YESHWANTRAO CHAVAN COLLEGE OF ENGINEERING
(An Autonomous Institution affiliated to R T M Nagpur University Nagpur)
Accredited by NAAC (1st Cycle) with 'A' Grade (Score 3.25 on 4 Point Scale)
Wanadongri, Hingna Road, Nagpur-441110

Department of Mechanical Engineering
(Minor in IMAML)

B.E. Minor in Integrated Manufacturing and Machine Learning
SoE & Syllabus 2021-22

B.E. Minor In Integrated Manufacturing and Machine Learning

Information Brochure of Minor Program

1. Title of Program: **INTEGRATED MANUFACTURING AND MACHINE LEARNING**
2. Type of Program: **Minor**
3. Department offering the program: **Mechanical Engineering**
4. Industry / Association / Collaboration: _Nil
5. Department/s eligible to opt for the program:

   The students from CV, EL, EE, ETC, CT, IT, CSE are eligible to opt for this program. Department of Mechanical Engineering students are not permitted to opt for the program

6. General information about courses in program:

   The nature of manufacturing systems faces ever more complex, dynamic and at times even chaotic behaviors. In order to being able to satisfy the demand for high-quality products in an efficient manner, it is essential to utilize all means available. One area, which saw fast pace developments in terms of not only promising results but also usability, is machine learning. Promising an answer to many of the old and new challenges of manufacturing, machine learning is widely discussed by researchers and practitioners alike. However, the field is very broad and even confusing which presents a challenge and a barrier hindering wide application. Manufacturing is a very established industry, however the importance of it cannot be rated high enough. Several mature economies experienced a reduction of the manufacturing contribution toward their GDP over the last decades. However, in the last years, several initiatives to revamp the manufacturing sector were started. This course contributes in presenting an overview of available machine learning techniques and structuring this rather complicated area. A special focus is laid on the potential benefit, and examples of successful applications in a manufacturing environment.

7. Employability potential of program:

   Number of graduates produced in each year by higher education institutions is increasing. Thus prediction of employability of graduate's plays a vital role for any industry for proper talent

acquisition and Utilization and also it helps students in identifying the qualification and skills that they need to improve, before completion of degree to get desired jobs. In this Digital Revolution, informal learning and skill enhancements is happening in unconditional method, relating and converging all this learning's to the employability rate is one of a biggest issue. The main objective is to address this issue by predicting and forecasting the skill acquisition continuously and mapping to industry needs using machine learning Algorithms. The proposed course used different machine learning algorithms like Logistic Regression, Decision tree, k-nearest neighbor, Support Vector Machine and Naïve Bayes for building model where ANN classifier resulted with the highest accuracy. This course would be helpful for all the students for employability prediction

8. Departmental Steering committee: For proper publicity / conduct of program

SN	Name of the Faculty Member	Post	Designation	e-mail ID	Contact Number
1	Dr. S. S. Chaudhari	Chairman	HOD	hod_me@ycce.edu	9545531727
2	Dr.J.P.Giri	Member	Associate Professor	jayantpgiri@gmail.com	9822929871
3	Prof.A.P.Edlabadkar	Member	Assistant Professor	ajinkyae@gmail.com	9764478622
4	Prof.A.R.Narkhede	Member	Assistant Professor	alok.narkhede@gmail.com	7666767483

9. Departmental coordinator

SN	Name of the Faculty Member	Post	Designation	e-mail ID	Contact Number
1	Prof.A.R.Narkhede	Member	Assistant Professor	alok.narkhede@gmail.com	7666767483

Scheme of Examinations
B.E. Minor in Integrated Manufacturing and Machine Learning

