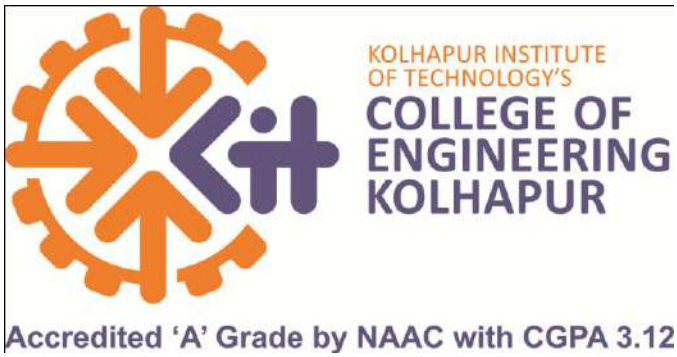
Kolhapur Institute of Technology's College of Engineering, Kolhapur

(An Autonomous Institute)



Curriculum (Structure)

for

Mechanical -Production Engineering

Academic Year 2017-2018

KIT's College of Engineering, Kolhapur
(An Autonomous Institute)
Teaching and Evaluation scheme for
First Year M. Tech. Program in MECHANICAL-PRODUCTION Engineering

SEMESTER-I

Subject Code	Subject	Teaching Scheme				Evaluation Scheme			
		L	T	P	Credits	Component	Marks		
							Max	Min for passing	
PPRD0101	Advanced Manufacturing Process –(MJP)	3	1	-	4	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD0102	Metal Forming Technology (RSP)	3	1	-	4	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD0103	Operations Management (GRN/MJP)	3	1	-	4	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD0161	Research Methodology (Audit Course)*	2	-	-	-	ESE	50	20	
PPRD01**	Professional Elective-I	3	1	-	4	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD01**	Professional Elective-II	3	1	-	4	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD0131	Advanced CNC Lab (SBS/AST)	-	-	2	1	ISE	50	20	
						ESE (POE)	50	20	
PPRD0132	Measurement and Instrumentation Lab (AKM) (RCB)	-	-	2	1	ISE	50	20	
						ESE (POE)	50	20	
PPRD0141	Seminar I	-	-	2	1	-	-	-	
						ESE (OE)	100	40	
	Total	17	5	6	23		600 (Th)	200 (Pr)	

Total Credits: 23
Total Contact Hours/Week: 26+2Hrs
Note: ESE: End Semester Examination, MSE: Mid Semester Examination, ISE: In Semester Evaluation.

* **Audit Course**

List of Professional Electives:

Course Code **	Professional Elective – I
PPRD0121	Manufacturing Engineering and Sustainable Development (PPP/SK)
PPRD0122	Manufacturing system design (NVD/VDK)
PPRD0123	Precision Manufacturing (SBS/AST)
PPRD0124	Facility Planning and Plant Layout (MHK)
PPRD0125	Mechatronics system design (SMK/NVD/VDK)

Course Code **	Professional Elective – II
PPRD0126	Advanced Casting Technology (BSK/SSM)
PPRD0127	Advanced Machine Tool Design (RRG/AMQ)
PPRD0128	Advanced Welding Technology (BSK/RGR)
PPRD0129	Polymer Science and Engineering (PRK)
PPRD0130	Industrial Automation and Robotics (SMK/VDK/NVD)

ISE: In Semester Evaluation
MSE: Mid Semester Examination
ESE: End Semester Examination

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SEMESTER-II

Subject Code	Subject	Teaching Scheme				Evaluation Scheme			
		L	T	P	Credits	Scheme	Marks		
							Max	Min for Passing	
PPRD0204	Tool and Die Design (RSP/VDK)	3	1	-	4	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD0205	Optimization Technique (MJP/HMT)	3	2	-	5	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD0206	Supply chain management (GRN)	3	1	-	4	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD0262	Industrial Ethics and Human Values (Audit)* (HMT)	2	-	-	-	ESE	50	20	
PPRD02**	Professional Elective III	3	1	-	4	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD02**	Professional Elective IV	3	1	-	4	ISE-I	10	20	40
						MSE	30		
						ISE-II	10		
						ESE	50	20	
PPRD0233	Automation and Simulation Lab (MHK)	-	-	2	1	ISE	50	20	
						ESE (POE)	50	20	
PPRD0234	Advanced Manufacturing Engineering Lab (SJS)	-	-	2	1	ISE	50	20	
						ESE (POE)	50	20	
PPRD0242	Seminar II	-	-	2	1	ESE	100	40	
PPRD0251	Mini Project	-	-	2	1				
Total		18	5	8	25		600 (Th)	200 (Pr)	

Total Credits: 25
Total Contact Hours/Week: 29+2Hrs

- **Audit Course**

List of Professional Electives:

Course Code **	Professional Elective – III
PPRD0221	Reliability Engineering (SSS/AKM)
PPRD0222	Lean Manufacturing (SSS/AKM)
PPRD0223	Total Quality Management (AKM)
PPRD0224	Safety Engineering (AMQ)

Course Code **	Professional Elective – IV
PPRD0226	Work system design (SSS)
PPRD0227	Human Resource Management (GRN)
PPRD0228	Entrepreneurship Development (GRN/)
PPRD0229	Project Management (MJP/)

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MSE: Mid Semester Examination
ESE: End Semester Examination

KIT's College of Engineering, Kolhapur
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Teaching and Evaluation scheme for
Second Year M. Tech. Program in MECHANICAL-PRODUCTION Engineering

SEMESTER III

Course Code	Subject	Teaching Scheme					Evaluation Scheme		
		L	T	P	Credit		Scheme	Marks	
								Max	Min for passing
PPRD0343	* Industrial Training	-	-	-	2		ISE	50	20
PPRD0352	Dissertation Phase-I	-	-	-	2		ISE-I	50	20
		-	-	-	4		ISE-II	100	40
PPRD0353	Dissertation Phase-II	-	-	-	4		ESE(OE)	100	40
	TOTAL			-	12		Total Marks	300	
Contact Hrs/Week = 5/student/week									

*Student should undergo industrial training of 15 days during vacation after F.Y.Part II. In plant training report for the training for at least two weeks undertaken in the semester II is to be submitted in semester III.

Total Credits: 12

KIT's College of Engineering, Kolhapur
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SEMESTER IV

Course Code	Subject	Teaching Scheme					Evaluation Scheme		
		L	T	P	Credit		Scheme	Marks	
								Max	Min for Passing
PPRD0454	Dissertation Phase- III	-	-	-	4		ISE I	100	40
		-	-	-	4		ISE II	100	40
PPRD0455	Dissertation Phase- IV	-	-	-	8		ESE(OE)	200	80
	Total				16			400	-
Total Contact Hours: 5/student/week									

Total Credits: 16

Title of the Course: Advanced Manufacturing Processes	**L**	**T**	**P**	**Credit**
Course Code: PPRD0101	**3**	**1**	**-**	**4**

Course Pre-Requisite: Manufacturing Processes, Machine Tools

Course Description: The course describes advancement in the manufacturing processes such as machining, casting, welding and metal forming.

Course Objectives:

1. To explain necessity and classification of advanced machining processes.
2. To explain different advance machining processes
3. To discuss advancements in casting process, welding process and forming process

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	Classify the advanced machining processes according to source of energy used for material removal.	2	Understanding
CO2	Illustrate working principle, equipment, process parameters and applications of different advanced machining processes.	2	Understanding
CO3	Solve the numerical for calculation of process parameters for advanced machining processes.	3	Applying
CO4	Explain advancements in casting processes, welding processes and forming processes.	2	Understanding
CO5	Demonstrate the following skills ❖ presentation skills ❖ communication skills ❖ report writing	2	Understanding

CO-PO Mapping:

	PO		
CO	**1**	**2**	**3**
CO1			1
CO2			2
CO3			2
CO4			2
CO5		1	2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three modules) ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.	
Course Contents:	
Unit 1:--- **Advanced Machining Processes:** Need and Classification of Advanced Machining Process. **Mechanical Energy Based Processes**: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining and Ultrasonic Machining- Working Principles, Equipment, Process parameters, Applications.	**6 Hrs.**
Unit 2:--- **Electrical Energy Based Processes**: Eclectic Discharge Machining & Wire Electric Discharge Machining- Working Principles, Equipment, Process parameters, Applications. **Chemical and Electro-Chemical Energy Based Processes**: Chemical Machining and Electro Chemical Machining- Working Principles, Equipment, Process parameters, Applications.	**8 Hrs.**
Unit 3:--- **Thermal Energy Based Processes**: Laser Beam Machining, Plasma Arc Machining, Electron Beam Machining- Working Principles, Equipment, Process parameters, Applications **Abrasive Finishing Processes**: Abrasive Flow Finishing- Machine, Tooling, Media, Process Variables, Magnetic Abrasive Finishing- Working Principle of MAF, bonded and unbounded magnetic abrasives, Machining fluid	**8 Hrs.**
Unit 4:--- **Advanced Casting Processes:** Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting	**6 Hrs.**
Unit 5:--- **Advanced Welding Processes:** Electron beam welding (EBW), laser beam welding (LBW), ultrasonic welding (USW)	**6 Hrs.**
Unit 6:--- **Advanced Metal Forming Processes**: Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming, Contour roll forming	**6 Hrs.**
Tutorials: 1. Assignment on mechanical energy based advanced machining processes. 2. Assignment on electrical, chemical and electrochemical energy based advanced machining processes. 3. Assignment on thermal and abrasive based advanced machining processes. 4. Assignment on advanced casting processes. 5. Assignment on advanced welding processes. 6. Assignment on advanced metal forming processes. At the end of course each student will prepare and present a report on topic related to advance manufacturing processes in consultation with course coordinator.	
Textbooks:	

1. Non-traditional Manufacturing Processes, G.F. Benedict, Marcel Dekker, Inc. New York.
2. Advanced Machining Processes, Vijay. K. Jain, Allied Publishers Pvt. Ltd., New Delhi.
3. Manufacturing Engineering & Technology, Kalpakjian. S., Pearson Education Asia.

References books:

1. Materials and Processes in Manufacturing, E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi
2. Manufacturing Science, A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.
3. Modern Machining Processes, Pandey P.C. and Shan H.S. Tata McGraw-Hill, New Delhi.
4. Material and Processes in manufacturing, Paul De Garmo, J.T.Black, and Ronald. A. Kohser, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Production Technology by HMT.
6. Advanced Machining Processes, Hassan El-Hofy, McGraw-Hill.

Unit wise Measurable students Learning Outcomes:

1. To elaborate need and classification of advanced machining processes.
2. To explain the different advanced machining processes involving electrical, chemical and electro-chemical energy for material removal.
3. To explain the thermal energy and abrasive based different advanced machining processes.
4. To explain advancement in the area of metal casting.
5. To discuss the welding techniques like electron beam welding, laser beam welding and ultrasonic welding.
6. To explain advanced metal forming techniques.

Title of the Course: Metal forming Technology	L	T	P	Credit
Course Code: PPRD0102	3	1		4

Course Pre-Requisite:

1. Fundamentals of Strength of material
2. Fundamentals of material
3. Fundamentals of forming processes

Course Description: Theories of forming processes are good application of theory of plasticity like yielding criteria, application of two and three dimensional problem.
forming processes use to produce different forming product for industrial application.

Course Objectives:

1. Gain the fundamental knowledge of metal working and formability.
2. Understand the analysis of flow of material and it's properties during the processes
3. Selection the process of metal forming as per the applications such as wire drawing, extrusion, rolling forging etc.
4. To introduce the students to the theory and practices of metal forming

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain concepts of deformation in forming process	1	Remember
CO2	Demonstrate the knowledge of stresses in metal forming process.	2	Demonstrate
CO3	Interpret the analysis of flow of material and it's properties during the processes	4	Analyze
CO4	Select process parameter of different metal forming process	3	Apply
CO5	Select the process of metal forming as per the applications	3	Apply

CO-PO Mapping:

	PO		
CO	**1**	**2**	**3**
CO1	1		1
CO2	2		2
CO3	1		2
CO4			2
CO5			2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30

ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Fundamentals of Metal forming Requirements for near net shape manufacturing. Mechanics of metal working, stress strain relationship, yield criteria, Equilibrium in Cartesian, cylindrical and spherical coordinates, Slab method and lower and upper bond methods for load, their significance in investigating and modeling of metal working operations; plastic work, work hardening, strain rate and temperature, deformation zone geometry, formability, forming limit diagrams.	6 **Hrs.**
Unit 2:--- Workability: Overview at the workability, workability in sheet metal forming, forging, rolling, and in extrusion and wire drawing. **Friction and Lubrication in metal forming** Various mode of friction in mft.,Lubrication in metal forming processes, principles and mechanism of lubrications, hydrodynamic and their film lubrication, boundary and extreme pressure lubricants, solid lubricants, and cold drawing	6 **Hrs.**
Unit 3:--- Forging: Equipments: Hammers, Presses, interaction between forging process and equipment, Forging materials and practices or processes: Light alloys, titanium alloys and heat resistance alloys. Effect of forging variables on properties; Forging die design: Design principles, Preform design considerations, Diematerials.	6 **Hrs.**
Unit4:--- Rolling: Classification of Rolling Processes, Rolling mills, Hot- Rolling, Rolling of Bars and Shapes; Forces and Geometrical relationship in Rolling, Simplified analysis of rolling load: variables, problems and defects in rolled products, Rolling mill control, Theories of cold rolling, hot rolling, torque and power, Roll pass design, lubricants used for rolling	6 **Hrs.**
Unit 5:--- Extrusion: Classification of extrusion processes, extrusion equipment, hot extrusion, defects in extrusion, Analysis of the extrusion process, cold Extrusion and cold forming, hydrostatic extrusion, extrusion of tubing, Production of seamless pipe and tubing. **Wire Drawing**: Introduction, wiredrawing, analysis of wiredrawing and Residual stress in wire, wire drawing dies. Lubricant in cold drawing	**6 Hrs.**
Unit 6:-- Sheet Metal Forming: Introduction, forming methods, shearing and blanking, bending, stretch forming, deep drawing, forming limit criteria, Defects in formed parts. **Latest Trends in Forming**: Isothermal forging, Near net shape manufacturing, thermo- mechanical treatments, High Energy Rate Forming (HERF), super plastic forming technology, hydro forming, Laser beam forming, fine blanking,	6**Hrs.**

Textbooks:

1. George E. Dieter - Mechanical Metallurgy, McGrew Hill, London, 1988
2. R. Sharan, S.N. Prasad - Forging Design and Practice
3. Forging Equipment, Material and Processes, J. Altan, F. W. Boulger - Metals Ceramic Information Center, Columbus 1973.
4. Metal Forming Fundamentals & Applications – Alan T, American Society of Metals, Metal Park 1983
5. Metal Forming Mechanics & Metallurgy, Hosford WF and Cadell R.M. , Prentice Hall, Englewood Cliffs, 1993

References:

1] G. E. Dieter - Workability Testing Techniques, American Society for Metals, Metals Park, 1984

2] Metal Forming Handbook, -Schuler, Springer-Verlag Berlin Heidelberg New York, (2008) ISBN 3- 540-61185-1

3)Roll Forming Handbook, - Geotge T. Halmos, (CRC Press, Taylor & Francis), (2006) ISBN 0-8247- 9563-6

4] ASM Hand Book - Forming and Forging, 9/e, Volume 14, (1998

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Unit wise Measurable students Learning Outcomes:

1. To elaborate fundamental concept of deformation and plasticity.
2. To explain condition of lubrication and friction in different forming process.
3. To explain advancement in the area of forging
4. To explain advancement in the area of rolling
5. To explain advancement in the area of Extrusion and wire drawing
6. To explain advancement in the area of Sheet Metal Forming and HERF

Title of the Course: Operations Management	L	T	P	Credit
Course Code: PPRD0103	3	1	-	4

Course Pre-Requisite: Elementary knowledge of calculus and probability.

