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(AICTE Model Curriculum Based Scheme)
Bachelor of Technology (B.Tech.) VII Semester (Industrial & Production Engineering)

w.e.f. July 2023

S.No.	Subject Code	Category Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours Per Week			Total Credits
				Theory			Practical			L	T	P	
				End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
1	IP71	PEC	Professional Elective Course-III	70	20	10	-	-	100	3	1	-	4
2	IP72	OEC	Open Elective Course-II	70	20	10	-	-	100	3	1	-	4
3	IP73	PCC	Industrial Robotics & Mechatronics	70	20	10	30	20	150	3	-	2	4
4	IP74	PCC	Computer Aided Design	70	20	10	30	20	150	3	-	2	4
5	IP75	PCC	Industrial Engineering	70	20	10	30	20	150	3	-	2	4
6	IP76	MC	Industrial Training Evaluation	-	-	-	60	40	100	-	-	4	2
			Total	**350**	**100**	**50**	**150**	**100**	**750**	**15**	2	**10**	**22**
7	IP77	DLC	Self-Learning Presentation (SWAYAM/NPTEL/MOOC)	-	-	-	-	-	-	-	-	-	8
8	IP78	MC	NSS/NCC/Swatchhata Abhiyan/Rural Outreach	Qualifier									
Additional Course for Honours or Minor Specialization				Permitted to opt for maximum 8 credits against additional MOOC courses in subject code IP77 for the award of Honours (Minor Specialization).									

Note: 01. Departmental BOS will decide list of three/four elective subjects for each PEC and OEC.
02. MOOC/NPTEL subjects shall be taken with permission of HOD/Coordinator
03. Industrial training presentation & viva shall take place in VII Sem. which students have already done in VI Sem.

Professional Elective Course-III		
S.No.	**Subject Code**	**Subject Name**
1	IP71A	Vibration & Maintenance Engineering
2	IP71B	Project Management
3	IP71C	Automobile Engineering
4	IP71D	Computer Aided Production Planning

Open Elective Course-II		
S.No.	**Subject Code**	**Subject Name**
1	IP72A	Advance Manufacturing Process
2	IP72B	Rapid Prototyping
3	IP72C	Research Methodology & Optimization Techniques
4	IP72D	Manufacturing System Design

1 hour lecture (L) = 1 credit | 1 hour Tutorial (T) = 1 credit | 2 hour Practical (P) = 1 credit

PEC: Professional Elective Course, OEC: Open Elective Course, PCC: Professional Core Course, DLC: Distance Learning Course, MC: Mandatory Course

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COURSE CONTENTS **w.e.f. July 2023**

Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
IP71A	Vibration & Maintenance Engineering	End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work	100	L	T	P	4
		70	20	10	-	-		3	1	-	

Course Objective:

- To provide the concept of vibration analysis.
- . Acquire the knowledge of maintenance management.
- To learn the concept of whirling motion & critical speed.
- To gain fundamental of condition-based maintenance

VIBRATIONS AND MAINTENANCE ENGINEERING
(IP-71A)

MODULE – I: Fundamental Aspects of Vibrations : Vibration, main causes, advantages and disadvantages; engineering applications of vibration; vector method of representing harmonic motion; characteristics of vibration, harmonic analysis and beats phenomenon, work done by harmonic forces on harmonic motion;; elements of vibratory system; lumped and distributed parameter systems, degreed of freedom.

Undamped Free Vibrations: Derivation of differential equation of motion: the energy method, the method based on Newton's second law of motion, and Rayleigh's method. Solution of differential equation of motion: Natural frequency of vibration. Equivalent spring stiffness, Systems involving angular oscillations: the compound pendulum.

MODULE -II: Damped Free Vibrations: Viscous damping: coefficient of damping; damping ratio; under damped, overdamped and critically damped systems; logarithmic decrement; frequency of damped free vibration; frequency, decay rate, systems with two degrees of freedom.

Whirling Motion and Critical Speed: Whirling motion and Critical speed : Definitions and significance, Critical–speed of a vertical, light –flexible shaft with single rotor : with and without damping, Free Transverse Vibration due to a Point Load on a Simply Supported Shaft, Free Torsional Vibration of a Single Rotor System

MODULE – III: Maintenance Concepts and Strategies: Introduction, maintenance functions and objectives, maintenance planning and scheduling, maintenance organization.