SN	Sem	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
					L	T	P	Hrs		MSEs*	TA**	ESE	
1	5	MEM101	Mechatronics	**T**	3	0	0	3	3	30	30	40	3
2	5	MEM102	Lab: Mechatronics	**P**	0	0	2	1	1	---	60	40	3
3	5	MEM103	Computer Integrated Manufacturing	**T**	3	0	0	3	3	30	30	40	3
4	6	MEM111	Fluid Power System	**T**	3	0	0	3	3	30	30	40	3
5	6	MEM112	Lab: Fluid Power System	**P**	0	0	2	1	1	---	60	40	3
6	6	MEM113	Machine Learning	**T**	3	0	0	3	3	30	30	40	3
7	7	MEM121	Industrial Robotics	**T**	3	0	0	3	3	30	30	40	3
8	7	MEM122	Lab Industrial Robotics	**P**	0	0	2	1	1	---	60	40	3
			TOTAL		**15**	**0**	**6**	**18**	**18**				

MSEs* = Three MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment

TA ** = for Theory : 20 marks on lecture quizzes, 8 marks on assignments, 2 marks on class performance

TA = for Practical : MSPA will be 15 marks each**

V Semester

MEM101	Mechatronics			L=3	T=0	P=0	Credits= 3
Evaluation Scheme *Best Two out of three MSE's would be considered	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Tota	ESE Duration
	15	15	15	30	40	100	3 Hrs.
Prerequisites							

Objective	Course Outcome
(1)Understand the concept of Mechatronics (2)Develop the ability to understand the working of various electronically and computer control devices. (3)Concept development to bridge the existing gap between machines, Automation and Computer control system.	(I) Students will be able to model various mechatronic systems. (II) Students will be able to understand the working of various motors used in mechatronic systems. Analyze the characteristics and use of various IC's (III) Student will be able to analyze the characteristics and use various IC's. (IV) Students will be able to analyze the internal hardware structure in Mechatronics Systems.

Unit 1 **[7 hrs]**

Introduction, sensors, actuators, modeling of systems. Recent trend of designing machine units along with electronic circuits for operation and supervision of mechanisms. Techniques of interfacing mechanical devices with computer hardware.

Unit 2 **[8 hrs]**

Basic principles ,working and specific applications of armature and field controlled D.C. Motors, Variable voltage and variable frequency control of 3 phase and single phase Induction motors, speed control of synchronous motors, Different types of stepper motors-Constriction ,working and application. Position control of stepper motors.

Unit 3 **[8 hrs]**

Common and commercial I.Cs used for amplification, timing and digital indication.
Different types of actuators, working of synchro-transmitter and receiver set, Pressure to current (P/I) and l/P conversion. Electrical and hydraulic servomotors.
Design of solenoid plungers and pressure and force amplification devices.

Unit 4 **[7 hrs]**

Add-on cards for sampling and actuation, 4-20 mA ports, AD-DA conversion, Peripheral interface organization, general layout of data bus and data transfer through serial and parallel modes of communication, schemes of computer networking and hierarchy in supervisory control.

Unit 5 **[8 hrs]**

Study of various integrated systems by using block diagrams. Study of systems used in Ink Jet Printers, Photo copying, Washing Machines, IC Engine fuel injection system etc

Unit 6 **[7 hrs]**

General philosophy of Artificial Neural Network simulations, Fuzzy logic for operation and control of mechatronic systems.

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Introduction to Mechatronics and Measurement Systems	2007	Michael B.Histand and David G. Alciatore	Tata McGraw-Hill Education
2	Mechatronics	2007	Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ.,	Chapman and Hall, 1991
3	Microprocessor Architecture, Programming and Applications	2002	Ramesh.S, Gaonkar	Prentice Hall
4	Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics	1996	Lawrence J.Kamm	John Wiley and Sons
5	Introduction to Microprocessors for Engineers and Scientists	2004,	Ghosh, P.K. and Sridhar	PHI Learning Pvt. Ltd.