Course Description:

Course Objectives:

1. To provide a comprehensive exposure to operations management and its significance in Industries.
2. To acquaint students with various activities of operations management.
3. To give insight into the ongoing & futuristic trends in the control of inventory.
4. To give exposure to operations scheduling.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain basics of operations management and its significance in industry	2	Understanding
CO2	Explain forecasting models, aggregate planning, operations scheduling and inventory management	2	Understanding
CO3	Compare different strategies and techniques for forecasting, aggregate planning, operations scheduling and inventory management	4	Analyzing
CO4	Solve the numerical on forecasting model, aggregate planning, operations scheduling and inventory management	3	Applying

CO-PO Mapping:

CO	1	2	3
CO1	1		
CO2	1		
CO3	2		
CO4	1		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---	6 Hrs.

Introduction: Introduction to operations management, Manufacturing and service sector trends, Service as part of operations management, operations management function and challenges, relevance of operations strategy, strategy formulation process, measure for operational excellence, sustainability in operations	
Unit 2:--- Forecasting Models: Classification, simple and weighted moving average method, exponential smoothening methods: additive model, trends and seasonality model, mixed model, Regression (linear and multiple) models, causal model, measures of forecasting accuracy, reliability of forecasts	**8 Hrs.**
Unit 3:--- Designing operations: Process and capacity analysis, process flow charting, analysis process, defining capacity, measure of capacity, capacity planning framework, decision tree for capacity planning	**6 Hrs.**
Unit 4:--- Operations Scheduling: Approaches to scheduling – infinite and finite loading, forward or backward scheduling, Assignment model for assigning jobs to work centers, dispatching rules for scheduling n jobs on one machine, composite rules, scheduling with Johnson's rule– n jobs- 2 stations with same and different sequence, 2 jobs- n stations (graphical method), preparation of Gantt's chart, job shop scheduling, open shop scheduling, dynamic scheduling in flexible manufacturing systems, employee scheduling for service	**8 Hrs.**
Unit 5:--- Independent Demand Inventory Management: Classification, EOQ models, order timing decisions, Safety Stock and reorder level decisions. Order quantity and reorder point, Continuous review systems, periodic review systems, selective inventory control - ABC analysis, Multi-item and Coordinated Replenishment Models- Spare parts and maintenance inventory models,	**6 Hrs.**
Unit 6:--- Inventory models with probabilistic demands: Single period discrete probabilistic demand model, multiple period probabilistic models Theory of constraints: Optimized Production Technology, Drum-rope-buffer models, Constant- WIP (CONWIP) models, Planning and Control of JIT Systems	**6 Hrs.**

Textbooks:

1. R. B. Khanna, (2007), Production & Operations Management, PHI
2. Martin K. Starr, (2007), Production & Operations Management, India Edition, Cengage Learning
3. Dr. K.C. Arora,(2009), Production & Operations Management, University Science Press (Laxmi Publications Pvt. Ltd.)

References books:

1. Edward S. Buffa & Rakesh K. Sarin, (2010), Modern Production / Operations Management, 8/e, Wiley India Pvt. Ltd.
2. Joseph S. Martinich, (2010), Production & Operations Management- An Applied Modern Approach, Wiley India Pvt. Ltd.
3. Everett E. Adam Jr, & Ronald J. Ebert, Production & Operations Management, Jay Heizer, Barry Render & Jagdeesh Rajshekhar, (2009), Operations Management, 9/e, Pearson Education
4. Lee J. Krajewski & Larry P Ritzman, Operations Management- Strategy & Analysis, 6/e, Pearson Education.
5. Operations management: theory and practices, B. Mahadevan, Pearson

Unit wise Measurable students Learning Outcomes:

Title of the Course: Research Methodology	L	T	P	Credit
Course Code: PPRD0161	2	-	-	2

Course: There are no Pre-Requisite for this course

Course Description: This course will provide an opportunity for participants to establish or advance their understanding of research through critical exploration of research language, ethics, and approaches.

Course Objectives:

1. Defending the use of Research Methodology
2. Judging the reliability and validity of experiments
3. Perform exploratory data analysis
4. Draw conclusions from categorical data
5. Using computer-intensive methods for data analysis
6. compare statistical models

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Defend the use of Research Methodology	Affective domain	Defend
CO2	Judge the reliability and validity of experiments	Psychomotor	Judge
CO3	perform exploratory data analysis	Psychomotor	analysis
CO4	draw conclusions from categorical data	Psychomotor	conclude
CO5	Use computer-intensive methods for data analysis	Psychomotor	data analysis
CO6	Drawing conclusions from statistical test results & compare statistical models	Psychomotor	compare

CO-PO Mapping:

CO	PO1	PO2	PO3
CO1	3	1	1
CO2	3	1	1
CO3	1	1	2
CO4	1	2	2
CO4	1	3	1
CO5	3	1	1
CO6	3	1	1

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	-
MSE	-
ISE 2	-
ESE	50

ESE: Assessment is based on 100% course content

Course Contents:

Unit I: Introduction to Research An Introduction, Meaning of Research , Objectives of Research, Motivation in Research, Types of Research, Research Approaches , Significance of Research , Research Methods versus Methodology Research and Scientific Method , Importance of Knowing How Research is Done , Research Process Criteria of Good Research, Problems Encountered by Researchers	5 **Hrs.**
Unit II: Research Design Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs	4 **Hrs.**
Unit III: Sampling Design Need for sampling, Population, Sample, Normal distribution, Steps in sampling, Systematic bias and Sampling error, Characteristics of good sample design, Probability sampling and Random sampling, Determination of sample size	4 **Hrs.**
Unit IV: Results and Analysis Importance and scientific methodology in recording results, importance of negative results, Different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective) and cross verification, correlation with published results, discussion, outcome as new idea, hypothesis, concept, theory, model etc	**4Hrs.**
Unit V : Measurement and Scaling Techniques Introduction, Concept of measurement - Measurement of scale, Developing measurement scale, Criteria of good measurement tools, Error measurement. Concept of Scaling, Classification, Approaches of scale construction, Types of scales - Rating scale, Ranking scale, Arbitrary scale, Differential scale, Summated scale, Cumulative scale, Factor scale.	3 **Hrs.**
Unit VI: Data Collection and Analysis of Data Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Collection of Secondary Data, Selection of	4 **Hrs.**

Appropriate Method for Data Collection, Data Processing Operations, Problems in Processing, Elements/Types of Analysis	

Textbooks:

1. Books: C. R. Kothari, "Research Methodology", New Age international, 2004.
2. Deepak Chopra and Neena Sondhi, "Research Methodology : Concepts and cases", Vikas Publishing House, New Delhi, 2008.
3. Ranjit Kumar, "Research Methodology: A Step by Step Guide for Beginners", 2nd Edition, Sage Publisher, 2011.

1. Kothari C.K., Research Methodology- Methods and Techniques (New Age International, New Delhi), 2004..

Unit wise Measurable students Learning Outcomes:

1. Recall research terminology
2. Be aware of the ethical principles of research, ethical challenges and approval processes
3. Describe quantitative, qualitative and mixed methods approaches to research
4. Identify the components of a literature review process
5. Critically analyze published research
6. Discuss Research Methodology

Title of the Course: Advanced CNC Laboratory	L	T	P	Credit
Course Code: PPRD0131	-	-	2	1

Course Pre-Requisite:

1. Fundamentals of drawing
2. Fundamentals of metal cutting
3. Information metal cutting machine

Course Description:

This laboratory is aimed at providing an introduction to the Know-how of common processes used in industries for manufacturing parts by removal of material in a controlled manner. Auxiliary methods for machining to desired accuracy and quality will also be covered. The emphasis throughout the laboratory course will be on understanding the basic features of the processes rather than details of I constructions of machine, or common practices in manufacturing or acquiring skill in the operation of machines. Evidently, acquaintance with the machine is desirable and the laboratory sessions will provide adequate opportunity for this.

Course Objectives:

1. To explain fundamental of computer aided manufacturing, computer numerical control and manual CNC programming
2. To develop manual CNC program for turning and milling operation
3. To select proper tool and machining parameters for operation like turning and milling operation on CNC machine
4. To carry out CNC program generation from CAD model
5. To perform turning and milling operation on CNC machine as per specified drawing

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain fundamental of computer aided manufacturing, computer numerical control and manual CNC programming	2	Explain
CO2	Develop manual CNC program for turning and milling operation	3	Develop
CO3	Select proper tool and machining parameters for operation like turning and milling operation on CNC machine	3	Select
CO4	Carry out CNC program generation from CAD model	5	Carry out
CO5	Perform turning and milling operation on CNC machine as per specified drawing	5	Perform

CO-PO Mapping:

CO	PO1	PO2	PO3
CO1	**2**		
CO2			**2**
CO3	**2**		
CO4			**3**
CO5			**3**

1=LOW, 2=MEDIUM, 3=HIGH

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

The Term Work shall consist of following exercises. 1) Manual CNC programming- CNC lathe (drilling, turning, taper turning, threading); VMC (profile cutting, drilling, reaming,) 2) Preparing a suitable CAD model for a part to be machined and generating the CNC part program to machine the same on a CNC machining center from the given form of raw material using a suitable CAM software and a post processor. (Operations like turning, taper turning, threading, drilling, tapping) 3) Preparing a suitable CAD model for a part to be machined and generating the CNC part program to machine the same on a CNC machining center (vertical) from the given form of raw material using a suitable CAM software and a post processor. (Operations like drilling, tapping, face/slot milling etc.) 4) Preparing a suitable CAD model for a part to be machined and generating the CNC part program to machine the same on a CNC machining center (vertical/horizontal) from the given form of raw material using a suitable CAM software and a post processor. (Operations like simple cylindrical/rectangular cavities or pockets).	20 **Hrs.**
Note: A different exercise shall be given to each student in the batch. Generating a simple part program using CAM software and executing it on a CNC machine (at least one exercise each) on CNC lathe and CNC machining center. Note: A different exercise shall be given to each group of two students in the batch. The journal shall consist of the printouts and report of the above exercises.	
Practical Examination: (Duration 2 hours) It shall consist of, 1) From a CAD model Generating and simulating a simple CNC part program (Lathe or Machining Center) using a CAM software by individual candidate (15 Marks) 2) Oral Examination based on the Term Work (10 Marks)	
References:	

1. Jon Stenerson and Kelly Curran "Computer Numerical Control'', Prentice-Hall India Pvt. Ltd. New Delhi, 2008.
2. Ibrahim Zeid "CAD/CAM – Theory and Practice" Mc Hill, International edition, 1998.
3. P. N. Rao "CAD/Cam principles and operations", Tata McGraw Hill
4. Thomas M. Crandell "CNC Machining and Programming, Industrial Press ISBN-0-831-3118-7
5. Bedworth, Wolfe and Henderson-Computer aided design and manufacturing, McGraw Hill.
6. A. Ghosh and Malik "Manufacturing Science" Affiliated East West Press Pvt. Ltd.
7. Tilak Raj "CNC Technology and Programming", Dhanpat Rai Publication Company.
8. Robert Quesada, T. Jeyapoovan "Computer Numerical Control: Machining and Turning Centers", Pearson Education.
9. Programming Manuals of various CNC machines (Lathes and Machining Centers) e.g. FANUC, SINUMERIC, MAZAK etc.
10. Catalogs of Commercial Tool Manufacturers e.g. SANDVIK, KENNAMETAL, ISCAR, TAEGUTECH, MITSUBISHI etc.
11. Manuals of CNC Simulation and CAM Software.
Reference Manuals of controllers like FANUC, Siemens, Mazak, etc.

Unit wise Measurable students Learning Outcomes:

1. Students shall be able to **develop** manual CNC program for turning and milling operation
2. Students shall be able to **carry out** CNC program generation from CAD model and carry out machining operations like turning, taper turning, threading, drilling, tapping.
3. Students shall be able to **carry out** CNC program generation from CAD model and carry out machining operations like drilling, tapping, face/slot milling.
4. Students shall be able to **carry out** CNC program generation from CAD model and carry out machining operations like cylindrical/rectangular cavities or pockets.

Title of the Course: Measurement and Instrumentation Lab Course Code : PPRD0132	L	T	P	Credit
	-	-	2	1

Course Pre-Requisite: Fundamental knowledge of electrical engineering, measurement.

Course Description:

Course Objectives:

1) Student should able to prepare experiment set up and perform the experiment and obtain the results.

CO No.	Course Outcome (CO) Statement
1	Distinguish between different instruments
2	To demonstrate the experiment
3	Prepare setup of experiments
4	Analyze the results obtained after experiment

	PO		
CO	1	2	3
1			
2			
3	1		2
4	1		2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

To Study various Temperature Measuring Instruments and to Estimate their Response times. (a) Mercury – in glass thermometer (b) Thermocouple (c) Electrical resistance thermometer (d) Bio-metallic strip To study the working of Bourdon Pressure Gauge and to check the calibration of the gauge in a dead-weight pressure gauge calibration set up To study a Linear Variable Differential Transformer (LVDT) and use it in a simple Experimental set up to measure a small displacement. To measure load (tensile/compressive) using load cell on a tutor. To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer. To measure the speed of a motor shaft with the help of non-contact type pickups (magnetic or photoelectric). Measurement of distance using capacitive pick up Measurement of vibrations of machine tool members / structures Static performance characteristics of operational amplifiers Use of Proportional/Integral/Derivative mode for measurement and control of speed/pressure/temperature	20 **Hrs.**
Practical examination: Duration 3 hours – The candidate shall carry out the practical exercise (15 marks) on one of the above topics. It will be followed by an oral examination (10 marks).	

SEMESTER-II

Title of the Course: TOOL & DIE DESIGN	**L**	**T**	**P**	**Credit**
Course Code: PPRD0204	**3**	**1**	**-**	**4**

Course Pre-Requisite:

1. Fundamentals of Strength of material
2. Fundamentals of material
3. Fundamentals of forming processes

Course Description:

design of jigs, and fixtures explain different techniques of designing jig and fixture by analyzing component and using different parts like locating, clamping and tool guiding system. **Modular Fixture Systems is use for flexibility in product** shape.

design of dies explain different techniques of designing according to shape of product and machine.

Course Objectives:

1. To understand concepts of different clamping and locating system use in jig and fixure
2. The student shall be able to design drilling jig , milling fixtures and Modular Fixture Systems for different product.
3. To understand concepts of different system use in die design.
3. The student shall be able to design dies for different processes of metal forming.