General Introduction to Maintenance Types: Breakdown, emergency, corrective, predictive, and preventive; maintenance prevention; design-out maintenance, productive maintenance, shutdown maintenance and scheduled maintenance.

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MODULE - IV: Condition Based Maintenance: Principles of CBM, pillars of condition monitoring, CBM implementation and benefits; condition monitoring techniques- visual monitoring, vibration monitoring, wear debris monitoring, corrosion monitoring, performance monitoring

MODULE - V: Reliability Centered Maintenance (RCM): –Concept, methodology, benefits;
Total Productive Maintenance: Evolution of TPM, TPM objectives, concept, pillars of TPM.
Failure Modes and Effects Analysis **(FMEA)/ Failure Modes, Effects and Criticality Analysis, (FMECA)**: Overview, elements of FMECA, applications and benefits, risk evaluation, risk priority numbers, criticality analysis, process FMEA, qualitative and quantitative approach to FMECA; design FMEA and steps for carrying out design FMEA

References:

1- Ambekar A.G., Mechanical Vibrations and Noise Engineering; PHI
2- Meirovitch Leonard; Element of Vibration Analysis; TMH
3- Dukikipati RV Srinivas J Text book of Mechanical Vibrations; PHI
4- Kelly SG and kudari SK; Mechanical Vibrations; Schaum Series; TMH
5- Thomson, W.T., Theory of Vibration with Applications, C.B.S Pub & distributors.
6- Singiresu Rao, Mechanical Vibrations ', Pearson Education.
7- G.K. Grover, Mechanical Vibration, Nem chand and Bross, Roorkee
8- V. P. Singh, Mechanical vibrations, Dhanpat rai and Co.
9- Sadhu Singh, Mechanical Vibrations, Khanna Publishers.
10- Ebeling CE; An Introduction to Reliability & Maintainability Engg; John Wiley and Sons
11- Mishra R.C; Reliability and Maintenance Engineering; New age international publisher.
12- Kelly Anthony; Maintenance Planning and Control
13- R.C. Mishra and Pathak; Maintenance Engineering and Management; PHI

Course Outcomes:

At the completion of this course, students should be able to-

CO1	Analyze Undammed free vibration systems.
CO2	Analyze Damped free vibration systems.
CO3	Whirling motion and critical speed in Harmonically excited Vibration.
CO4	Analyze condition-based maintenance.
CO5	Analyze Reliability Centered Maintenance

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	1	1	1	0	0	1	1	1	1
CO2	1	3	1	0	3	1	0	1	0	1	1	0
CO3	1	3	3	1	3	0	1	0	0	1	1	1
CO4	1	1	1	0	1	0	0	0	0	1	1	1
CO5	1	2	1	1	2	0	0	0	0	1	1	1

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Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
		End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work		L	T	P	
IP71 B	Project Management	70	20	10	-	-	100	3	1	-	4

Course Objective:

- To acquire the basic concept of project management.
- To establish knowledge regarding planning, costing and financing.
- To build-up knowledge regarding project organization, culture and leadership.
- To know about project management performance and human resourses.

Course content:

PROJECT MANAGEMENT
(IP71 B)

Module- I: Concepts of Project Management: Meaning, Introduction Project Management Role & Scope of Project Management, Need for Project Management, definition and characteristics of a project, Project objectives and functions, Project classification, Project life cycle phases, elements of project management, Tools & Techniques in Project Management, roles, and attributes for project manager. Methods and techniques for developing project managers.

Module- II: Project selection and initiation: Project identification, Projection screening and selection criteria. Establishing the project scope, detailed project report, Market and demand study, Primary and secondary information, Nature of Project Decision, The Project Development Cycle, Opportunity Studies, Pre-feasibility and Feasibility Studies, Project feasibility report, Technical Analysis.

Module- -III: Project planning, Costing and Financing: Project planning, Project Scheduling Project management system, Work breakdown structure, Schedule development Costing of Projects, Costing and Pricing of Project, Types of Cost Estimates in Projects, Project Scoping Project Financing, Sources of Long-Term Rupee Funds, Sources of Long-Term Rupee Loans, Sources of Long-Term Free Exchange, Sources of Short-Term Rupee Funds, Feed forward Project Control.