V Semester

MEM102	Lab : Mechatronics			L= 0	T = 0	P = 1	Credits = 1
Evaluation Scheme	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Total	ESE Duration
*Best Two out of three MSE's would be considered	--	--	--	60	40	100	3 Hrs
Prerequisites							

Objective	Course Outcome
(1) Understand the concept of Mechatronics (2) Develop the ability to understand the working of various electronically and computer control devices. (3) Concept development to bridge the existing gap between machines, Automation and Computer control system.	(I) Students will be able to model various mechatronic systems. (II) Students will be able to understand the working of various motors used in mechatronic systems.. Analyze the characteristics and use of various IC's. (III) Student will be able to analyze the characteristics and use various IC's. (IV) Students will be able to analyze the internal hardware structure in Mechatronics Systems.

List of Practical (Minimum 10 Experiments)

1. Verification of P, P+I, P+D, P+I+D control actions.
2. Demonstration on XY position control systems.
3. Demonstration on linear conveyor control system.
4. Demonstration on rotary table positioning systems.
5. Demonstration on different switches and relays.
6. Analysis of control system using software like MATLAB/SIMULINK or equivalent.
7. Development of ladder diagram/programming PLC for level control, position control or any other mechanical engineering application.
8. Demonstration on A/D and D/A converters.
9. Demonstration on Flip Flops and Timers.
10. Demonstration on Application of Op – Amp circuits.
11. Demonstration on Data acquisition system.
12. Demonstration on Microcontrollers. .

V Semester

MEM103	Computer Integrated Manufacturing			L=3	T=0	P=0	Credits= 3
Evaluation Scheme *Best Two out of three MSE's would be considered	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Tota	ESE Duration
	15	15	15	30	40	100	3 Hrs.
Prerequisites							

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles.	**CO1 : The Students will have ability to design and evaluate experimentation on CNC machines.** **CO2: Designing of GT cell layouts for transforming into flexible manufacturing system.** **CO3: The students will be able to compose and transform robot programs various industrial applications.** **CO4: The students will have ability to justify CAPP and CAQC to design computer integrated manufacturing**

Unit 1 **[7 hrs]**

Concept and scope of CIM, components of CIM, benefits, limitations.Basics of computer graphics NC basics, NC words, Manual part programming (NC part programming) Punch Tape, Tape Format CNC , DNC, APT programming Adaptive control, application. Tooling for CNC machine.

Unit 2 **[7 hrs]**

Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT. Part families , classification and coding , Production flow analysis , Machine cell design , Benefits

Unit 3 **[8 hrs]**

Introduction & Components of FMS , Application work stations , Computer control and functions , Planning, scheduling and control of FMS , Scheduling , Knowledge based scheduling , Hierarchy of computer control , Supervisory computer Manufacturing data systems , data flow , CAD/CAM considerations , Planning FMS database]

Unit 4 **[8 hrs]**

Industrial robotics Robot anatomy, Robot control, accuracy, repeatability, End Effectors Sensor, Introduction to robot programming, Robot application (Material handling processing assembly and inspection) introduction to robot Kinematics.

Unit 5 **[10 hrs]**

Process Planning in the Manufacturing cycle , Process Planning and Production Planning Process Planning and Concurrent Engineering, CAPP, Variant process planning , Generative approach , Forward and Backward planning, Input format, Logical Design of a Process Planning , Implementation considerations ,manufacturing system components, Automated material handling systems, AS/RS, general considerations , selection, evaluation and control . Inspection and Quality control, CAQC, CMM types, working, applications Expert process planning

Unit 6 **[5 hrs]**

Totally integrated process planning systems, Integration of CNC robotics for CIM, Agile manufacturing, Nano Manufacturing. Simulation

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Systems Approach to Computer Integrated Design and Manufacturing	1996	Nanua Singh	John Wiley & Sons, 1996.
2	Automation, Production Systems and Computer Integrated Manufacturing	2002	Groover M.P	Prentice-Hall of India Pvt. Ltd., New Delhi, 2002
3	Handbook of Flexible Manufacturing Systems	1991	Jha, N.K	Academic Press Inc., 1991
4	Group Technology in Engineering Industry	1979	Burbidge, J.L	Mechanical Engineering pub. London, 1979.
5	G.T Planning and Operation, in The automated factory-HandBook: Technology and Management	1991	Askin, R.G. and Vakharia, A.J	Cleland, D.I. and Bidananda, B (Eds), TAB Books, NY, 1991.