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Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Define of locating and clamping system used in designing of jig and fixture	1	Remember
CO2	Plan sequence of operation for given component for machining	3	Apply
CO3	Design of drilling jig and milling fixture	6	Create
CO4	Classify sheet metal operation on basis of cutting and non cutting operation.	5	Evaluate
CO5	design dies for different processes of metal forming	6	Create

CO-PO Mapping:

	PO		
CO	**1**	**2**	**3**
CO1			1
CO2			2
CO3	2		2
CO4			2
CO5			2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction: Jigs and Fixtures, Flexible Fixture, Materials for Tools, Fixture and Dies.. **Modular Fixture Systems**: Development of modular fixtures, T- slot based and Dowel pin based Modular Fixture systems, Interactive Computer Aided Fixture Design (I-CAFD) Structure, Locating / clamping Model, classification, Fixture Component Selection, Fixture component Assembly Manipulation.	9 **Hrs.**
Unit 2:--- Group Technology based Computer Aided Fixture Design: Fixture Design process analysis, Fixture Structure Analysis, Fixture Feature Analysis, Fixture Design Similarity Analysis, Representation of Fixture, Feature information, Automated Fixture configuration Design.	6**Hrs.**
Unit 3:--- Geometric and Accuracy Analysis: Geometric constraint conditions, Assembly Analysis, 3-D Fixture configurations, Locating Accuracy and Error analysis	5 **Hrs.**
Unit 4:--- Bending methods – Bending Terminology, V – Bending, Air bending, bottoming Dies, Wiping dies, spring back & its prevention, channel dies. Design Principles- Bend radius, Bend allowance, Spanking, width of die opening, Bending pressure **Die Design for Hydro Forming:** Process Technology, Die design considerations, die layout, die clamping, lubricants.	8 **Hrs.**

Unit 5:--- Die Design for Deep Drawing design considerations, die materials, efforts of friction, wear and lubrication, Die handling, Die clamping, dies for hydro mechanical deep drawing	5 **Hrs.**
Unit 6:--- Extrusion Dies: Die Design for metal and plastic extrusion, die materials, die clamping, die handling, Dies for Solid Sections, Dies for hollow section. **Forging die disign** classification of forging dies, Single impression dies, Multiple Impression dies, Forging design factors – Draft, fillet & Corner radius, parting line, shrinkage & die wear, mismatch, finish allowances, webs & ribs	7 **Hrs.**

Textbooks:

1)Rong, Yeming; "Computer Aided Fixture Design", Marcel Dekker, ISBN 0-8247-9961-5
2) Dies for Plastic Extrusion – M.V. Joshi – Mc Millan.
3) Design of Jigs and Fixtures – Hoffman (Pearson)
4) An Introduction to Jig & Tool Design, M.H.A. Kempster, (ELBS)
5) Jigs and Fixture Design Manual, Henrikson (Industrial Press, NY)
6) Die Design Fundamentals, J. R. Paquin, R. E. Crowley, Industrial Press Inc.
7) Jigs & Fixtures; Design Manual – (2/e), P.H. Joshi, (TMH) (2003)

References:

1) Metal Forming Handbook – Schuler, Springer- Verlag Berlin.
2) ASM Handbook – Forming – ASME
3) Handbook of Die Design, 2/e – Suchy, I (McGraw Hill), 2006.
4)Tool Design – C. Donaldson, LeCain & Goold (TMH)
5) Tool Design – H.W. Pollack (Taraporwalla)

Unit wise Measurable students Learning Outcomes:

1. To elaborate fundamental knowledge Modular Fixture Systems
2. To elaborate fundamental knowledge Group Technology based Computer Aided Fixture Design.
3. To elaborate fundamental concept of Geometric and Accuracy Analysis
4. To Explain fundamental of die design of bending and HERF
5. To Explain fundamental of die design of Deep Drawing
6. To Explain fundamental of die design of forging and extrusion

Course Title:	Optimisation Technique	L	T	P	Credit
Course Code:	PPRD0205	3	2	-	5

Course Pre-requisites:

Course Description:

Course Objectives:

1. To introduce the students how to use variables for formulating complex mathematical models in management science, industrial engineering and transportation science.

2. To provide the students with opportunity of using various software package for solving linear programming and integer programming models

3. To introduce the students to the use of basic methodology for the solution of linear programs and integer programs.

4. To introduce the students to the basic concepts of polyhedral theory and valid inequalities and how to integrate the theory to the solution methods for integer programming.

5. To introduce the students to the advanced methods for large-scale transportation and assignment problems

Course Learning Outcomes

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	To provide a formal quantitative approach to problem solving and an intuition about situations where such an approach is appropriate.		
CO2	To introduce some widely used advanced operations research models.		
CO3	Identify and develop operational research models from the verbal description of the real system.		
CO4	Understand the mathematical tools that are needed to solve optimisation problems.		
CO5	Use mathematical software to solve the proposed models. Analyse the results and propose recommendations.Understand the role of uncertainty in decision-making.		

CO-PO Mapping

CO	PO1	PO2	PO3
CO1	2.00		2.00
CO2		2.00	3.00
CO3	1.00		2.00
CO4	3.00		
CO5	3.00		2.00

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE1	10
MSE	30
ISE2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three modules) ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents

Unit	Unit Contents	Hours
1	Introduction to OR and Linear Programming: Introduction, Models, Areas of Application, Linear Programming (L.P.): Mathematical Formulation of L.P. problem, Graphical Method, Simplex Method – Concept of slack, surplus & artificial variables, Manual solutions of L.P.P. upto 3 iterations, Minimization & Maximization Problems, Special Cases – (i) Alternative optima (ii) Unbounded solutions & (iii) Infeasible solutions to be shown graphically & also by simplex method	

2	Transportation & Assignment Models: Definition of the transportation model. Balanced / Unbalanced, Minimization / Maximization. Determination of the initial basic feasible solution using (i) North-West Corner Rule (ii) Least cost method & (iii) Vogel's approximation method for balanced & unbalanced transportation problems, Optimality Test & obtaining of optimal solution, Assignment Problem – Hungarian method, Statement of Transportation & Assignment Problems as L.P. Problems	
3	Network Analysis: Construction of Network – Rules & Precautions, C.P.M. & P.E.R.T. Networks, Obtaining of Critical Path, Time estimates for activities, Probability of completion of project, Determination of floats (total, free, independent & interfering) Crashing of Simple Networks	
4	Decision Theory And Decision Tree: Decision Environments – risk & uncertainty, Payoff table, Regret table, Decision making under uncertainty, Maximin & Maximax criteria, Minimax Regret criterion, Laplace criterion, Hurwicz criterion, Expected Monetary Value criterion, Expected Value of Perfect Information (E.V.P. I.), Expected Opportunity Loss (E.O.L.), Decision Tree, Simple examples	

Textbook

1. Operations Research – An introduction 6th Edition , Taha H.A., Hall of India

Reference Books

1. Operations Research Techniques for Management 7th Edition, Kapoor V.K., Sultan Chand & Sons
2. Operations Research 9th Edition, Kantiswarup, Gupta P.K. & Sultan Chand & Sons Manmohan
3. Operations Research 8th Edition, Sharma S.D., Kedarnath, Ramnath & Company
4. Operations Research 2nd Edition, Bronson R, Shaum's Outline Series
5. Quantitative Techniques in Management 3rd Edition , Vora N.D., Tata McGraw Hill co.
6. Principles & Application 3rd Ed, Shreenath L.S., PERT & CPM, Affiliated East-West Press Pvt. Ltd.
7. Principles of Operations Research 2nd Edition, Wagener H.M., Prentice – Hall of India
8. Operations Research – Methods & Problems 1st Edition , Sasieni M, Yaspan A & John Wiley & Sons Friedman L
9. Operations Research, Natrajan Balasubramani, Tamilarasi, Pearson Education
10. Linear Programming, G. Hadley, Narosa Book Distributors Private Ltd
11. Quantitative Techniques (For Managerial Decisions VOL I), L.C. Jhamb, Everest Publishing House, Pune.
12. Linear Programming, Paul Loomba, Tata McGraw Hill Publishing Co. Ltd.
13. Operations Research Edition 2008, Aditham B. Rao, Jaico Publishing House, Mumbai

Title of the Course SUPPLY CHAIN MANAGEMENT Course Code: PPRD0206	L	T	P	Credit
	3	1	-	

Course Pre-Requisite:

Course Description: This course focuses on management and improvement of supply chain processes and performance. It will be valuable for students who would like to pursue a career in consulting or take a position in operations, marketing or finance functions in a manufacturing or distribution firm. We explore important supply chain metrics, primary tradeoffs in making supply chain decisions, and basic tools for effective and efficient supply chain management, production planning and inventory control, order fulfillment and supply chain coordination. We will also investigate topics such as global supply chain design, logistics, and outsourcing, several other recent supply chain innovations.

Course Objectives:

1. To explain Strategic Framework of Supply Chain and SCM Drivers & Obstacles.
2. To explain Demand Forecasting and Supply in Supply in Supply Chains.
3. To Explain Inventory Planning in Supply Chain Management
4. To Discuss Significance of Logistics in Supply Chain Management.
5. To Explain Financial factors Influencing Supply Chain Decisions
6. To Motivate Students to Develop self- learning Attitude

Course Learning Outcomes: The students shall have the knowledge of the fundamentals and applications of various techniques of Supply Chain Management in practice.

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**LIST** factors affecting Supply Chain Performance.		
CO2	**: SELECT** the appropriate forecasting techniques for demand forecast in Supply Chains..		
CO3	**: DEMONSTRATE** ability to apply Supply Chain Principles through application of a case study.		
CO4	**SELECT** an appropriate Inventory Management method based on organizational objectives.		
CO5	**CLASSIFY** the Financial and DesignConsiderations to enhance performance of supply chain		

CO6	**: APPRAISE** the supply chain and logistic systems by distinguishing facts and inferences through the existing case studies.		

CO-PO Mapping:

CO	a	b	c
CO1	1		
CO2	1		
CO3		1	
CO4		1	
CO5		1	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- : Introduction to Supply Chain Management: Building a Strategic framework to Analyze Supply Chains: Understanding the supply chain, supply chain performance, Supply chain drivers & obstacles.(5)	-5- **Hrs.**
Unit 2:--- : Planning Demand & Supply in Supply Chains: Demand forecasting in supply chain, aggregate planning in supply chain, planning demand & supply in supply chains	6-- **Hrs.**
Unit 3:--- Managing economies of scale in a supply chain: cycle inventory, managing uncertainty in supply chain: safety inventory, determining optimal level of product availability.	6-- **Hrs.**

Unit 4:--- : Design consideration in Supply Chain: Transportation, Network Design, & Information technology in a supply chain: Transportation in supply chain, facility decisions: network design in a supply chain, information technology in a supply chain	-7- **Hrs.**
Unit 5:--- Supply Chain Coordination Logistics in SCM: Coordinating in a Supply Chain & role of E-Business: Coordination in a supply chain, E-business & the supply chain. **Logistics In Supply Chain Management: I**ntroduction, Strategy, Transportation Selection, Trade-off, Models for Transportation and Distribution, Third Party Logistics,, Overview of Indian Infrastructure for Transportation.	-7- **Hrs.**
Unit 6:--- Financial consideration in Supply Chain: Financial factors Influencing Supply Chain Decisions: Financial evaluation of supply chain decisions, the impact of financial factors on supply chain decisions, evaluating supply chain decisions using decision trees.	-6- **Hrs.**

Textbooks:

1 Sunil Chopra & Peter Meindl, ―Supply Chain Management: Strategy, Planning, & Operation‖, Addison Wesley Long man.
2. A. J. Vanweela, ―Purchasing & Supply Chain Management‖Cengage learning(Nov2004) ISBN 1844800245.

References:

1] . R.H. Ballou, ―Supply Chain Management‖ Pearson[2007] ISBN 8131705846
2] - Simchi-Levi, Kaminsky, ―Designing and Managing the Supply Chain, Concepts Strategies and Case Studies‖, 2nd edition, Tata McGraw Hill, ISBN 0-07-058666-7
3. R. Monczka, ―Purchasing & Supply Chain Management‖ Cengage learning business Press.,ISBN

Course Title:	Industrial Ethics & Human Values (Audit Course)	L	T	P	Credit
Course Code:	PPRD0262	2	-	-	-

Course Pre-requisites

Course Description

Course Objectives

1. To identify and analyse an ethical issue in the subject matter under investigation or in a relevant field.

2. To identify the multiple ethical interests at stake in a real-world situation or practice.

3. articulate what makes a particular course of action ethically defensible & assess their own ethical values and the social context of problems.

4. To identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects.

5. To demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work.

6. To integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research.

Course Learning Outcomes

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Identify and analyse an ethical issue in the subject matter under investigation or in a relevant field		
CO2	Identify the multiple ethical interests at stake in a real-world situation or practice		

CO3	Articulate what makes a particular course of action ethically defensible & assess their own ethical values and the social context of problems		
CO4	Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects		
CO5	Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work and apply knowledge of ethical dilemmas.		

CO-PO Mapping

CO	PO1	PO2	PO3
CO1	2.00		1.00
CO2	1.00		2.00
CO3	2.00		1.00
CO4	2.00	2.00	
CO5	3.00		3.00

Teacher Assessment

One End Semester Examination (ESE) having 100% weight.

Assessment	Marks
ESE	50

ESE: Assessment is based on 100% course content.

Course Contents

Unit	Unit Contents	Hours
1	Ethics and Human Values: Ethics and Values, Ethical Vision, Ethical Decisions, Human Values – Classification of Values, Universality of Values.	

2	Engineering Ethics: Nature of Engineering Ethics, Profession and Professionalism, Professional Ethics, Code of Ethics, Sample Codes – IEEE, ASCE, ASME and CSI.	
3	Engineering as Social Experimentation: Engineering as social experimentation, Engineering Professionals – life skills, Engineers as Managers, Consultants and Leaders, Role of engineers in promoting ethical climate, balanced outlook on law.	
4	Safety Social Responsibility and Rights: Safety and Risk, moral responsibility of engineers for safety, case studies – Bhopal gas tragedy, Chernobyl disaster, Fukushima Nuclear disaster, Professional rights, Gender discrimination, Sexual harassment at work place.	
5	Global Issues: Globalization and MNCs, Environmental Ethics, Computer Ethics, Cyber Crimes, Ethical living, concept of Harmony in life.	

Text Books

1. Govindharajan, M., Natarajan, S. and Senthil Kumar, V.S., Engineering Ethics, Prentice Hall of India, (PHI) Delhi, 2004.

Reference Books

1. Charles D, Fleddermann, "Engineering Ethics", Pearson / PHI, New Jersey 2004 (Indian Reprint)

2. Subramainam, R., Professional Ethics, Oxford University Press, New Delhi, 2013.

Title of the Course: Automation and Simulation Lab	**L**	**T**	**P**	**Credit**
Course Code: PPRD0233	**0**	**0**	**2**	**1**

Course Pre-Requisite:

1. Hydraulic and Pneumatic Circuits
2. Micro Processor
3. PLC
4. Industrial Robots

Course Description:

This laboratory is aimed to study automation and simulation for Mechanical Systems.

Course Objectives: This subject provides students with

1. Basics of simulations and model building activity.
2. Analyzing performance of simulated model of manufacturing system.
3. Hands on experiences in different simulation software, robot, PLC programming.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Develop** Model and **analyze** a given manufacturing scenario using simulation.	III IV	Develop Analyze
CO2	**Develop** PLC programs for control of traffic lights, water level, lift and conveyor belt	III	Develop
CO3	**Develop** microcontroller program to guide a robot in a given arena.	III	Develop
CO4	**Develop** pneumatic and hydraulic circuits using Automaton studio.	III	Develop

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**
CO1	2	1	3
CO2	1		1
CO3	1		1
CO4	1		

1=LOW, 2= MEDIUM, 3=HIGH

Assessments:

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	25

ESE	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE: Assessment is based on oral examination

Course Contents:

Experiment No. 1: - Study, design / simulation of automation projects in material handling/packaging using manufacturing simulation software.	**6 Hrs.**
Experiment No. 2: - Exercise on flexible automation using PLC, different sensors and actuators	4 **Hrs.**
Experiment No. 3: - Simulation of Robotic system for automation using a suitable software	2 **Hrs.**
Experiment No. 4: - Simulation of Electrohydraulic / Electro pneumatic circuits using a suitable software -like FESTO PneuSim & HydroSim (Demo versions available on Internet) or Automation Studio or similar simulation software	4 **Hrs.**
Experiment No. 5: - Exercise on control of electrical motors using suitable microcontroller / microprocessor.	4 **Hrs.**
Note- • Term work shall be assessed on the basis of completion of above assignments and submission of reports. • Practical examination: Duration 3 hours – The candidate shall carry out the practical exercise on one of the above topics. It will be followed by an oral examination.	