Module- -IV: Project organization, culture, and leadership: Organization structure, Characteristics of organization, Elements of organization, Process of organization, Principles of organization Types of Organization Structures, Hierarchical Organization Structures, Functional organization Matrix organization Line and Staff organization, Integrating Projects in Functional Organizations, comparison of functional, matrix and project organization. Evolution of Organization Structures in Projects, Types of Matrix Organization Structures.

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Module- -V: project management performance and close out: Factors influencing project success, factor responsible for project failure, Performance indicator, time overrun, cost overrun, project sickness, Approaches to performance analysis, Project close out, computer project management system (CPMS). Schematic of Planning and Control.

Human Resources: Human Beings as a Resource, Balancing Human Resources, Types of Problems in Balancing Human Resources, Delegation, documenting project authority, Principles of delegations of authority.

References:

1. Prasana Chandra: Projects: planning Implementation control; TMH.
2. Gray Clifford F And Larson EW; Project The managerial Process; TMH
3. Panneerselven and Serthil kumar; Project management, PHI
4. Burke ; Project Management-Planning and control technics; Wiley India
5. Kamaraju R; Essentials of Project Management; PHI Learning

Course Outcomes:

At the completion of this course, students should be able to

CO1	To get the knowledge about concept of project management.
CO2	To know about project selection & initiation.
CO3	To know about project planning, costing, and financing.
CO4	To get the knowledge about project organization, culture & leadership.
CO5	To acquire the knowledge about project management performance & human resources.

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1	0	0	1	0	1	0
CO2	0	2	1	0	1	1	0	1	0	1	0	0
CO3	0	1	1	1	2	0	1	0	0	0	0	1
CO4	0	1	0	0	1	0	0	0	0	0	0	0
CO5	0	0	1	1	0	0	0	0	0	0	0	1

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COURSE CONTENTS **w.e.f. July 2023**

Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
IP71 C	Automobile Engineering	End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work	100	L	T	P	4
		70	20	10	-	-		3	1	-	

Course Objective:

- To acquire the basic knowledge of chassis & body.
- To establish knowledge regarding Steering system, transmission system, suspension system, electrical system, and control system.

Course content:

AUTOMOBILE ENGINEERING
(IP 71 C)

MODULE I: Chassis & Body Engg: Types, Technical details of commercial vehicles, types of chassis, lay out, types of frames, testing of frames for bending & torsion on unutilized body frame, vehicle body and their construction, driver's visibility and methods for improvement, safety aspects of vehicles, vehicle aerodynamics, optimization of body shape, driver's cab design, body materials, location of engine, front wheel and rear wheel drive, four-wheel drive.

MODULE -II: Steering System: front axle beam, stub axle, front wheel assembly, principles of types of wheel alignment, front wheel geometry viz. camber, Kingpin inclination, castor, toe-in and toe-out, condition for true rolling motion, Centre point steering, directional stability of vehicles, steering gear, power steering, slip angle, cornering power, over steer & under steer, gyroscopic effect on steering gears.

MODULE -III: Transmission System: Function and types of clutches, single plate, multi-plate clutch, roller & spring clutch, clutch lining and bonding, double declutching, types of gear Boxes, synchronizer, gear materials, determination of gear ratio for vehicles, gear box performance at different vehicle speed, automatic transmission, torque converters, fluid coupling, principle of hydrostatic drive, propeller shaft, constant velocity universal joints, differential gear box, rear axle construction.

MODULE -IV: Suspension system : Basic suspension movements, Independent front & rear suspension, shock absorber, type of springs: leaf spring, coil spring, air spring, torsion bar, location of shackles, power calculations, resistance to vehicle motion during acceleration and breaking, power & torque curve, torque & mechanical efficiency at different vehicle speeds, weight transfer, braking systems, disc theory, mechanical, hydraulic & pneumatic power brake systems, performance, self-energization, air bleeding of hydraulic brakes, types of wheels and tires, tyre specifications, construction and material properties of tyres & tubes.