VI Semester

MEM111	Fluid Power Systems			L=3	T=0	P=0	Credits= 3
Evaluation Scheme *Best Two out of three MSE's would be considered	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Tota	ESE Duration
	15	15	15	30	40	100	3 Hrs.
Prerequisites							

Objective	Course Outcome
• To provide an insight into the capabilities of hydraulic and pneumatic fluid power. • To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems. • To examine concepts centering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems. • Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications. • To familiarize with logic controls and trouble shooting	**CO1** **Identify and analyse the functional requirements of a fluid power transmission system for a given application.** **CO2** **Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.** **CO3** **Design an appropriate hydraulic or pneumatic circuit or combination circuit like electrohydraulic, electro-pneumatics for a given application.** **CO4** **Select and size the different components of the circuit.** **CO5** **Develop a comprehensive circuit diagram by integrating the components selected for the given application.**

Unit 1 **[7 hrs]**

Introduction to fluid power systems Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications. Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, and quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers; sources of contamination and contamination control; heat exchangers.

Unit 2 **[8 hrs]**

Pumps and actuators Pumps: Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps. Accumulators: Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor.

Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders.

Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flowrate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors)

Unit 3 **[8 hrs]**

Components and hydraulic circuit design

Components: Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves. Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder- metering in, metering out and bleed off circuits. Pilot pressure operated circuits. Hydraulic circuit examples with accumulator.

Unit 4 **[09hrs]**

Pneumatic power systems Introduction to Pneumatic systems:

Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit.

Pneumatic Actuators: Linear cylinder –types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols..

Unit 5 **[09hrs]**

Pneumatic control circuits

Simple Pneumatic Control:

Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling.

Signal Processing Elements:

Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates.

Multi- Cylinder Application:

Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).

Electro- Pneumatic Control:

Principles - signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application.

Unit 6	**[3hrs]**
Applications of Power systems Practical and Industrial Applications	

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with applications", Pearson edition,2000 .
2. Majumdar S.R., "Oil Hydraulics",TalaMcGRawHllL, 2002 .
3. Majumdar S.R., "Pneumatic systems - Principles and Maintenance",Tata McGraw-Hill, New Delhi, 2005

REFERENCE BOOKS:

1. John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw Hill International Edition, 1980.
2. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3. FESTO, Fundamentals of Pneumatics, Vol I,IIandIII.
4. Herbert E. Merritt, "Hydraulic Control Systems", John Wiley and Sons, Inc.
5. Thomson, Introduction to Fluid power, PrentcieHaIl, 2004
6. John Watton, "Fundamentals of fluid power control", Cambridge University press, 2012.

VI Semester

MEM112	Lab. : Fluid Power Systems			L= 0	T = 0	P = 1	Credits = 1
Evaluation Scheme	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Total	ESE Duration
*Best Two out of three MSE's would be considered	--	--	--	60	40	100	3 Hrs
Prerequisites							

Objective	Course Outcome
• To provide an insight into the capabilities of hydraulic and pneumatic fluid power. • To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems. • To examine concepts centering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems. • Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications. • To familiarize with logic controls and trouble shooting	**CO1** Identify and analyse the functional requirements of a fluid power transmission system for a given application. **CO2** Visualize how a hydraulic/pneumatic circuit will work to accomplish the function. **CO3** Design an appropriate hydraulic or pneumatic circuit or combination circuit like electrohydraulic, electro-pneumatics for a given application. **CO4** Select and size the different components of the circuit. **CO5** Develop a comprehensive circuit diagram by integrating the components selected for the given application.

List of the practical's.

1) Study of Positive Displacement Rotary Pumps
2) Trial on Reciprocating Pump
3) Trial on Centrifugal Pump
4) Trial on reciprocating compressor
5) Trial on rotary Blower.
6) Trial on Pelton wheel
7) Trial on Francis Turbine
8) Trial on Kaplan Turbine
9) Heat balance on Multicylinder Diesel Engine.
10) Performance on Vapor Compression Refrigeration System (VCRS).
11) Performance on air-conditioning system.