Title of the Course: ADVANCE MANUFACTURING ENGINEERING LAB Course Code:PPRD0234	L	T	P	Credit
	0	0	2	1

Course Pre-Requisite: Solid modeling, process study, and basic conventional and non conventional process along with various joining process.

Course Description:

Advanced Manufacturing Engg. Lab is the study of the engineering, design, production, supervision and management utilized to remain competitive in today's technologically advanced manufacturing facilities. Included will be the study of lean manufacturing techniques used to reduce costs and increase plant efficiency and productivity. Use of Process improvement, quality operating systems, and much more. Students will use their knowledge of solid modeling skills to design parts and will have the ability to machine them using CNC equipment or print them using the latest Additive (3D) printing technology. . Through classroom lessons and discussions, visits to local manufacturing plants and guest lectures, students will learn about a variety of manufacturing processes and facilities.

Course Objectives:

1.Classify Advanced Manufacturing Processes
2.Make component on advanced manufacturing machines using latest techniques.
3. Explain the use and application of CMM.
4.Develop a process for manufacturing with standard quality tools

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Understand the advanced Manufacturing processes		
CO2	Able to manufacture simple components using 3D printing/CNC machine		
CO3	Understand construction and working of CMM		
CO4	Able to demonstrate implementation and documentation required for Quality system		

CO-PO Mapping:

CO	1	2	3
CO1	1		
CO2		2	1
CO3	1		
CO4		3	

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Course Contents:

Experiment No. 1:---Design considerations for welding fixtures for the welded part to be prepared.	2 **Hrs.**
Experiment No. 2:---Making of simple part by using extrusion/wire drawing/stamping/ blanking process. Die design considerations to be studied and reported.	4**Hrs.**
Experiment No. 3:---Study of construction and operation of a coordinate measuring machine (CMM). Preparation of inspection report of a machined part on CMM. (Through an Industrial Visit)	4 **Hrs.**
Experiment No. 4:--- Machining of a work piece by EDM, WEDM (wire EDM) or WJM(water Jet Machining and study of process parameters (Through an Industrial Visit	4**Hrs.**
Experiment No. 5:--- Process planning for a fairly complex part along with PPAP(***Production Part Approval Process*** **)** documentation for the same.	2 **Hrs.**
Experiment No. 6:--- Manufacturing of a component using solid modeling skills to design parts and will have the ability to machine them using CNC equipment or print them using the latest Additive (3D) printing technology.	4 **Hrs.**

Title of the Course: Manufacturing Engineering and Sustainable Development **Course Code: PPRD0121**	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite:
Fundamentals of manufacturing strategy, knowledge about lean manufacturing, and sustainable development

Course Description:
Organizations are increasingly required to be sustainable and this call for sustainability extends into the realm of manufacturing. However, there is substantial ambiguity and differences in interpretation regarding what is meant by sustainable manufacturing

Course Objectives:
This course will provide the basis for understanding (1) what is envisioned as sustainable manufacturing and how that relates to larger issues such as global warming, energy independence, and human rights; (2) what comprises sustainable manufacturing practices in for-profit enterprises, (3) how to measure and track improvement toward sustainable manufacturing, (4) techniques and tools for product and manufacturing process design and development, and (5) effective communication of sustainability performance to internal and external audiences.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Understand the fundamentals of Manufacturing Strategy.		
CO2	Obtain knowledge about Theory of constrain.		
CO3	Get idea about lean manufacturing, JIT, KANBAN concept.		
CO4	Familiarize with six sigma concept and its application.		
CO5	Know the Sustainable development , life cycle assessment methodology		

CO-PO Mapping:

CO	1	2	3
CO1	1		
CO2	1		
CO3		1	
CO4	1		
CO5		1	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Problems in manufacturing, diagnostic review and opportunity assessment, conceptual framework for manufacturing strategy, manufacturing audit and strategy formulation	7 **Hrs.**
Unit 2:--- Basics of clockspeed, Process redesign concepts and methodology, Product strategy and supply chain strategy, integration of product, manufacturing and supply chain strategies, concurrent engineering and E-manufacturing as a strategies	7 **Hrs.**
Unit 3:--- Lean six-sigma as a manufacturing strategy, Lean tools (Theory of Constraint-ToC, JIT, Value stream mapping), Six-sigma tools (DMAIC), Integration of lean and six-sigma, Case studies on successful lean six-sigma implementation	6 **Hrs.**
Unit 4:--- Introduction to green manufacturing models, carbon footprint, Value chain and Life cycle assessment methodology, Green purchasing and logistics	12 **Hrs.**
Unit 5:--- Introduction to sustainable operations, Sustainable products and manufacturing, Design for Environment, Waste management and re-cycling	8 **Hrs.**

References:

1) Manufacturing in the corporate Strategy, Skimmar,Wickham, John Wiley and sons, NewYork.
2) Economic product Design, Hearm Buck and Butler, D.M., Colhins, London.
3) Cluttarbuck, "JIT – A Global Status Report, IFS publications.
4) Manufacturing operations and supply chain management: the LEAN approach, David L.
Taylor, David Brunt, Thomson Learning
5) What Is Six Sigma, Pande Pete, Holpp Larry, Tata Mcgraw Hill
6) Power of Six Sigma, Subir Chowdhury, Pearson Education, New Delhi
7) Strategic planning Formulation of Corporate Strategy, Ramaswamy, v.s., Macmillan, India Limited, Delhi.
8) Production And Operations Management, Muhlamann, A., Macmillan, NEW DELHI.
9) Production And Operation Management, Chary, S. N., Tata Mcgraw Hill, New Delhi

Title of the Course: Manufacturing System Design Course Code: PPRD0122	L	T	P	Credit
	3		1	4

Course Pre-Requisite:

Basics of Production Management concepts, basics of operations research and network analysis

Course Description:

This course focuses on better understanding of different aspects of manufacturing systems, and improving manufacturing systems performance by modifying system characteristics.

Course Objectives:

The objectives of the course are:

1. to introduce the fundamental concepts of Manufacturing Systems.
2. to make the learners aware of the importance of optimizations in manufacturing systems and methods to improve efficiency of manufacturing systems.
3. to provide hands on experience of solving data management issues, forming cellular layouts and analyzing the networks in manufacturing systems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Compare** and **contrast** different types of manufacturing systems.	II	Understanding
CO2	**Analyze** networks and process dependencies in manufacturing system.	IV	Analyzing
CO3	**Estimate** different costs involved in manufacturing systems.	V	Evaluating
CO4	**Make use of** databases for storing and retrieving different data in manufacturing systems.	III	Applying
CO5	**Explain** procedure to evaluate the manufacturing systems and decision makings based on evaluations.	II	Understanding
CO6	**Develop** the machine cells and layout for manufacturing processing resources.	III	Applying

CO-PO Mapping:

CO	PO1	PO2	PO3
CO1			
CO2	1		1
CO3	1		1
CO4	1		1
CO5			
CO6			1

1=LOW, 2=MEDIUM, 3=HIGH

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- **Fundamentals**: System concept and design, Hierarchical structure, Decision making procedure, System types in manufacturing environments; Manufacturing Systems: Structural aspects, transformational aspects, procedural aspects, integrated manufacturing systems; Modes of Production- Jobbing/Intermittent/ Continuous; Mass Production- Economies of Scale, Optimum production scale, Mass Customization; Multi-Product Small Batch Production- Economies of Scope with Diversification; Logistic Systems- Material flow: conversion / transportation / storage	7 **Hrs.**
Unit 2:--- **Product / Process Planning and Design**: Product Life Cycle, planning of a new product, Product Design Aspects, Design cost considerations, Concurrent Engineering; Process and Operation Design- Computer Aided Process Planning, Optimum routing analysis using Dynamic Programming and Network Techniques, Criteria for line balancing.	8 **Hrs.**
Unit 3:--- **Manufacturing Optimization**: Criteria for Evaluation, Optimization of single stage manufacturing- Unit production time and cost; Optimization of multistage manufacturing system- Scope, basic mathematical models; Cost Estimating- Classical metal cutting cost analysis, Industrial cost estimation practices, Estimating material, setup and cycle times.	7 **Hrs.**
Unit 4:--- **Information Systems in Manufacturing**: Database structures, hierarchical, network, Relational- concepts, keys, relational operations, query languages; Shop Floor Data Collection Systems- Types of data, on-line and off-line data collection, Automatic data collection systems.	6 **Hrs.**

Unit 5:--- **Computer Simulation in Manufacturing System Analysis**: Characteristics, Models, applications of probability and statistics; Design and evaluation methodology, General framework, Analysis of situation, Setting objectives, Conceptual modeling, Detailed design, Evaluation and Decision.	6 **Hrs.**
Unit 6:--- **Modern approaches in Manufacturing**: Cellular Manufacturing- Group Technology, Composite part, Rank Order Clustering Technique, Hollier method for GT cell layouts; Flexible Manufacturing- Concept, components, architecture; Lean Production concept, principles, Agile Manufacturing- concept, principles and considerations for achieving agility.	6 **Hrs.**

Term Work:

Any six assignments out of the following:

1. Case Study of a manufacturing system in a small / medium organization.
2. Exercise on Concurrent Engg., Optimum routing analysis, Line Balancing
3. Exercise on Optimization of Single stage / Multi stage manufacturing system
4. Cost estimation of manufacturing a medium complex component of an assembly.
5. Creation of a relational database for a module of a manufacturing system, use of a suitable query language and generation of reports
6. Exercise on designing and analysis of GT Cell layouts
7. Simulation and performance testing of a manufacturing system

Textbooks:

1. Katsudo Hitomi, (1998), “Manufacturing Systems Engineering”, Viva Low Priced Student Edition, ISBN 81-85617-88-0

References:

1. B. Wu, “Manufacturing Systems Design & Analysis: Context and Techniques” (2/e), Chapman & Hall, UK, ISBN 041258140X
2. Mikell P. Groover, (2002), “Automation, Production Systems and Computer Integrated Manufacturing”, (2/e), Pearson Education, ISBN 81-7808-511-9
3. Radhakrishan P., Subramaniyan S. and Raju V., “CAD / CAM / CIM”, (3/E), New Age International Publication
4. Luca G. Sartori,(1998), “ Manufacturing Information Systems”, Addison Wesley Publishing Co.
5. N. Viswanadhan & Y, Narhari, (1998), “Performance Modeling of Automated Manufacturing Systems”, Prentice Hall of India
6. Phillip F. Ostwald, Jairo Munez, (2002), “Manufacturing Processes and Systems”, John Wiley & Sons (Students’ Edition), ISBN 9971-512-34-3
7. Sanjay B. Joshi, Jeffrey S. Smith, (1994), “Computer Control of Flexible Manufacturing Systems: Research and Development”, Springer, ISBN 0412562006, 9780412562006
8. Manufacturing Systems Control Design: A Matrix-based Approach- Bogdan S., Lewis, S., Kovacic,

Z., Mireles J.; Springer (2011), ISBN: 9788184898903

Unit wise Measurable Students Learning Outcomes:

After the completion of the course the student should be able to

1. **Compare** and **contrast** different types of manufacturing systems.
2. **Analyze** networks and process dependencies in manufacturing system.
3. **Estimate** different costs involved in manufacturing systems.
4. **Make use of** databases for storing and retrieving different data in manufacturing systems.
5. **Explain** procedure to evaluate the manufacturing systems and decision makings based on evaluations.
6. **Develop** the machine cells and layout for manufacturing processing resources.

Title of the Course: Facility Layout and Plant Layout	L	T	P	Credit
Course Code: PPRD0124	3	0	1	4

Course Pre-Requisite: Basic knowledge of spreadsheet software (like MS Excel) and introduction to operation research

Course Description: This course focuses on better understanding of different factors considered for selecting facility location and deciding layout of the facility, and improving manufacturing systems performance by modifying facility layout, selecting right material handling equipment and smoothening the material flow in the manufacturing system.

Course Objectives:

As a result of this course, each student will develop an understanding of the following:

1. Work area layout, equipment specifying, and plant services.
2. Facilities design procedures.
3. Material handling and flow methods and equipment.
4. Warehouse space allocation.
5. Machine cells and Part families.

Course Learning Outcomes:

1. **Explain** significance and scope of facility layout and design.
2. **Solve** facility location problems for locating single new facility in manufacturing system.
3. **Develop** layout of manufacturing system using systematic layout planning procedure.
4. **Develop** the machine cells and layout for manufacturing processing resources.
5. **Choose** and **Analyze** flow patterns and Material Handling Systems for given manufacturing environment.
6. **Plan** warehouse products spaces allocation for given warehouse.

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Explain** significance and scope of facility layout and design	II	Understanding
CO2	**Solve** facility location problems for locating single new facility in manufacturing system.	III	Applying
CO3	**Develop** layout of manufacturing system using systematic layout planning procedure.	III	Applying
CO4	**Develop** the machine cells and layout for manufacturing processing resources.	III	Applying
CO5	**Choose** and **Analyze** flow patterns and Material Handling Systems for given manufacturing environment.	III IV	Applying Analyzing
CO6	**Plan** warehouse products spaces allocation for given warehouse.	III	Applying

CO-PO Mapping:

CO	PO1	PO2	PO3
CO1			
CO2	2		1
CO3	3		2
CO4	1		

CO5			
CO6	1		1

1=LOW, 2=MEDIUM, 3=HIGH

Assessments:

Teacher Assessment:

Two components of in Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: --- **Introduction**, nature, significance and scope of facility layout and design.	**4 Hrs.**
Unit 2: --- **Facility location**: location analysis, single-facility and multi-facility location problems, location models, set covering problems, warehouse location problems, location allocation problems.	**8 Hrs.**
Unit 3: --- **Facility layout**: definition, significance, objectives, steps in layout planning, quantitative techniques, computerized layout planning procedures, Space determination and area allocation.	**8 Hrs.**
Unit 4: --- **Group technology**: Production Flow analysis, Rank Order Clustering, design of assembly and production lines, line balancing.	**6 Hrs.**
Unit 5: --- **Material handling**: definition, principles of material handling, unit load concept, Master flow pattern, material or product handling methods, processes General flow patterns, flow planning criteria. Design of a flow pattern. Techniques for analyzing materials flow, material handling system design, equipment types and selection, packaging requirements and containers selection, safety considerations.	**6 Hrs.**
Unit 6: --- **Storage and warehousing**: functions, objectives, and principles, warehouse	**8 Hrs.**

allocations problems, facility services Automatic storage and retrieval systems, design principles, upcoming trends.	
Term Work: **Details of assignments are as follows:** 1. Assignment on facility Location models. 2. Assignment for solving facility location problems using spreadsheet software. 3. Assignment on Development of Facility Layout. 4. Assignment on Group Technology. 5. Assignment on storage and warehousing. 6. Assignment of FlexSim Manufacturing Simulation Software. 7. Any Two Research Articles Presentation in the area of Facility Planning and Plant Layout. 8. One case study of industry about location and layout strategy	

Textbooks:

1. Tompkins, J.A. and J.A.White, Facilities planning, John Wiley, 2003.
2. Richard Francis.L. and John A.White, Facilities Layout and location-an analytical approach, Prentice Hall India, 2002.
3. Mikell P. Groover, (2002), "Automation, Production Systems and Computer Integrated Manufacturing", (2/e), Pearson Education, ISBN 81-7808-511-9

References:

1. James Apple, Plant layout and Material Handling, John Wiley, 1977.
2. Panneerselvam,R, "Production and Operations Management", Prentice Hall India, 2007

Unit wise Measurable Students Learning Outcomes:

1. **Explain** significance and scope of facility layout and design.
2. **Solve** facility location problems for locating single new facility in manufacturing system.
3. **Develop** layout of manufacturing system using systematic layout planning procedure.
4. **Develop** the machine cells and layout for manufacturing processing resources.
5. **Choose** and **Analyze** flow patterns and Material Handling Systems for given manufacturing environment.
6. **Plan** warehouse products spaces allocation for given warehouse.