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MODULE V: Electrical and Control Systems: storage battery, construction, and operation of lead acid battery, testing of battery, principle of operation of starting mechanism, different drive systems, starter relay switch, regulator electric fuel gauge, fuel pump, horn, wiper, Lighting system, head light dazzling, signaling devices, battery operated vehicles, choppers. importance of maintenance, scheduled and unscheduled maintenance, wheel alignment, trouble Shooting probable causes & remedies of various systems, microprocessor-based control system for automobile, intelligent automobile control systems. Emission standards and pollution control: Indian standards for automotive vehicles-Bharat I and II, Euro-I and Euro-II norms, fuel quality standards, environmental management systems for automotive vehicles, catalytic converters, fuel additives, and modern trends in automotive engine efficiency and emission control.

References:

1. Crouse, Automotive Mechanics TMH.
2. Srinivasan S; Automotive engines; TMH
3. Gupta HN; Internal Combustion Engines; PHI;
4. Joseph Heitner, Automotive Mechanics, Principles and Practices, CBS Pub.
5. Kripal Singh, Automotive Engineering Khanna Pub.
6. Newton & Steeds, Automotive Engineering
7. Emission standards from BIS and Euro –I and Euro-II

Course Outcomes:

At the completion of this course, students should be able to

CO1	To acquire the basic knowledge of chassis & body.
CO2	To establish knowledge regarding Steering system.
CO3	To build-up knowledge regarding transmission system.
CO4	To know about suspension system.
CO5	To know about electrical & control system.

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1	0	0	1	0	1	0
CO2	0	2	1	0	1	1	0	1	0	1	0	0
CO3	0	1	1	1	2	0	1	0	0	0	0	1
CO4	0	1	0	0	1	0	0	0	0	0	0	0
CO5	0	0	1	1	0	0	0	0	0	0	0	1

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Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
		End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work		L	T	P	
IP71 D	Computer Aided Production Planning	70	20	10	-	-	100	3	1	-	4

Course Objective:

- To acquire the basic knowledge of Computer aided forecasting.
- To establish knowledge regarding Group Technology, computer aided planning, operation management, testing, MRP & ERP with simulation.

Course content:

Computer Aided Production Planning
(IP71D)

Module I

Computer Aided Forecasting: Nature and use of forecast, sources of data, demand patterns, forecasting models, selection of forecasting technique, measurement of forecast Accuracy, Adoptive methods. Computerized relative allocation of facility technique, automated layout design program and computerized relationship layout planning for facility location and layout.

Module II

Group Technology: - Introduction, objectives part families, algorithms and models for G.T. - Rank order clustering, Bond energy, mathematical model for machine – component cell formation. Design and manufacturing attributes. Parts classification and coding, concept of composite job machine group, cell group tooling, design rationalization, CAD/CAM and GT benefits.

Module III

Computer Aided Process Planning, Operation Management, Computer Aided Inspection- Computer Aided Testing, contact type, non-contact type.

Module IV

MRP: Introduction, Objective, Input, Computational procedure, information provided by the system. Detailed capacity planning, manufacturing resources planning
ERP: Introduction, main features, generic model of ERP system, selection of ERP, proof of concept approach, analytic hierarchy approach, ERP implementation.

Module V

Simulation – Major activities, purpose, simulation process, types methodology, simulation packages, process quality simulator, computer requirements trends, applications simulation of manufacturing systems.

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Reference Books

1. An introduction to Automated Process Planning – Tien – Chien Chang and Richard Awysk/Prentice Hall
2. M.P. Groover, Automation production systems and computer aided mfg.-
3. P.N. Rao, N.K. Tewari, T.K. Kundra, Computer aided manufacturing
4. G.T. in the engineering industry Bur bridge
5. MRP – by Orlikey
6. Buffa & Sarin, Modern Production Management
7. P.B. Mahapatra, Computer Aided production management
8. Averill M Law & David Kelton, Simulation modeling and analysis, Tata McGraw Hill

Course Outcomes:

At the completion of this course, students should be able to

CO1	To acquire the basic knowledge computer aided forecasting.
CO2	To establish knowledge regarding group technology.
CO3	To build-up knowledge of computer aided process planning & operation management.
CO4	To know about computer aided MRP & ERP.
CO5	To know about computer aided simulation.