VI Semester

MEM113	Machine Learning			L=3	T=0	P=0	Credits= 3
Evaluation Scheme *Best Two out of three MSE's would be considered	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Tota	ESE Duration
	15	15	15	30	40	100	3 Hrs.
Prerequisites							

Objective	Course Outcome
Understanding Human learning aspects. 2. Understanding primitives in learning process by computer. 3. Understanding nature of problems solved with Machine Learning	1.Students will be able to model the learning primitives. 2. Students will be able to build the learning model. 3. Student will be able to tackle real world problems in the domain of Data Mining, Information Retrieval, Computer vision, Linguistics and Bioinformatics.

UNIT – I INTRODUCTION TO MACHINE LEARNING 7 Hours

Why Machine learning, Examples of Machine Learning Problems, Structure of Learning, Learning versus Designing, Training versus Testing, Characteristics of Machine learning tasks, Predictive and descriptive tasks, Machine learning Models: Geometric Models, Logical Models, Probabilistic Models. Features: Feature types, Feature Construction and Transformation, Feature Selection.

UNIT – II CLASSIFICATION AND REGRESSION 8 Hours

Classification: Binary Classification- Assessing Classification performance, Class probability EstimationAssessing class probability Estimates, Multiclass Classification. Regression: Assessing performance of Regression- Error measures, Overfitting- Catalysts for Overfitting, Case study of Polynomial Regression. Theory of Generalization: Effective number of hypothesis, Bounding the Growth function, VC Dimensions, Regularization theory.

UNIT – III LINEAR MODELS 7 Hours

Least Squares method, Multivariate Linear Regression, Regularized Regression, Using Least Square regression for Classification. Perceptron, Support Vector Machines, Soft

Margin SVM, Obtaining probabilities from Linear classifiers, Kernel methods for non-Linea
UNIT – IV LOGIC BASED AND ALGEBRAIC MODELS 6 Hours Distance Based Models: Neighbours and Examples, Nearest Neighbours Classification, Distance based clustering-K means Algorithm, Hierarchical clustering, Rule Based Models: Rule learning for subgroup discovery, Association rule mining. Tree Based Models: Decision Trees, Ranking and Probability estimation Trees, Regression trees, Clustering Trees
UNIT – V PROBABILISTIC MODELS 6 Hours Normal Distribution and Its Geometric Interpretations, Naïve Bayes Classifier, Discriminative learning with Maximum likelihood, Probabilistic Models with Hidden variables: Estimation-Maximization Methods, Gaussian Mixtures, and Compression based Models.
UNIT – VI TRENDS IN MACHINE LEARNING 8 Hours Model and Symbols- Bagging and Boosting, Multitask learning, Online learning and Sequence Prediction, Data Streams and Active Learning, Deep Learning, Reinforcement Learning

Text Books

1. Peter Flach: Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press, Edition 2012.
2. Hastie, Tibshirani, Friedman: Introduction to Statistical Machine Learning with Applications in R, Springer, 2nd Edition-2012.

Reference Books

1. C. M. Bishop : Pattern Recognition and Machine Learning, Springer 1st Edition-2013.
2. Ethem Alpaydin : Introduction to Machine Learning, PHI 2nd Edition-2013.
3. Parag Kulkarni : Reinforcement and Systematic Machine Learning for Decision Making, WileyIEEE Press, Edition July 2012.