Title of the Course: Mechatronics System Design Course Code: PPRD0125	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite:

4. Fundamentals of Electronics
5. Electrical Machines and Electronics

Course Description:

Mechatronics refers to a flexible, multi-technological approach for integration of mechanical engineering, computer engineering, electronics and information sciences. Mechatronics is essential in the design of intelligent products. It allows engineers to transform their virtual concepts into real life applications. It is a relatively new concept relating to the design of systems, devices and products aimed at achieving an optimal balance between basic mechanical structure and its overall control.

Course Objectives:

1. Apply mechanical engineering and electrical engineering knowledge and skills to problems and challenges in the areas of mechatronic engineering.
2. Integrate and use systems or devices incorporating modern microelectronics, information technologies and modern engineering tools for product design, development and manufacturing.
2. To demonstrate team-oriented skills within the field of mechatronics.
3. Interface common sensors and actuators to PCs or microcontrollers
4. To demonstrate knowledge of electrical circuits and logic design.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Demonstrate the knowledge of sensors and actuators effectively using working models	2	Demonstrate
CO2	Develop PLC program for given application by using suitable software	3	Develop
CO3	Identify appropriate signal conditioning method for given application	3	Identify
CO4	Design a simple mechatronic system for given application	6	Design

CO-PO Mapping:

CO	PO1	PO2	PO3
CO1	√		
CO2	√	√	√
CO3	√		
CO4	√	√	√

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- A) I**ntroduction**: Introduction to mechatronic system, evolution, scope and components of mechatronic systems, mechatronics in product and measurement system, control system and modes of control, traditional design and mechatronic design. B) Actuators, Sensors and Transducers: Hydraulic, pneumatic and electrical actuators and their system modeling, performance terminology, system modeling of sensors; displacement, position and proximity sensors, velocity and acceleration sensors, flow sensors, force sensors, temperature sensors, ultrasonic and fibre-optic sensors, selection of sensor, piezo-electric sensors.	9 **Hrs.**
Unit 2:--- **Hardware Components:** Number systems in Mechatronics, binary logic, Karnaugh map minimization, transducer signal conditioning process, principals of analogue and digital signal conditioning, protection, filtering, operational and instrumentation amplifiers and their gains, analogue to digital and digital to analogue conversion, multiplexers, pulse modulation.	6 **Hrs.**
Unit 3:--- **Programmable Logic Controller:** Review of logic gates, basic structure, features, input/output processing, programming, functional block diagram (FBD), ladder diagram, logic functions, latching, sequencing, jumps, internal relays, counters, shift registers, master and jump control, data handling, data movement, data comparison, arithmetic operations, code conversion, analog input and output, applications for automation, diagnostics and condition monitoring.	4 **Hrs.**
Unit 4:--- **Microcontroller:** Comparison between microprocessor and microcontroller, programming of 8051, Arduino. Introduction to Proteus and Keil software, programming of 8051 for simple applications using Proteus and Keil, interfacing	8 **Hrs.**

input and output devices, interfacing D/A converters and A/D converters, Various applications for automation and control purpose. Interfacing of different sensors with Microcontroller.	
Unit 5:--- **Real-Time Interfacing:** Introduction, Elements of Data Acquisition and Control System, Overview of I/O Process, Installation of the I/O Card and Software, Installation of the application Software, Examples, Over framing. Interfacing of sensors with the PLC.	4 **Hrs.**
Unit 6:--- **Advanced Applications in Mechatronics:** Mechatronic control in automated manufacturing, Artificial Intelligence in mechatronics, Introduction to Fuzzy logic,Fuzzy Logic application in Mechatronics, Micro sensors in Mechatronics, and case studies of Mechatronic systems.	5 **Hrs.**

Textbooks:

1. Mechatronics, 3/e --- W. Bolton (Pearson Education)
2. Mechatronics -Dan Necsulescu (Pearson Education)
3. The 8051 Microcontroller: Architecture, Programming and Applications, 2/e Kenneth J.Ayala (Penram International)
4. Mechatronics: Principles, Concepts and Applications - N.P.Mahalik (TMH)
5. Introduction to Mechatronics & Measurement Systems – David G. Alciatore& Michael B.Histand (TMH)
6. Process Control & Instrumentation Technology –Critis D. Johnson (Pearson Education)
7. Mechatronics System Design – DevdasShetty, Richard A. Kolk (Thomson)
8. Computer Control of Manufacturing Systems - YoramKoren (McGraw Hill)
9. Automated Manufacturing Systems: Sensors, Actuators - S. Brain Morriss (McGraw Hill)
10. Industrial Automation – David W. Pessen (John Wiley & Sons)
11. 99 Examples of Pneumatic Applications – FESTO Controls Pvt. Ltd. Bangalore.
12. Modular Pick and Place Device– FESTO Controls Pvt. Ltd. Bangalore.
14. Rationalization with Handling Technology– FESTO Controls Pvt. Ltd. Bangalore.
15. Rationalization with Small Work piece Feeding- FESTO Controls Pvt. Ltd. Bangalore.
16. Sensors for Handling & Processing Pechnology- FESTO Controls Pvt. Ltd. Bangalore.
17. Sensors in Production Engg. - FESTO Controls Pvt. Ltd. Bangalore.
18. Handbook of Industrial Automation – Richard L. Shell & Ernest L. Hall (Marcel Decker Inc.)
19. Programmable Logic Controllers"Programming Methods and Applications" (with CD Rom) –Jack R. Hackworth & Fredrick D. Hackworth,Jr.(Pearson Education).

References:

1. Mechatronics – Dan Necsulescu (Pearson Education) ISBN 81-7808 -676 – X. 8. The

8051 Microcontroller: Architecture, Programming & Applications, 2/e – Kenneth J. Ayala (Penram International) ISBN – 81-900828-7

2. Introduction to Mechatronics & Measurement System – David G. Alciatore & Michael B. Histand (TMH) ISBN 0-07-052908

Unit wise Measurable students Learning Outcomes:

1. The student shall be able to select appropriate sensor and controller for given application
2. The student shall be able to understand different signal conditioning tech
3. The student shall be able to construct PLC ladder program
4. The student shall be able to understand the concept of microprocessor and microcontroller
5. The student shall be able to understand interfacing techniques
6. The student shall be able to understand the applications of Mechatronics

Term Wok:

1. Experiments on Op-Amp, 555. (Min Four)
2. Exercises on analog-digital trainer to study fundamentals of digital electronics including OPAMPs (Minimum Three)
3. Experiments on various sensors (Minimum Four)
4. programs on PLC for system automation involving of interfacing of sensors and actuators,
5. One simple exercise on microcontroller like 8051/ Arduino
6. Interfacing of sensors and actuators with microcontroller like 8051/ Arduino.
7. At least two exercises on a total Mechatronic System Design for applications like packaging, loading/unloading, pick and place etc.

Additional requirements in the Mechatronics Laboratory.

1. Arduino boards
2. Bread Boards
3. Various sensors
4. One more Allen Bradley PLC

Addition to the Syllabus

1. Introduction to Arduino Micro controller
2. Introduction to Keil and Proteus Software
3. Interfacing of different sensors with Microcontroller.
4. Interfacing of sensors with the PLC.

Title of the Course: Advanced Casting Technology Course Code: PCCC0126	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite:

Fundamental knowledge of materials and basic metal Casting processes

Course Description:

Casting is the process from which solid metal shapes (castings) are produced by filling voids in molds with liquid metal. The basic steps involved in making castings are patternmaking, molding, melting and pouring, shakeout and cleaning, heat treating, and inspection. Casting is a defect prone manufacturing process. Hence Casting simulation helps to visualize mold filling and casting solidification; to predict sand casting defects. Proficient students will build on the knowledge and skills of the casting Technology course while learning additional forming techniques not covered in previous courses.

Course Objectives

CO1: To Show knowledge in an advanced foundry by taking into account the fundamental of casting process.

CO2: To Explain special molding, core making and advanced casting techniques and modern equipment's in casting operation

CO3: To Analyze manufacturing and management related problems in casting technology.

CO4: To Perform optimization of gating system with use of modern software.

CO5: To Standardize the process with various productivity and quality control techniques in a casting industry

CO6: To predict the possible defect locations using simulation softwares and select proper remedial actions to avoid defect formation

Course Learning Outcomes:

CO	After the completion of the course the student should be able	Bloom's Cognitive level	Descriptor
CO1	To Show knowledge in an advanced foundry by taking into account the fundamental of casting process.	II	Knowledge
CO2	To Explain special molding, core making and advanced casting techniques and modern equipment's in casting operation	IV	Knowledge
CO3	To Analyze manufacturing and management related problems in casting technology.	V	Skill
CO4	To Perform optimization of gating system with use of modern software.	VI	Knowledge
CO5	To Standardize the process with various productivity and quality control techniques in a casting industry	VI	Knowledge
CO6	To predict the possible defect locations using simulation softwares and select proper remedial actions to avoid defect formation	VI	Knowledge

CO-PO Mapping:

CO	PO1	PO2	PO3
	An ability to independently carry out research /investigation and development work to solve	An ability to write and present a substantial technical report/document	Students should be able to demonstrate a degree of mastery over the area as per the

	practical problems		specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
CO1	**2**		
CO2	**1**		
CO3	**1**		
CO4		**2**	
CO5	**1**		
CO6			**1**

Assessments :

Teacher Assessment:
Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/Moodle quiz/Topic seminar/Group Discussions, Industrial case study etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Recent Trends , advancements and Scope In Foundry Industry :	**6Hrs**

Review of conventional method of casting and pattern design, pattern and die design considerations,Position of foundry industry worldwide and in India, analysis of data in respect of production and demand, recent trends in quality specifications like dimensional accuracy, surface finish and property requirements, specifications, properties and applications of modern cast alloys- SG iron,Al – alloys, Cu- alloys, Zn – alloys, Mg -Alloys

Unit 2: Design considerations in manufacturing of pattern, dies and toolings	**7Hrs**

Computer aided casting component design, Computer aided design and manufacturing of patterns and dies, advanced materials for patterns and dies - selection and applications, allowances in patterns and dies, , rapid tooling and use of Rapid prototyping in foundry

Unit 3: Design of Gating System:	**7Hrs**

Elements and types of gating systems, gating ratio pressurized and non-pressurized gating, systems- applications, Risers – types and functions of risers, directional solidification – factor affecting and significance, use of exothermic sleeves, bricks, chills and their types, types and uses of filters, computer aided design for gating and risering systems.Nucleation kinetics, fundamentals of growth, solidification of single-phase alloys, solidification of eutectic alloys, Use of simulation software for casting methoding and metal flow simulation

Unit 4: Advancement in molding and modern casting techniques:	**6Hrs**

Coated Sands & Processing: shell sand, no-bake sand systems, CO_2, sand, cold box sand, ,developments in sand mullers and sand plants, sand reclamation - cost and environmental issues,

types of reclamation methods, High pressure molding technology, flaskless molding technology, magnetic molding, Core shooters used in shell core making and cold box process, Mold and core washes / coats – types, applications, selection and significance, Use of ceramic components and filters, their selection and significance, Permanent Mold & Special Casting Techniques: Process parameters for Die casting- gravity, pressure and low pressure, Centrifugal casting, Vacuum casting, Investment casting, Squeeze casting; Advantages, limitations and applications.

Unit 5: Melting and Post processing of Castings:	**7Hrs**

Recent advancement in melting practice, Melting technologies for steels, grey C.I., S.G. iron and compacted graphite iron, Al-Si alloys, Magnesium and Titanium based alloys; Inoculation, modification, de-oxidation, de-gassing, grain refinement treatments for various alloys, advanced methods for chemical analysis for metal compositions and temperature measurement, Fettling and cleaning of castings, Shot blasting, using pneumatic chippers and grinders,Salvaging , Heat treatment and painting of castings, Defects, inspection and testing of castings, Casting defects and their classification, rejection analysis, remedial measures; instrumentation, mechanization and automation, instrumentation, Safety aspects in foundries, Environmental issues and regulations, Possible hazards in foundries, Safety measures, Safety devices, Foundry mechanization and automation, Automatic Ladle System, industrial safety

Unit 6: Quality Control, Modernization , Mechanization and Productivity Improvement Techniques in Foundry	**7Hrs**

Quality specifications in respect of raw materials used in foundry sand, sand additives, furnace charging material, checklists maintained for raw materials, mould; Heat wise pouring reports, melting log sheets, test bars, calibration of testing equipments (U.T.M., Sand testing equipments); chemical analysis, mechanical properties, test reports, rejection report analysis, defect diagnosis, remedies, use of cause - effect or fish- bone diagrams, S.Q.C. in foundries, control charts ,Auditing in foundries, optimization techniques, costing of castings; importance and implementation of TS, ISO and QS in foundries, KAIZEN, safety measures, pollution and its control (compliance to pollution control norms as specified by govt. authorities, Mechanization in Foundries: Conveying system, automated Pouring sand reclamation plants, foundry layout

Textbooks and reference books:

1. Advanced Pattern Making – Cox I.L. (The Technical Press, London.)
2. AFS and Control hand book – AFS.
3. ASM Handbook – Vol. 15 Castings.
4. Foundry Engineering – Taylor, Fleming & Wulff (John Wiley)
5. Fundamentals of Metal Casting – Flinn, Addison Wesley
6. Fundamentals of Metal Casting Technology - P.C. Mukherjee (Oxford, IBH)
7. Heineloper & Rosenthal, Principles of Metal Casting, Tata McGraw Hill, 2000.
8. IIF - Foundry Journal
9. Jain P.L., Principles of Foundry Technology,Tata McGrawHill Publishers, 2003
10. Mechanization of Foundry Shops – Machine Construction - P.N. Aeksenov (MIR)
11. Metal Castings – Principles & Practice - T.V. Ramana Rao. (New Age International Pvt. Ltd. Publishers.)
12. Principles of Foundry Technology - P.L. Jain (TMH)
13. Principles of Metal Castings - Heine, Loper and Rosenthal (TMH)
14. Principles of Metal Manufacturing Processes, J. Beddoes & M.J. Bibby (Elsevier, Butterworth, Heinemann) (2003)
15. The Foseco Foundryman's Handbook, -Foseco, CBS Publishers & Distributors
16. The New Metallurgy of Cast Metals Castings – Campbell, CBS Publishers & Distributors,

Reference books

1. Casting Technology And Casting Alloys by A.K.Chakrabarti, (PHL Learning Pvt Ltd.)
2. Iron and steel making by Ahindra Ghosh, Amit Chatterjee (PHL Learning Pvt Ltd.)
3. Complete Casting Handbook-Metal Casting Processes, Metallurgy, Techniques & Design by John Campbell (BH Publication
4. Casting simulation website ***www.efoundryiitb.ac.in***
5. The FOSECO Foundry man's handbook 10th edition by Butter Worth-Heinemann (BH Publication)
6. ASM Handbook on casting

Title of the Course: Advanced Machine Tool Design	L	T	P	Credit
Course Code: PPRD0127	3	1	-	4

Course Pre-Requisite: Acquaintance with the basic concepts of Machine Design and Strength of Materials.