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1	0	0	1	0	1	0
CO2	0	2	1	0	1	1	0	1	0	1	0	0
CO3	0	1	1	1	2	0	1	0	0	0	0	1
CO4	0	1	0	0	1	0	0	0	0	0	0	0
CO5	0	0	1	1	0	0	0	0	0	0	0	1

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Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
		End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work		L	T	P	
IP72A	Advance Manufacturing Process	70	20	10	-	-	100	3	1	-	4

Course Objective:
To learn about advance manufacturing processes their process parameters and working principle.

Course content:

ADVANCED MANUFACTURING PROCESSES
(IP72A)

MODULE I

Abrasive Jet Machining (AJM): Principles of Abrasive jet machining, Process parameters, Metal removal rate, Effect of parameters on Abrasive jet machining, Application & limitation.
Water Met Machining: Procedure of Water jet machining, Jet cutting equipments, process detail, Practical applications.

MODULE II

Ultrasonic Machining: Principle, Process parameters, Cutting tool design, tool feed mechanism, transducer, design of velocity transformers, Mechanics of cutting , Effect of parameters, Economic consideration, Applications & limitations.
Plasma Arc Machining: Non-thermal generation of plasma, Mechanics of metal removal, Parameters, Accuracy & surface finish, Applications.

MODULE III

Electrochemical Machining: Principle, Elements of process, Metal removal rate, Electro-chemistry of process, tool design, Applications, choice of electrolyte. Electrochemical grinding, Electrochemical deburring and Electrochemical honing.
Chemical Machining: Elements of process, Applications and advantages.

MODULE IV

Electro Discharge Machining: Process, Mechanism of metal removal, Electrode feed control , Metal removal rate, Machining accuracy, tool material, dielectric fluid, flushing, application & limitation. Wire cut EDM, Electro discharge grinding.

MODULE V

Laser Beam Machining: Features, Metal removal rate, Thermal analysis, Cutting speed and accuracy.
Electron Beam Machining Procedure, Forces in machining, Process capability.
High Energy Rate Forming: High energy rate forming process, High Velocity Forming process, Explosive Forming, Electro Hydraulic Forming. Electromagnetic forming, High-speed forming machines.

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References:

1. Modern Machining Process, P.C. Pandey &H.S. Shan, Tata McGraw hill.
2. New Technology, Dr. Amitabh Bhattacharya, The Institution of Engineers.
3. Unconventional Manufacturing Process, Dr. V.K. Jain, Allied Publishers
4. Principles of Engineering Production, A.S. Lissaman & S.J. Martin
5. Production Engineering, P.C. Sharma, S Chand company Ltd

Course Outcomes:

At the completion of this course, students should be able to

CO1	Understand Principles of Abrasive jet machining.
CO2	Understand non-thermal generation of plasma, Mechanics of metal removal in plasma arc machining.
CO3	Understand Electrochemical deburring and Electrochemical honing.
CO4	Understand Process of electro discharge machining.
CO5	Understand Process of Laser Beam Machining, electron beam machining

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	2	1	0	0	1	0	1	0
CO2	1	2	1	0	2	1	0	1	0	1	0	0
CO3	1	1	1	1	2	0	1	0	0	0	0	1
CO4	1	1	1	0	2	0	0	0	0	0	0	0
CO5	1	0	1	1	2	0	0	0	0	0	0	1

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Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
		End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work		L	T	P	
IP72 B	Rapid Prototyping	70	20	10	-	-	100	3	1	-	4

Course Objective:

- To acquire the basic knowledge of Rapid Prototyping.
- To establish knowledge regarding 3d printers, prototype properties, applications & fundamental processes.

Course content:

Rapid Prototyping
(IP72 B)

Module I
Introduction to RP, Technology Description and Definition to RP, Overview of RP, Benefits and Application. RP Processes: Process overviews, STL file Generation, File Verification and Repair, Build File Creation, Part Construction, Part Cleaning and finishing, Process Strength, and its limitations.

Module II
Classes of RP systems: 3D Printers, Enterprise Prototyping centers, Direct digital tooling, Direct digital manufacturing, system classification, Stereo lithography, SL with photo polymerization, SL with liquid thermal polymerization, Selective Laser Sintering, Fused deposition modeling, Laminated object manufacturing, Laser powder forming.