VII Semester

MEM121	Industrial Robotics			L=3	T=0	P=0	Credits= 3
Evaluation Scheme *Best Two out of three MSE's would be considered	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Tota	ESE Duration
	15	15	15	30	40	100	3 Hrs.
Prerequisites							

Objective	Course Outcome
• Gain knowledge of Robotics and automation. • Understand the working methodology of robotics and automation. • Write the program for robot for various applications	On completion of course students will • have knowledge of Robotics, automation, robotics motion, sensors and control, machine vision, robotic programming and roles of robots in industry • Understand the working methodology of robotics and automation, motion and control, machine vision and programming, application of robots in industry. • write the program for robot for various application

Unit 1 **[7 hrs]**

FUNDAMENTALS OF ROBOT

Robot – Definition – Robot anatomy – Co-ordinate systems, work envelope, types and classification – Specifications – Pitch, yaw, roll, joint notations, speed of motion and pay load – Robot parts and their functions – Need for robots – Different applications..

Unit 2 **[8 hrs]**

ROBOT DRIVE SYSTEMS

Pneumatic drives – Hydraulic drives – Mechanical drives – Electrical drives – D.C. servo motors, stepper motor and A.C. servo motors – Salient features, applications and comparison of all these drives.

END EFFECTORS

End effectors – Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers – Two fingered and three fingered grippers – Internal grippers and external grippers – Selection and design considerations.

Unit 3 **[8 hrs]**

SENSORS

Requirements of a sensor, principles and applications of the following types of sensors – Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors) – Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters) – Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors) – Touch sensors (Binary sensors, Analog sensors) – Wrist Sensors – Compliance Sensors – Slip Sensors.

Unit 4 **[7 hrs]** **MACHINE VISION** Camera, frame grabber, sensing and digitizing image data – Signal conversion – Image Storage – Lighting techniques – Image processing and analysis – Data reduction – Segmentation – Feature extraction – Object recognition – Other algorithms – Applications – Inspection, identification, visual serving and navigation.
Unit 5 **[8 hrs]** **ROBOT KINEMATICS** Forward kinematics – Inverse kinematics – Differences: Forward kinematics and Reverse kinematics of manipulators with two and three degrees of freedom (In 2 dimensional), four degrees of freedom (In 3 dimensional) – Deviations and problems
Unit 6 **[7 hrs]** **ROBOT PROGRAMMING** Teach pendant programming – Lead through programming – Robot programming languages – VAL programming – Motion commands – Sensor commands – End effecter commands – Simple programs. **IMPLEMENTATION** RGV – AGV – Implementation of robots in industries – Various steps - Safety considerations for robot operations.

Text Books:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, Industrial Robotics: Technology, Programming and Applications, 2 nd Edition, Tata McGraw Hill, 2012.
2. Roland Siegwart, Illah R. Nourbakhsh, an d Davide Scaramuzza, "Introduction to Autonomous Mobile Robots, 2 nd Edition, PHI, 2011

Reference Books:

1. S.P. SukhatMT, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).
2. C. S. Solanki, Solar Photovoltaic's: FundaMTntal Applications and Technologies, Prentice Hall of India, 2009.
3. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

VII Semester

MEM122	Lab. : Industrial Robotics			L= 0	T = 0	P = 1	Credits = 1
Evaluation Scheme	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Total	ESE Duration
*Best Two out of three MSE's would be considered	--	--	--	60	40	100	3 Hrs
Prerequisites							

Objective	Course Outcome
• Gain knowledge of Robotics and automation. • Understand the working methodology of robotics and automation. • Write the program for robot for various applications	On completion of course students will • have knowledge of Robotics, automation, robotics motion, sensors and control, machine vision, robotic programming and roles of robots in industry • Understand the working methodology of robotics and automation, motion and control, machine vision and programming, application of robots in industry. • write the program for robot for various application

List of the practical's.

1. Study components of a real **robot** and its DH parameters.
2. Forward kinematics and validate using a software (Robo Analyser or any other free software tool).
3. Inverse kinematics of the real **robot** and validation using any software.
4. Use of open source computer vision programming tool open CV.
5. Image Processing using open CV.
6. Image processing for color/shape detection.
7. Positioning and orientation of Robotic Arm
8. Control experiment using available hardware and software.
9. Integration of assorted sensors, Micro-controllers and ROS in Robotic arm.