Course Description:

Principles of Machine Tool Design, Analysis of forces, Design of Spindles, Machine tool Structure and Dynamics of machine tool, control systems for machine tool.

Course Objectives:

1. To understand core concepts of Machine Tool & Product Design.

2. To understand the basic approach for designing machine tool components and implement the appropriate method.

3. To compute the power requirements of various machine tools.

4. To learn to design quality based manufacturing system.

5. To learn to design a product using innovative concepts of 'Product Design'

6.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	The student shall be able to apply the concepts of machine tool design.	III	Applying
CO2	The student shall be able to select the correct design approach & design the important components of machine tools.	III	Applying

CO3	The student shall be able to calculate the forces acting and the subsequent power requirements of machine tools.	V	Evaluating
CO4	The student shall be able to specifically design the critical components comprising a manufacturing system & emphasize on the quality of the system.	VI	Creating
CO5	The student shall be able to analyse the various phases of the design cycle sequentially and envision the concept of "Scratch to Market" w. r. t a product	IV	Analyzing

CO-PO Mapping:

CO	**a**	**b**	**c**
CO1	1		
CO2	1	1	2
CO3	2	1	2
CO4	2	1	2
CO5	3	2	3

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction to Machine & Machine Tool Types, capabilities, features of construction like working & auxiliary motions in machine tools, parameters defining the working motions of a machine tool, machine tool drives, general requirements of machine tool design, methodology for machine tools design considering quality, quantity of production and economic aspects. **Principle of Machine Tool Design** Design from the point of view of quality, production rate, strength, rigidity, assembly, ergonomics, aesthetics, maintenance and interchangeability	6-- **Hrs.**
Unit 2:--- a) **Analysis of forces** Forces affecting machine tool elements, determination of motive power for different operating conditions, use of handbooks. **b) Design considerations and selection of standard components** Drive systems with pulleys, belts, ropes and chains; selection of oil seals, gaskets and electric motors from standard catalogues.	5 -- **Hrs.**
Unit 3:--- Kinematics of Machine Tools Classification of various driving systems, basic considerations in the design of drives, aims of speed & feed regulation, stepped regulation of speeds, design of gear box, laws of stepped regulations, selection of range ratio, G.P. ratio, break up of speed steps, structural diagram, Ray diagram & speed chart,	8 -- **Hrs.**

design of feed box, machine tool drives using multiple speed motors, general recommendations for developing gearing diagram, determining the number of teeth on gears, stepless regulation of speed and feed rates.	
Unit 4:--- a) Design of Spindle & Spindle Support Functions of spindle unit and requirements, materials and construction, spindle ends, spindle support, design calculations, mounting arrangements of spindle bearings, spindle bearing lubrication b**) Selection of Machine Tool Bearing** Journal, rolling and hydrostatic bearings, basic principles, assembly, mounting and maintenance, procedure for selection of bearings from manufacturer's catalogue based on load and life considerations	7 -- **Hrs.**
Unit 5:--- a) Design of Machine Tool Structures Functions of machine tool structures and their requirements, design criteria, materials, static and dynamic stiffness, profiles of machine tool structures, basic design procedure, design of beds, columns, housings, rams etc, Causes of vibrations in machine tools and methods of elimination. **(b) Design of Guide ways** Functions and types of guideways, materials, design criteria and calculations of slide-ways based on wear and accuracy, design of anti-friction guideways, hydrostatic and hydrodynamic lubrication of guideways.	8 -- **Hrs.**
Unit 6:--- a) Dynamics Of Machine Tools Concept of dynamic cutting process, Physical causes of chatter and vibrations, Types of Chatter. Stability chart, chatter vibration in Lathe, Drilling machine, Grinding machine and Milling machine. Different methods for avoiding machine tool chatter and vibration **b) Control Systems in Machine Tools** Functions, requirements and classification. Control system for speed and feeds centralized control pre selective control, control system for forming and auxiliary motions, Mechanical control , Ergonomic consideration and compatibility – Automatic control system – Electric Hydraulic and pneumatic systems.	7 -- **Hrs.**

Textbooks:

1. Machine tool design by N.K.Mehta (TMH)

2. Principles of machine tools by Gopal Chandra Sen and Amitabh Bhattacharya (New Central Book Agency).

3. Design of Machine Tool, Dr. S. K. Basu (Oxford IBH)

4. Design of Machine Elements, V. B. Bhandari, Tata McGraw-Hill Publishing Company Ltd.

5. Machine Tool Design Handbook, C.M.T.I, Bangalore, (TMH).

6. Product Design and Manufacturing, (3/e), A. K. Chitale and R. C.Gupta, Prentice Hall of India Pvt. Ltd

References:

1] Design of Machine Elements, Dobrovalsky

2] Catalogues of Bearing Manufacturers, example, S.K.F, NACHI, TIMKEN, NRB etc

3] Elements of Machine Design, N. C. Pandya and C. S. Shaha, Charotkar Publishing House

4] Engineering Design, a Materials and Processing Approach, G. Dieter, Tata McGraw-Hill Publishing Company Ltd.

Unit wise Measurable students Learning Outcomes:

1. The student shall be able to apply the principles of machine tool design to general and single purpose machine tools.
2. The student shall be able to calculate the forces acting and the subsequent power requirements of machine tools.
3. The student shall be able to design a speed box, the design of relevant shafts, pulleys, belts, selection of gaskets, seals etc.
4. The student shall be able to design a spindle for deflection and select bearings from the manufacturer's catalogue.
5. The student shall be able to apply the principles of machine tool design to machine tool structures and guideways.
6. The student shall be able to analyse the causes of chatter and vibrations and methods to avoid the same, design a control system pertaining to hydraulic, pneumatic and electric systems.

Title of the Course: Advanced Welding Technology Course Code: PPRD0128	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite:

Fundamental knowledge of basic science

Course Description:

Welding is the most economical and efficient way to join metals permanently. It is the only way of joining two or more pieces of metal to make them act as a single piece.

Course Objectives

1. To understand the basic principles of welding
2. To know the various types of advanced joining processes
3. To know about welding defects and remedial measures for it
4. To know the inspection Techniques of welding.
5. To know use of automation and Robotics in welding

Course Learning Outcomes:

CO	After the completion of the course the student should be able	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Develop welding techniques for various alloys	II	Knowledge
CO2	Develop welding application concepts	IV	Knowledge
CO3	Develop mechanized welding techniques	V	Skill
CO4	Develop welding electrodes and inspection techniques	V	Skill
CO5	Develop use of automation and robotics in welding	IV	Knowledge

CO-PO Mapping:

CO	PO1	PO2	PO3
CO1	1		
CO2			
CO3	2		
CO4			
CO5			3

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/Moodle quiz/Topic seminar/Group Discussions, Industrial case study etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Power sources	**6Hrs**
Classification of welding processes - heat sources, power sources, arc characteristics, V-I relationship, different types of electrodes, ingredients and function of electrode coverings, types of weld joints.	
Unit 2: Fusion welding processes	**5Hrs**
Shielded metal arc welding, gas welding, TIG welding, MIG welding, Submerged arc welding processes	
Unit 3: Solid state welding processes	**8Hrs**
Resistance, friction, friction stir, ultrasonic, induction pressure, diffusion welding processes, explosive welding .	
Unit 4: Special welding processes	**7Hrs**
Electron beam, laser beam welding, plasma arc processes; advantages, limitations, Introduction to Robotic welding, underwater welding	
Unit 5 Welding metallurgy and Inspection and Testing of Welds	**6Hrs**
Weld thermal cycles and their effects, effects of pre and post weld heat treatments, concept of HAZ, concept of weldability and its assessment. Welding of different materials, defects in welds, their causes and remedies. Destructive testing of weld – Tensile, Bend, Impact, Nick Break, Hardness, Etch Tests, Non Destructive Testing of Welds	
Unit 6:: Welding Automation and Robotics	**6Hrs.**
Introduction, Automation options, Simple Mechanization, Dedicated and Special Purpose Automation, Robotic welding, Modular Automation, Programmable control, Remote Control Slave and Automated Systems, Welding Fixtures:Introduction, welding fixtures, their characteristics, classification and selection considerations, Principles governing design of good welding fixtures, various types of welding fixtures.	

Estimation of Welding Cost: Introduction, main components costs of welding processes, factors involved in welding costs, basic costing procedure for arc welding, basic costing procedure for gas welding, factors affecting welding costs.

Textbooks and reference books:

17. ASM Handbook vol.6, welding Brazing & Soldering, 2003
18. Carrry B., Modern Welding Technology, Prentice Hall Pvt Ltd., 2002
19. Cornu.J. Advanced welding systems – Volumes I, II and III, JAICO Publishers, 1994.
20. Iotrowski – Robotic welding – A guide to selection and application – Society of mechanical Engineers, 1987.
21. Lancaster.J.F. – Metallurgy of welding – George Alien & Unwin Publishers, 1980
22. Metallurgy of Welding Technology-D. Seferian, Chapman & Hall
23. Parmer R.S., Welding Engineering and Technology, Khanna Publishers,2002
24. Principles of Metal Manufacturing Processes, J. Beddoes & M.J. Bibby (Elsevier, Butterworth, Heinemann) (2003)
25. Schwariz, M.M. – Source book on innovative welding processes – American Society for Metals (OHIO), 1981
26. Srinivasan N.K., Welding Technology, Khanna Tech Publishers, 2002
27. Welding and Welding Technology- R.Little, TMH.
28. Advance Welding Technology by Sa Rizvi Wajahat Ali

Unit wise Measurable students Learning Outcomes:

Unit 1	Power sources	ULO1.1:To learn the basic concept of welding processes.
Unit 2	Fusion welding processes	ULO2.1: To learn different fusion welding processes
Unit *3*	Solid state welding processes	ULO 3.1 To learn different solid state welding process
Unit 4	Special welding processes	ULO4.1: To learn different special welding processes. .
Unit 5	Welding metallurgy and Inspection and Testing of Welds	ULO5.1To Analysis of stresses in welded structures ULO5.2: To identify and test welding defects and weldment
Unit 6	Welding Automation and Robotics	ULO 6.1: To use welding automation and robotics

Title of the Course: Polymer Engineering and Science Course Code: PPRD0129	L	T	P	Credit
	3	1	0	4

Course Pre-Requisite: Students MUST have passed: Plastic technology

Course Description:
This course gives an introduction to polymer science and engineering, covering the properties of polymers, polymer reactions and reactors, and polymer forming processes.

Course Objectives:
1. To know the different class of polymers and polymerization.
2. Appreciate properties of polymer and factors which determine their use.
3. Demonstrate understanding of thermal aspects in polymers.
4. To study different composites and their strengthening mechanisms with examples.
5. To understand the importance and application of composites.
6. Develop their understanding of the most common processing methods used in plastics

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Describe** common families of plastics materials and synthesis techniques to include thermoset, thermoplastic, crystalline and amorphous materials.	1	Remembering
CO2	**Explain** the mechanical properties of polymers	2	Understanding
CO3	**Explain** the effects of microstructural parameters on the properties of composite.	2	Understanding
CO4	**Explain** the various polymers and chemistry of polymerization	2	Understanding

CO-PO Mapping:

CO	PO1	PO2	PO3
CO1		1	3
CO2	1		
CO3	1		
CO4	1		2

Assessments :
Teacher Assessment:
Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks

ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.
Tutorial is based on Assignments, Case studies related to course content.

Course Contents:

Introuction: Introduction to polymer science, Chemistry of polymerization – chain, step and miscellaneous polymerization reactions, Kinetics of polymerization – free radical, cationic, anionic and polycondensation polymerization, molecular weight and size of polymer.	**7 Hrs.**
Thermal aspects in Polymers: Glass transition temperature in polymer, factor influencing glass transition temperature, structure of crystal, crystal shape, crystallinity of polymer, copolymerization, polymer degradation.	**7 Hrs.**
Properties of Polymers: Viscoelasticity, nature of viscoelasticity – creep, stress relaxation and dynamic properties, Theory of linear viscoelasticity – zener model, distribution of relaxation times, origin of temperature dependence, stiffness, Yielding, crazing and fracture properties of polymer.	**7 Hrs.**
Processing of Polymers: Processing of polymer composites – Pultrusion, filament winding, hand lay-up, hand spray-up, compression molding, reinforced reaction injection molding. Forming – flow properties of polymer melt, extrusion – single and twin screw extruder, thermoforming, blow molding, transfer molding.	**7 Hrs.**
Polymer Blends: Introduction to polymer blends, Polymer-polymer miscibility, factors governing miscibility, immiscible systems and phase separation Importance of interface on the property development, compatibilizers and compatibilization Blends of amorphous & semi-crystalline polymers, rubber toughened polymers, particulate, fiber reinforced composites. Various processing techniques like solution mixing, melt processing.	**7 Hrs.**
Rheological Properties of Polymer Blends Unique properties of blends in rheological, mechanical, and physical properties and applications.	**7 Hrs.**

Textbooks:

1. V R Gowariker et.al, Polymer Science, New Age International Publisher, 2005.

2. Textbook of Polymer Science, 3ed Paperback – 24 Jan 2007, by Fred W. Billmeyer
3. Polymer Science and Technology: Plastics, Rubber, Blends and Composites, by Premamoy Ghosh.
4. Polymer Science and Technology 2005, by Fried.
5. Polymer Science: A Textbook, 1 December 2009, by V. K. Ahluwalia and Anuradha Mishra.
6. Experiments in Polymer Science,2008, by D.G.Hundiwale and U.R.Kapadi.
7. Principles Of Polymer Science, 2002, by Bahadur P.

References:

1. N G McCrum et.al, Principles of Polymer Engineering, Oxford Science Publications, 1989.
2. Practicals in Polymer Science, by Siddaramaiah
3. Modern Styrenic Polymers: Polystyrenes and Styrenic Copolymers (Wiley Series in Polymer Science), by John Scheirs and Duane Priddy
4. Plastics Additives: An A-Z reference (Polymer Science and Technology Series), by Geoffrey Pritchard.
5. Filled Polymers I: Science and Technology: Volume 96 (Advances in Polymer Science), by Nikolay S. Enikolopyan and Michael L. Fridman.
6. Polymers in Medicine: Biomedical and Pharmacological Applications (Polymer Science and Technology), by Emo Chiellini and Paolo Giusti
7. A Laboratory Manual of Polymers: Volume 1, 28 November 2011 | Import, by S.M. Ashraf and Sharif Ahmad

Unit wise Measurable students Learning Outcomes:

1. Upon completion of Unit 1 the student will familiar with various types of polymers and polymerization.
2. Upon completion of Unit 2 the student will able to undersand thermal aspects in polymers.
3. Upon completion of Unit 3 the student will able to analyze importance of viscoelasticity of polymers.
4. Upon completion of Unit 4 the student will able to summarize knowledge to processing of polymer composites.
5. Upon completion of Unit 5 the student will able to understand interfacial interactions and processing techniques of polymers.
6. Upon completion of Unit 6 the student will able to understand rheological properties of polymer blends.