Module III
Prototype properties: Material properties, color, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties.

Module IV
RP Applications: Design, Concept Models, Form & fit checking, Ergonomic Studies, Functional testing, Requesting Price quotes, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, Archeology, Paleontology & forensic Science, miniaturization.

Module V
Fundamental Process: Background, The line spread function of scanned Gaussian Laser Beam. The Parabolic Cylinder, The working curved equation, The curved line width function, Mechanical properties, Bilateral exposure of a Thin Sample, The Photo modulus Model, Experimental Method, Experimental Results.

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REFERENCES

1. T. A. Grimm & Associates, Users Guide to Rapid Prototyping, Society of Manufacturing Engineers (SME) ISBN 0872636976
2. Frank W. Liou, Rapid Prototyping & engineering applications, CRC Press, ISBN 978-0-8493-3409-2
3. Rapid Prototyping theory & practice, Manufacturing System Engineering Series, Ali K. Kamarani, Springer Verlag
4. Rapid Prototyping- case book, J. A. McDonalds, C. J. Ryall, Wiley Eastern
5. Rapid & Virtual Prototyping & applications, C. E. Bocking, AEW Rennie, Wiley Eastern
6. Paul F. Jacobs, Rapid Prototyping and Manufacturing, First Edition Published by Society of Manufacturing Engineers. ISBN: 0-87263-425-6

Course Outcomes:

At the completion of this course, students should be able to

CO1	To acquire the basic knowledge rapid prototyping.
CO2	To establish knowledge regarding classes of rapid prototype system.
CO3	To build-up knowledge of prototype properties.
CO4	To know about rapid prototyping applications.
CO5	To know about fundamental processes of rapid prototyping.

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1	0	0	1	0	1	0
CO2	0	2	1	0	1	1	0	1	0	1	0	0
CO3	0	1	1	1	2	0	1	0	0	0	0	1
CO4	0	1	0	0	1	0	0	0	0	0	0	0
CO5	0	0	1	1	0	0	0	0	0	0	0	1

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COURSE CONTENTS **w.e.f. July 2023**

Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
		End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work		L	T	P	
IP72 C	Research Methodology & Optimization Techniques	70	20	10	-	-	100	3	1	-	4

Course Objective:

- To acquire the basic knowledge of Research Methodology.
- To establish knowledge regarding Integer linear programming methods, multi-objective optimization methods and Algorithm.

Course content:

RESEARCH METHODOLOGY AND OPTIMIZATION TECHNIQUES
(IP72C)

Module I

Introduction to Research Methodology, Various Types of Techniques, Alternative approaches to the study of the research problem and problem formulation. Formulation of hypotheses, Feasibility, Preparation, and presentation of research proposal.

Introduction to Experimental Design, Taguchi Method, Concept of Orthogonal Array, Primary and Secondary data collection, S/N ratio, Validation, Regression, and correlation analysis. Tests of significance based on normal. t and chi square distributions, Analysis of variance.

Module II

Edition, tabulation & testing of hypotheses, interpolation of results, presentation, styles for figures, tables, text, quoting of reference and bibliography. Use of software for statistical analysis like SPSS, Mini Tab or MAT Lab, Report writing, preparation of thesis, use of software like MS Office. The course will include extensive use of software, reporting writing and seminars in tutorial class.

Module III

Integer linear programming methods and applications, Introduction to integer non-linear Programming, Basics of geometric programming.

Module IV

Multi-objective optimization methods and applications, Formulation of problems – Separable programming and stochastic programming.

Module V

Introduction to Genetic algorithms, neural network-based optimization, and optimization of fuzzy systems, Evolutionary Algorithm and Ant Colony Optimization techniques.

Note: - Some of the algorithm is used to be exercised using MAT LAB

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RECQMMENDED BOOKS:

1. C.R Kothari, Research Methodology, Wishwa Prakashan
2. P.G Tripathi, Research Methodology, Sultan Chand & Sons, N. Delhi
3. Fisher, Design of Experiments, Hafner
4. Sadhu Singh, Research Methodology in Social Sciences, Himalya Publishers
5. Kalyanmoy Deb, Optimization for Engineering design – algorithms and examples. PHI, New Delhi 1995
6. Singiresu S.Rao, "Engineering optimization – Theory and practices", John Wiley and Sons, 1998.
7. Garfinkel, R.S. and Nemhauser, G.L., Integer programming, John Wiley & Sons, 1972.

