr. No.	Course Code	Name of the Course	Contact Hours Per Week			Evaluation Scheme		Credit
			L	T	P	CIA	SEE	
1	IAMVOC411	Intellectual Property Rights (Self-Study Mode)	0	4	0	20	80	4
2	IAMVOC412	Case Study Report of Any Existing Industrial Project	----	----	00	00	200	6
3	IAMVOC413	Industrial Project – Phase IV	400 hours (through semester)			---	600	20
							Total Credits	30

IAMVOC411: Intellectual Property Rights
(Self- Study Mode)

(4 Credits: 100 Marks)

Learning Objectives

This course is intended mainly to acquaint students with fundamental concepts of IPR, basics of patent law, know the requirements of patentability, learn how to read and interpret patent specifications, analyze patent office procedures and case studies for developing the basic understanding for drafting a patent specification. The course also looks forward to give fundamental ideas and procedures of other dimensions of IPR namely Copyright, Design and GI. Mostly, Indian perspectives of IPR will be discussed.

Course Outcomes

On completion of the Course, students should be able to-

1. Recognize the different dimensions of Intellectual Properties and subsequent Rights
2. Discuss basic traits pertaining to different dimensions of Intellectual Property Acts
3. Express requirements of a Patent Specification
4. Describe steps of Patent prosecution
5. Recognize practices of patent office

Course Contents:

Unit 1: Introduction to IPR and Patents (10 Hrs)

Introduction to Intellectual Property, Concept of property and rights in IPR, Meaning of intellectual in IPR, Characterises of IP, Kinds of IPR, Rights granted by IP, Intangible economy, Traits of intangibility, Enforcement of IP; Patents- Introductory concepts, Subject matter, Patents in India, To file or not to file a patent, Publish or Patent, Who can file a patent, When and how to file a patent, Requirements of a patent application, Types of Patent application

Unit 2: Patents (13 Hrs)

Patent law as concepts, Understanding the patent act and rules, Preliminary sections, Preliminary rules, Reading patent act and rules; Patentability of Inventions, Inventions not patentable, Novelty, Anticipations, Inventive step, Capable of Industrial Application, Person skilled in art, Prior knowledge; Drafting of patents -Complete and Provisional specifications, Contents of specifications, Structure of a patent specification, Drafting of Provisional specification, Drafting of Complete specification; Patent search; Case study

Unit 3: Patent Prosecution (13 Hrs)

Powers of Controller, Patents of Addition, Priority Dates, Publication of Application, Request for Examination, Examination of Application, Expedited Examination of Application, Search for Anticipation, Procedure in case of Anticipation, Consideration of Report of Examiner, Refuse, Require Amendment, and Division of Applications, Dating of Application and Anticipation,

Potential Infringement, Orders Regarding Substitution of Applicants, Putting Applications in Order for Grant, Amendments during Prosecution, Introduction to Opposition to Grant of Patents

Pre-Grant Opposition, Post-Grant Opposition, Opposition in General

Unit 4: Practices at Patent Office **(13 Hrs)**

Secrecy Provisions, Grant of Patents, Rights conferred by Grant, Rights of Co-Owners of Patents and Power of Controller to give directions, Patent obtained by Fraud of True and First Inventor, Term of Patent, Restoration of Lapsed Patents, Surrender of Patents, Revocation of Patents, Register of Patents, Patent Office and its Establishment, Patent Agents, Use and Acquisition by Government, Penalties; Introduction to compulsory licensing

Unit 5: Trademark, GI, Design, Copyright **(11 Hrs)**

Trade Marks, International Arrangements, Trade marks in India, What can be protected, Registration of trade mark, Rights and Defences; Geographical Indication; Design; Introduction to copyright – Copyright in India, Criteria of protection, Subject matter, Rights an infringement, Educational exceptions; Case studies

Unit 6:

Tutorials, Assignments, Demonstrations and Presentation based on Unit 1 to 5

REFERENCES:

WEB SUPPORT:

1. Lectures of Professor Feroz Ali (Department of Humanities and Social Sciences, IIT Madras) on 'Intellectual Property' available with NPTEL; https://nptel.ac.in/courses/109/106/109106137/
2. Lectures of Professor Feroz Ali (Department of Humanities and Social Sciences, IIT Madras) on 'Patent Laws for Scientists and Engineers' available with NPTEL; https://nptel.ac.in/courses/110/106/110106081/

SUGGESTED READING:

1. V. K. Ahuja, 'Intellectual Property Rights in India', Lexis Nexis; ISBN: 978-9351433880
2. V. K. Ahuja, 'Law Relating to Intellectual Property Rights', Lexis Nexis; ISBN: 978-8131251652
3. 'Intellectual Property Laws', Universal's Legal Manual, ISBN: 978-9350355855
4. 'Manual of Patent Office Practice and Procedure-2019', The Office of Controller General of Patents, Designs & Trademarks; IPO
5. 'The Patents Act-1970' ; IPO
6. 'Manual of Designs Practice and Procedure', The Office of Controller General of Patents, Designs & Trademarks; IPO
7. 'Manual of Trademarks Practice and Procedure', The Office of Controller General of Patents, Designs & Trademarks; IPO
8. 'Practice and Procedure Manual', Copyright Office

IAMVOC412: Case Study Report of Any Existing Industrial Project

(6 Credits: 200 Marks)

Course Outcomes:

On completion of this course, students should be able to –

1. Recognize the underlying factors of problem identification/manufacturing support in industrial realm
2. Apprehend the procedural steps towards root cause analysis and comprehensive solution approach
3. Conceptualize financial planning issues in commissioning a project
4. Realize pay off and benefit cost analysis

Activity

1. Students (group of max 3 students) should identify one industrial project commissioned in industry - to alleviate certain problem/to support existing manufacturing facility. They are expected to study the project in depth and submit a detailed report to the department on –

    i. Problem identification process
    ii. Justification for machineries installation
    iii. Economic Considerations (elements of cost, capital cost, facility cost etc.)
    iv. Payoff and cost benefit analysis
    v. Installation aspects & safety measures installed
    vi. Co-working of the project with existing systems in the plant
    vii. Benefit factors

Final evaluation will be based on presentation, and viva-voce examination

IAMVOC413: Industrial Project – Phase IV

(20 Credits: 600 Marks)

Students are expected to work on concluding part of the experimental work, analyze the results, standardize the complete work with optimum aesthetic integration before submitting to the department. A neatly prepared report in soft-format (CD) should be submitted to the department along with the project. Final evaluation of Industrial Project -Phase IV coursework will be based on power-point presentation, demonstration and viva-voce examination.