Title of the Course: Industrial Automation and Robotics Course Code: PPRD0130	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite:

Basic knowledge of manufacturing
Basics of Hydraulics and Pneumatics
Basics of Programming

Course Description:

This course is an introduction to fixed and flexible automation equipment. An emphasis is placed upon flexible equipment components such as the industrial robot. Robot topics includes fundamentals of robots, robot control system, end effectors and sensors, robot programming and kinematics

Course Objectives:

1. To be familiar with the automation and brief history of robot and applications.
2. To give the student familiarities with the kinematics of robots.
3. To give knowledge about robot end effectors and their design.
4. To learn about Robot Programming methods & Languages of robot.
5. To give knowledge about various Sensors and their applications in robots.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Distinguish the types of automation	4	Distinguish
CO2	Identify robot configurations	3	Identify
CO3	Select a sensor for given application	3	Select
CO4	Select an appropriate programming language for given application	3	Select

CO-PO Mapping:

CO	a	b	c
CO1	1		
CO2	1		
CO3		1	
CO4	1		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- **Introduction:** Automated manufacturing systems, fixed /programmable /flexible automation, need; Basic elements of automated systems- power, program and control; Advanced automation functions, Levels of automation; Industrial control systems in process and discrete manufacturing industries, Continuous and discrete control; Low cost automation, Economic and social aspects of automation.	7 **Hrs.**
Unit 2:--- **a)Transfer Lines:** Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications; Analysis of transfer lines without and with storage buffers. **b)Assembly Automation:** Types and configurations, Parts delivery at workstations-Various vibratory and non-vibratory devices for feeding and orientation, Calculations of feeding rates, Cycle time for single station assembly machines and partially automated systems; Product design for automated assembly	8 **Hrs.**
Unit 3:--- **Fundamentals of Industrial Robots:** Specifications and Characteristics, Basic components, configurations, Criteria for selection, various industrial applications.	4 **Hrs.**
Unit 4:--- **Robotic Control Systems:** Drives, Robot Motions, Actuators, Power transmission systems; Robot controllers, Dynamic properties of robots- stability, control resolution, spatial resolution, accuracy, repeatability, compliance	5 **Hrs.**
Unit 5:--- **Robotic End Effectors and Sensors:** Transducers and sensors- sensors in robotics and their classification, Touch (Tactile) sensors, proximity and range sensors, force and torque sensing, End Effectors- Types, grippers, Various process tools as end effectors; Robot-End effectors interface, Active and passive compliance, Gripper selection and design	7 **Hrs.**
Unit 6:--- **Robot Programming:** Lead through method, Robot program as a path in space,	7 **Hrs.**

Methods of defining positions in space, Motion interpolation, branching; Textual robot programming languages

Robot Kinematics:
Introduction, forward, reverse & homogeneous transformations, manipulator path control, introduction to robot dynamics configuration of a robot controller.

Textbooks:

1. Groover, M.P., (2004), "Automation, Production Systems & Computer Integrated Manufacturing" 2/e, (Pearson Edu.) ISBN: 81-7808-511-9

2. Morris, S.Brian (1994), "Automated Manufacturing Systems", (McGraw Hill) ISBN: 0-07-113999-0

3. Pessen, David W.(1990), "Industrial Automation, Circuit Design & Components", (John Wiley & Sons, Singapore)

4. Groover, M.P.; Weiss, M.; Nagel, R.N. & Odrey, N.G. "Industrial Robotics, Technology, Programming & Applications", (McGraw Hill Intl. Ed.) ISBN:0-07-024989-X

5. Fu, K.S.; Gonzalez, R.C. & Lee, C.S.G. "Robotics-Control, Sensing, Vision and Intelligence", (McGraw Hill Intl. Ed.) ISBN:0-07-100421-1

References:

1. Keramas, James G. (1998), " Robot Technology Fundamentals",(CENGAGE) ISBN:981-240-621-2 7. Noff, Shimon Y. "Handbook of Robotics", (John Wiley & Sons)

2.Niku, Saeed B. (2002), "Introduction to Robotics, Analysis, Systems & Applications", (Prentice Hall of India)

3. Koren, Yoram "Robotics for Engineers", (McGraw Hill)

4.Schilling, Robert J.(2004), "Fundamentals of Robotics, Analysis & Control", (Prentice Hall of India), ISBN: 81-203-1047-0

Unit wise Measurable students Learning Outcomes:

1. The student shall be able to understand different types of automation
2. The student shall be able to understand the concept of transfer line
3. The student shall be able to understand basics of robotics
4. The student shall be able to understand robotic control system
5. The student shall be able to select appropriate end effectors
6. The student shall be able to write a robot program using suitable programming language

Title of the Course: Reliability Engineering **Course Code : PPRD0221**	**L**	**T**	**P**	**Credit**
	3	**1**	**-**	**4**

Course Objectives:

i. To summarize reliability engineering and its management throughout the product life cycle.

ii. To perform reliability engineering analysis.

iii. To compute reliability engineering parameters and estimates for applications in mechanical devices and manufacturing environments.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	**Demonstrate understanding of basic reliability measures such as MTTF,MTBF,MTTR ,Availability, failure rate ,bathtub curve etc.**		
CO2	**Compute and evaluate reliability for redundant, series and parallel system.**		

CO-PO Mapping:

CO	**a**	**b**	**c**
CO1			**1**
CO2	**2**		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10

ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:

Fundamental concepts:- (7 Hrs)

Reliability definitions, failure, Failure density, Failure Rate, Hazard Rate, Mean Time To Failure, MTBF, maintainability, availability , pdf, cdf, safety and reliability, Quality, cost and system effectiveness, Life characteristic phases, modes of failure, Areas of reliability,Quality and reliability assurance rules, product liability, Importance of Reliability,

Unit 2:

Probability theory:- (7 Hrs)

Set theory, laws of probability, total probability theorem, probability distributions binomial, normal, poisson , lognormal, weibull , exponential, standard deviation, variance, skewness coefficient , chebyshev inequality, central limit theorem.

Unit 3:

System reliability and modelling: (7 Hrs)

Series, parallel, mixed configuration, k- out of n structure, complex systems- enumeration method, conditional probability method, cut set and tie set method, Redundancy, element redundancy, unit redundancy, standby redundancy- types of stand by redundancy, parallel components single redundancy, multiple redundancy. Markov analysis.

Unit 4:

Maintainability and Availability: (7 Hrs)

Objectives of maintenance, types of maintenance, Maintainability, factors affecting maintainability, system down time, Availability - Inherent, Achieved and Operational availability, reliability and maintainability trade-off.

Unit 5:

System reliability Analysis: (6 Hrs)

Reliability allocation or apportionment, Reliability apportionment techniques – equal apportionment, AGREE, ARINC, feasibility of objectives apportionment, dynamic programming apportionment, Reliability block diagrams and models, Reliability predictions from predicted unreliability, minimum effort method.

Unit 6:

Failure Mode, Effects and Criticality Analysis- (6 Hrs)

Failure mode effects analysis, severity/criticality analysis , FMECA examples, RPN, Ishikawa diagram for failure representation , fault tree construction, basic symbols development of functional reliability block diagram, Fau1t tree analysis, fault tree evaluation techniques, minimal cut set method, Delphi methods, Monte carlo evaluation.

Reference Books

A.K. Govil, Reliability Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1983. .

B.S. Dhillion, C. Singh, Engineering Reliability, John Wiley & Sons, 1980.

M.L. Shooman, Probabilistic, Reliability, McGraw-Hill Book Co., 1968. .3

P.D.T. Conor, Practical Reliability Engg., John Wiley .4 & Sons, 1985.

K.C. Kapur, L.R. Lamberson, Reliability in Engineering Design, John Wiley & Sons, 1977.

A.Birolini , Reliability Engineering, Theory and Practice, Third Edition, Springer,. 1999

Text Books:

L.S. Srinath, Concepts of Reliability Engg., Affiliated East-Wast Press (P) Ltd., 1985.

E. Balagurusmy, Reliability Engineering, Tata McGra

Course Title:	LEAN MANUFACTURING	L	T	P	Credit
Course Code:	PPRD0222	3	1	-	4

Course Pre-requisites:

Course Description:

Course Objectives:

To apply the above tools to implement LM system in an organization.

Course Learning Outcomes:

It is desired that at the end of the course, the student will be equipped with the basic knowledge of lean manufacturing, tools, techniques and implementation outcomes.

CO No.	Course Outcome (CO) Statement
1	**It is desired that at the end of the course, the student will be equipped with the basic knowledge of lean manufacturing, tools, techniques and implementation outcomes.**

CO	1	2	3
1			2

Unit	Unit Contents	Hours
1	**UNIT I** INTRODUCTION TO LEAN MANUFACTURING , Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools.	
2	**UNIT II** CELLULAR MANUFACTURING, JIT, TPM Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM – Pillars of TPM, Principles and implementation of TPM.	
3	**UNIT III** SET UP TIME REDUCTION, TQM, 5S, VSM Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and implementation. 5S Principles and	

	implementation - Value stream mapping - Procedure and principles.	
4	**UNIT IV** SIX SIGMA Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation	
5	**UNIT V :** CASE STUDIES Various case studies of implementation of lean manufacturing at industries.	

Text Books

1. Govindharajan, M., Natarajan, S. and Senthil Kumar, V.S., Engineering Ethics, Prentice Hall of India, (PHI) Delhi, 2004.

Reference Books

1. Charles D, Fleddermann, "Engineering Ethics", Pearson / PHI, New Jersey 2004 (Indian Reprint)
2. Subramainam, R., Professional Ethics, Oxford University Press, New Delhi, 2013.

Course Title:	Total Quality Management	L	T	P	Credit
Course Code:	PPRD0223	3	1	-	4

Course Pre-requisites:

Course Description:

Course Objectives:
To apply the above tools to implement LM system in an organization.

Course Learning Outcomes:

1) Student should able to demonstrate to the core concepts and the emerging trends in Quality Management.
2) Student should able develop hands-on-skills on tools and techniques of Quality management for industrial problem-solving.
3) To student should able to demonstrate implementation and documentation requirements for Quality system.

CO No.	Course Outcome (CO) Statement
1	Define Quality concept
2	Explain quality aspects related to mechanical industries
3	Organise quality based manufacturing system.
4	Classify quality control techniques
5	Explain quality improvement methods
6	Solve quality related problems encountered in industries.

CO	1	2	3	Justification
1				
2				
3		1	1	Organise quality based manufacturing system
4				
5	2		1	Explain quality improvement methods
6			1	Solve quality related problems encountered in industries.

Unit	Unit Contents	Hours
1	Principles and Practice Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM	
2	Leadership Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making	
3	Continuous Process Improvement Tools and Techniques Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Tools and Techniques: Benching marking, quality management systems, environmental management system, quality function deployment, quality by design, failure mode and effect analysis, total productive maintenance	
4	Quality Management Tools Why Why, forced filed analysis, nominal group technique, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, prioritization matrices, process decision program chart, activity network diagram	
5	Statistical Process Control Pareto diagram, process flow diagram, cause and- effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.	
6	Quality Improvement: Single parameter experiments, Orthogonal array, Analysis of Means, Analysis of Variance ANOVA (one - way), Statistical inferences, Variance reduction, Process capability, Correlation analysis, Linear regression models	

Reference Books:

1. Dale H. Besterfiled, “Total Quality Management”, Pearson Education Asia
2. Rose, J.E. Total Quality Management, Kogan Page Ltd. 1993.
3. John Bank, The essence of total quality management, Prentice Hall, 1993.
4. Greg Bounds and Lyle Yorks, Beyond Total Quality Management, McGraw Hill, 1994.
5. Masaki Imami, KAIZEN, McGraw Hill, 1986.
6. Phil Crosby, Quality Without Tears, McGraw Hill
7. Six Sigma: Hemant Urdhwareshe

Course Title:	Safety Engineering	L	T	P	Credit
Course Code:	PPRD0224	3	1	-	4

Course Pre-requisites: Introduction of ergonomics, introduction of work study.

Course Description: Ergonomic principles, Human-machine-environment interface, Anthropometry, work station design, Manual material handling, physiological cost of activity, work load and work capacity, displays and controls, safety rules and factory acts, guarding of hazards.

Course Objectives:

1. To understand basic principle of Ergonomics and safety and its importance
2. To understand and apply anthropometry in work station design.
3. To analyze physiological cost of activity.
4. To analyze and design manual material handling task.
5. To identify hazard and avoid it.
6. To study factories act and rules related to safety.

Course Learning Outcomes

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
01	The students shall be able to understand and apply fundamentals of Ergonomics and safety in designing work system.	III	Applying
02	The students will be able to apply anthropometry principles in design of work systems.	III	Applying
03	Students will be able to analyze physiological cost of activity	IV	Analyzing
04	Students will be able to analyze and design manual material handling tasks to reduce risk.	IV	Analyzing
05	Students will be able to identify and avoid Hazards.	IV	Analyzing
06	Students will understand various factories acts and rules related to employee's safety.	III	Applying

CO-PO Mapping

CO	a	b	c
CO1	1	2	
CO2	2	2	3
CO3	2	2	3
CO4	2	2	3
CO5	1	2	
CO6	1		

Teacher Assessment

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE1	**10**
MSE	**30**
ISE2	**10**
ESE	**50**

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three modules) ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents

Unit	Unit Contents	Hours
1	Introduction to Ergonomics, Brief history, Modern ergonomics, Human-Machine-Environment Interface, Anatomy, Posture and body mechanics: Stability and support, Control of muscle function, fatigue and discomfort, musculoskeletal problems in sitting and standing, extreme postures	**05**
2	Anthropometry & Work Surface Design: Anthropometric data, Principles of anthropometry applied in design, Design for everyone, Workstation design, Design for standing work, Design for seated work, Work surface design, Visual display terminals	**06**
3	a) Design of manual tasks: Lifting, Carrying, The NIOSH approach, Slip, trips, and falls, Work-related musculoskeletal disorders: Injuries to upper body, Control of neck problem, Shoulder, elbow and wrist problems, Repetitive strain injuries b) Workload and work capacity: Physical work capacity, Maximum oxygen uptake, VO2 max and industrial work, Factors affecting work capacity, Workload, Physical fitness and health, Heat stress, heat stroke, Cold stress, Thermal comfort, Humidity, Illumination, lighting, Glare, contrasts, and VDT, Visual fatigue, eye strain, Light, circadian rhythm, Noise exposure, Noise-induced hearing loss, Vibration and health, Vibration and work performance	**10**
4	Displays, controls, and human-machine interaction, Principles of design of visual displays, Grouping, resolution, color coding, Digital displays, multiple display configuration, Computer-generated displays, Three-dimensional displays, Design of controls, Control distinctiveness, Control-display integration, Panel design, Human-machine interaction, mental workload, human error	**06**
5	Objectives, scope, applications and major provisions of Factories Act, 1948; Minimum Wages Act, 1948; Payment of Wages Act, 1936; Equal	**04**

	Remuneration Act, 1976; Employees' State Insurance Act, 1948; The Child Labour (Prohibition and Regulation) Act, 1986; Industrial Employment (Standing Orders) Act, 1946; Industrial Disputes Act, 1947; The Labour Laws Act, 1988;	
6	a) General safety rules, principles, maintenance, Inspections of machines, standards and codes, hazards. b) Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard, construction- guard opening, authorized entry to hazardous installations-benefits of good guarding systems.	**09**

Textbook

1. Introduction to Ergonomics by R S Bridger, McGraw Hill
2. Safety in Industry, N.V. Krishnan JaicoPublishery House, 1996.
3. Industrial, Labour and Geereal Laws, Module 2, Paper 7, The Institute of Company Secretaries of India

Reference Books

4. Occupational Ergonomics: Principles and applications by F Tayyari and J Smith, Kluwer Academic Publishers, Boston Putz-Anderson, V., 1988.
5. Cumulative trauma disorders : A manual for musculoskeletal diseases of the upper limbs. Taylor and Francis, London.
6. Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.

LAB WORK

Experiment No. 1. Measure the dimensions of any one work station. Draw the neat sketch and verify whether the dimensions are as per ergonomic principles. (For ex. any machine tool, any assembly station from industry, office table with computer and connections, CNC machine, etc.)
Experiment No. 2. Analysis of manual material handling task using techniques like REBA, RULA, NIOSH equation. (Any two activities – Example - lifting of boxes, lifting of heavy components in any industry)
Experiment No. 3. Physiological cost analysis of any one activity such as manual material handling, cart pulling, construction site activity, etc.
Experiment No. 4. Study of display panel of any four machines or instruments with neat sketch, comments and suggestions.
Experiment No. 5. Study of various machine guarding techniques used in industry. (Any Five machines)
Draw lay out sketch, comment and give suggestions.
Experiment No. 6. Study of factories act and safety equipments used in industry.

Lab equipment required: Human modeling software, Gonimeters, strength dynamometer, Heart rate monitor watch and belt, Noise level meter, weighing scale, Electromyography machine, Treadmill.

Title of the Course: Work System Design	**L**	**T**	**P**	**Credit**
Course Code: PPRD0226	**3**	**1**	**-**	**4**

Course Pre-Requisite: Students should finish one of the courses: Organizational behavior or human resource management. Industrial Engineering

Course Description: Work systems are systems in which human, computer, materials, tools, space and other systems, come together performing activities over time to produce products, services, or research. Work systems we encounter daily have mostly existed over a long time. However, work forms, social environment and expectation of employees changing with new technologies and ideas, which lead to the needs for continually improvement and even new design of work systems

Course Objectives:

The course will help students understand that work systems nowadays are complex sociotechnical systems which contain human, technology, internal and external environments, organization and management. Work system structure and design has strong impact on work performance, strain and stress, safety and health of workers. Well-designed work system benefit both employers and employees.

Course Learning Outcomes:

CO	Students will be able to	Bloom's Cognitive level	Descriptor
CO1	Calculate the basic work content of a specific job for employees of an organization.	2	Understanding
CO2	Analyze and calculate the level of risk in a job causing stress, fatigue and musculoskeletal disorders and design appropriate work systems.	3	Applying
CO3	Analyze the existing methods of working for a particular job and develop an improved method through questioning technique.	3	Applying

CO-PO Mapping:

CO	**a**	**b**	**c**
CO1	1		
CO2	1		
CO3		1	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10

ESE	50

Course Contents:

Unit-I **Work Study Fundamentals:** Productivity, Definition and Scope of Motion and Time Study, History of Motion and Time Study, Work Methods Design – the Broad View and Developing a Better Method, Reducing Work Content and Ineffective Time, Human Factors in the Application of Work Study.	**6 Hrs.**
Unit-II **Method Study:** Process Analysis, Activity Charts, Man-Machine Charts, Operation Analysis, Different Charts and Diagrams Used, Basic Procedure, Micro Motion Study, Fundamental Hand Motions, Principles of Motion Economy, Use of Films in Method Analysis.	**6 Hrs.**
Unit-III **Work Measurement:** Its Purposes and Uses, Basic Procedure, Techniques of Work Measurement – Work Sampling, Stop-Watch Time Study, Concepts of Rating and Allowances, Setting Standard Times for Jobs, Standard Data, Predetermined Time Standards: Work-Factor, and Methods-Time-Measurement.	**6 Hrs.**
Unit-IV **Part-A Ergonomics Fundamentals:** Simple and complex worksystems, Ergonomic aspects in workstation design and analysis, History of ergonomics, Modern ergonomics. **Part-B Anthropometric Principles and Postural Analysis in Workspace Design:** Anthropometry and its uses, principles of applied anthropometry, applications of anthropometry in design, postures and body mechanics, musculoskeletal problems in sitting and standing.	**10 Hrs.**
Unit-V **Design of Manual Handling Tasks:** Anatomy and biomechanics of manual handling, design of manual handling tasks; lifting and carrying, NIOSH approach, EC guidelines. Physiology, Workload, and Work Capacity: Physical work capacity, factors affecting work capacity, measurement of physiological cost of work, fitness for work.	**6 Hrs.**
Unit-VI **Design of Physical Environment:** Human thermoregulation, measuring thermal environment, measurement of light, lighting design considerations, measurement of sound, industrial noise control, vibration, principles for the design of visual displays, design of control, work organization and worksystem design.	**6 Hrs.**

Textbooks and References

•Methods, standards, and work design, Niebel, W. B. and Freivalds, A., McGraw Hill, 2004.

•Human Factors in Engineering and Design, Sanders, M. S. and McCormick, E. J., McGraw-Hill, Sixth Edition.

•Introduction to Ergonomics, Bridger, R. S., McGraw-Hill, 1995.

•A Guide to the Ergonomics of Manufacturing, Halender, M., East-West Press (Taylor and

Francis), 1996.

•Motion and Time Study: Design and Measurement of Work, Barnes, R. M., John Wiley and Sons, 1980.

•Introduction to Work Study, International Labor Organization, Third Revised Edition.

Title of the Course: Human Resource Management	**L**	**T**	**P**	**Credit**
Course Code: PPRD0227	**3**	**1**	**-**	**4**

Course Pre-Requisite: Any graduate student.

Course Description: Management of human resources is the most important function in any organization. It is essential to achieve a balance between caring for one's employees, helping them work to their maximum potential and achieving the goals of an organization through the work the employees put in. This course is specifically designed to sensitize students who are preparing to enter the workforce to issues related to workforce management.

Course Objectives: Help students to:

1. Understand the need and the importance of the HRM in the organization/department.
2. Conduct the job analysis and build the job description.
3. Design the suitable recruitment procedures for the organization/department.
4. Know different methods of training and design the new training programs.
5. Understand the different compensation structures.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Identify the human resources needs of an organization or department		
CO2	Conduct a job analysis and produce a job description from the job analysis		
CO3	Evaluate the procedures and practices used for recruiting and selecting suitable employees.		
CO4	Assess training requirements and design a successful orientation and training program.		
CO5	Design and evaluate the compensation structure for an organization/department		
CO6	Discuss workplace health and safety programs and the roles of the employer and the employee in enforcing health and safety policies and procedures.		

CO-PO Mapping:

CO	**a**	**b**	**c**

CO1	1		
CO2	1		
CO3		1	
CO4		1	
CO5	1		
CO6	1		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Introduction to HRM - Overview of HR Function in Business Organization, HR metrics, HR processes	**3 Hrs.**
Unit 2: Staffing, Recruitment, Testing and selection- Job analysis, HR planning, Steps in recruitment process, succession planning, forecasting tools,	**6 Hrs.**
Unit 3:,**Introduction to performance management system (PMS)** – Types of performance appraisal, methods of performance appraisal, performance evaluation, performance feedback, errors in appraisal	**6 Hrs.**
Unit 4: Training and Development System - Training process, need for training, training methods, general and specific Training/ Training evaluation, careers and talent management	**6 Hrs.**
Unit 5: Compensation- Components of wage structure, wage and salary administration, compensation structure, compensation benchmarking, internal and external parity, competency based pay, establishing strategic Pay Plans, pay for Performance and Financial Incentives	**6 Hrs.**
Unit 6: Employee Relations: Ethics, Justice and Fair treatment in HR / Collective Bargaining /Employee Safety and Health / Managing Global Human Resources / International HRM	**3 Hrs.**
Unit 7: Strategic Human Resource Management and HR Scorecard: Linking people, strategy and performance a. HR – Strategic Partner b. Creating an HR scorecard c. Measuring HR alignment	**3 Hrs**

Textbooks:

1. Dessler, Gary, and Biju Varkkey. "Human Resource Management: Dorling

Kindersley (India) Pvt." *Ltd, New Delhi* (2011).
2. Gary, Dessler. *Fundamentals of Human Resource Management: Content, Competencies and Applications*. Pearson Education India, 2010.
3. Aswathappa, K. *Human resource management: Text and cases*. Tata McGraw-Hill Education, 2013.

References:

1. Beatty, R.W., Huselid, M.A. and Schneier, C.G. (2003), New HR Metrics: Scoring on the Business Scorecard, Organizational Dynamics, Vol. 32, No. 2, pp. 107–121.
2. Ref. article; Saini, D.S.,2009, Labour laws in India: Structure and working in Bhatnagar, J. and Budhwar, P. (edis.), Changing Face of People Management in India.), Routledge, London

Title of the Course: ENTREPRENEURSHIP DEVELOPMENT Course Code: PPRD0228	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite:

Course Description: To familiarize students with fundamentals of Entrepreneurship and to encourage them to become successful entrepreneurs.
The students shall demonstrate the knowledge of Entrepreneurship and shall be motivated to become successful entrepreneurs.

Course Objectives:

1. To gain basic knowledge about entrepreneurial process. And to understand relationship between entrepreneurship and economic development.
2. TO understand role of SSI, planning of SSI, Govt. and policies and facilities. And to understand role of government support organizations. for SSI .
3. To know the basic concepts and the process of Business Plan Preparation
4. To know the techniques of small business management. And to understand business aspects like export procedure,IP Act,etc;
5. To gain knowledge about various aspects of project report preparation and understand statutory requirements for SSI

Course Learning Outcomes: The students shall demonstrate the knowledge of Entrepreneurship and shall be motivated to become successful entrepreneurs.

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Discuss entrepreneurial competencies required taking into account consideration case studies of successful entrepreneurs.		
CO2	Identify the working capital requirement for proposed SSI business		
CO3	Apply qualitative and quantitative forecasting techniques for business opportunity identification.		
CO4	Classify government facilities and support systems for SSI and interpret the support match for SSI.		
CO5	Demonstrate application of small business planning principles taking into account product selection, machinery selection, site selection, marketing, finance to prepare a sample report of a business plan		

CO-PO Mapping:

CO	a	b	c
CO1	1		
CO2		1	
CO3		1	
CO4	1		
CO4	1		
CO5		1	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Entrepreneurship: Definition of Entrepreneur and Entrepreneurship, entrepreneurial process, Entrepreneurship and economic development, job creation, Indian scene. **Entrepreneurial Motivation**: Self-disclosure, personality effectiveness, risk taking,entrepreneurial competencies, case studies.	-6- **Hrs.**
Unit 2:- Small Scale Units: Concept and definition, role of S.S.I. in Indian economy,government policies and facilities. **Planning Small Scale Business:** Business opportunity identification, idea generation ideas from marketplace, market assessment, demand estimation.	-8- **Hrs.**
Unit 3:--- Government Support Organizations: a) Central Government b) State government c) Financial support organizations d) Government schemes and procedures	-5- **Hrs.**
Unit 4:-Business plan preparation: Meaning of business plan, project parameters,information sources of economical and technical know how, selection of location,identification of raw material, suppliers, plants/machinery, process, manpower and other inputs such as power, water etc.	-5- **Hrs.**

Unit 5:--- Small Business Management: Techniques of marketing, materials, production,manpower and financial management, crisis management, working capital management,fixed capital assessment, cash flow analysis, ROI, techniques of decision making. **Statutory Requirements:** Factories Act 1948, Industrial disputes Act 1947, Indian Contract Act, Indian sales and Goods Act, Indian Partnership Act, Central Excise Sales tax, Income Tax Act, Value Added Tax (VAT).	-6- **Hrs.**
Unit 6:--- Preparation of project report: 1) Selection of product 2) Process and plant and machinery selection 3) Layout planning 4) Financial viability 5) Marketing and distribution of goods 6) Study of probable reasons of failure **Business Aspects:** Business ethics, export environment, procedure and documentation, venture capital financing, intellectual property act, patents, GATT	8-- **Hrs.**
Textbooks: 1. S.S.I. and Entrepreneurship- Vasant Desai (Himalaya Publication) 2. Dynamics of Entrepreneurial Development & Management- Vasant Desai (Himalaya Publication) 3. Project Planning & Entrepreneurship Development - T. R. Banga. 4. S.S.I. and Entrepreneurship- Vasant Desai (Himalaya Publication) .	
.References: 1] Developing New Entrepreneurs - Entrepreneurship Development Institute of India, Ahmedabad. 2] Motivating Economic Achievement- David C. McClelland, David G. Winter. .	

Title of the Course: Project Management Course Code: PPRD0229	L	T	P	Credit
	3	1	-	4

Course Pre-Requisite: Industrial Engineering, Industrial Management

Course Description: The course describes the various stages of project management. The project management deals with network analysis and network scheduling. The course also describes the financial aspects of project and monitoring the progress of project.

Course Objectives:

1. To discuss concept of project management.
2. To explain use of network analysis for project management.
3. To explain financial aspects of managing the project.

Course Learning Outcomes

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Illustrate the project proposal considering fundamentals, project selection, project scope, project environment and project life cycle etc.	2	understanding
CO2	Estimate the project completion time and project cost using network analysis.	5	Evaluating
CO3	Make use of project scheduling software	3	Applying
CO4	Plan for post implementation project review and performance evaluation.	3	Applying

CO-PO Mapping:

	PO		
CO	**1**	**2**	**3**
CO1		1	2
CO2			2
CO3	1		2
CO4			2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: **Assessment is based on 50% of course content (Normally first three modules)**

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---	**6 Hrs.**

Introduction: Foundations of Project Management, Project Life Cycle, Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure.	
Unit 2:--- Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modeling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations.	**8 Hrs.**
Unit 3:--- Network analysis: Shortest path method, minimal spanning tree, Floyd and Dijkastra algorithm PERT/COST Accounting, Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Crashing of project.	**8 Hrs.**
Unit 4:--- Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT.	**6 Hrs.**
Unit 5:--- Financial Analysis; Estimation of cost of project and means of financing, estimates of sales and production, cost of production, Working capital requirement and its financing, estimates of working results, breakeven points – projected cash flow statement	**6 Hrs.**
Unit 6:--- Monitoring Project Progress, Project Appraisal and Selection, Project review and administrative aspects; Initial review, performance evaluation, abandonment analysis, administrative aspects of capital budgeting, evaluating the capital budgeting system of an organization, recent trends in Project Management.	**6 Hrs.**

Tutorials:

1. Assignment on fundamentals of project management.
2. Assignment on network scheduling.
3. Assignment on network analysis.
4. Assignment on financial analysis.
5. Assignment on project monitoring.
6. Case study on actual/hypothetical project indicating different stages of project management, network analysis, financial analysis, monitoring techniques etc.

Textbooks:

1. Project Management – A Managerial Approach, by Jack R. Meredith, and Samuel J. Mantel Jr., John Wiley and Sons, 2006
2. Project Management – A Systems Approach to Planning, Scheduling and Controlling, by Harold Kerzner, John Wiley and Sons, 2006
3. Project Planning: Analysis, Selection, Implementation and Review by Prasanna Chandra, Tata Mc Graw Hill.
4. Project Management and Control by Narendra Singh, HPH, 2003.

References books:

1. Introduction to Operations Research, Hillier and Lieberman, Tata McGraw Hill.
2. Project Management for Business and Technology: Principles and Practice, John M. Nicholas and Herman Steyn, Prentice Hall India.
3. Clifford F. Gray & Eric W. Larson, "Project Management: The Managerial Process", Tata Mc Graw Hill
4. Construction Project Management, Planning, Scheduling and Control, Chitkara Tata McGraw-Hill,
5. Project Management, Merdith & Gopalan, Wiley India (P) Ltd.