Course Outcomes:

At the completion of this course, students should be able to

CO1	To acquire the basic knowledge research methodology.
CO2	To establish knowledge regarding edition, tabulation, testing of hypothesis etc.
CO3	To build-up knowledge of Integer linear programming methods.
CO4	To know about multi objective optimization methods.
CO5	To know about Genetic & evolutionary algorithm.

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1	0	0	1	0	1	0
CO2	0	2	1	0	1	1	0	1	0	1	0	0
CO3	0	1	1	1	2	0	1	0	0	0	0	1
CO4	0	1	0	0	1	0	0	0	0	0	0	0
CO5	0	0	1	1	0	0	0	0	0	0	0	1

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COURSE CONTENTS **w.e.f. July 2023**

Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
		End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work		L	T	P	
IP72 D	Manufacturing System Design	70	20	10	-	-	100	3	1	-	4

Course Objective:

- To acquire the basic knowledge Manufacturing System.
- To establish knowledge regarding production, planning, design, cost optimization, computer simulation & modern approaches in manufacturing system.

Course content:

Manufacturing Systems Design
(IP72D)

Module I

Fundamentals: System concept, Hierarchical structure, System design, 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.

Module II

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.

Module III

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.

Module IV

Computer Simulation in Manufacturing System Analysis: Characteristics, Simulation Models, applications of probability and statistics; Design and evaluation methodology of manufacturing systems, General design framework, Analysis of situation, Setting objectives, Conceptual modeling, Detailed design, Evaluation and Decision.

Module V

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.

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Reference Books:

1. Katsudo Hitomi, (1998), "Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN 81-85617-88-0
2. B. Wu, "Manufacturing Systems Design & Analysis: Context and Techniques" (2/e), Chapman & Hall, UK, ISBN 041258140X
3. Mikell P. Groover, (2002), "Automation, Production Systems and Computer Integrated Manufacturing", (2/e), Pearson Education, ISBN 81-7808-511-9
4. Radhakrishan P., Subramaniyan S. and Raju V., "CAD / CAM / CIM", (3/E), New Age International Publication
5. Luca G. Sartori, (1998), "Manufacturing Information Systems", Addison Wesley Publishing Co.
6. N. Viswanadhan& Y, Narhari, (1998), "Performance Modeling of Automated Manufacturing Systems", Prentice Hall of India
7. Phillip F. Ostwald, JairoMunez, (2002), "Manufacturing Processes and Systems", John Wiley & Sons (Students' Edition), ISBN 9971-512-34-

Course Outcomes:

At the completion of this course, students should be able to

CO1	To acquire the basic knowledge manufacturing system.
CO2	To establish knowledge regarding product/process planning & design.
CO3	To build-up knowledge of manufacturing optimization.
CO4	To know about computer simulation in manufacturing system.
CO5	To know about modern approaches in manufacturing system.

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1	0	0	1	0	1	0
CO2	0	2	1	0	1	1	0	1	0	1	0	0
CO3	0	1	1	1	2	0	1	0	0	0	0	1
CO4	0	1	0	0	1	0	0	0	0	0	0	0
CO5	0	0	1	1	0	0	0	0	0	0	0	1

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COURSE CONTENTS **w.e.f. July 2023**

Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
		End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work		L	T	P	
IP73	Industrial Robotics & Mechatronics	70	20	10	30	20	150	3	-	2	4

Course Objective:

- To be familiar with Automation and Robotics.
- To provide the knowledge of Structure of Robotic System, Robot Sensors and Vision, Robot Programming, and mechatronics basics.

INDUSTRIAL ROBOTICS AND MECHATRONICS
(IP73)

MODULE I: **Introduction to Robotics:** Introduction, Definition, Automation and Robotics, Need and importance, basic concepts, Anatomy of Robots, Structure and classification of Robots, Robot configurations, Comparative advantages of different configurations, Resolution, Accuracy, Repeatability.

MODULE II: **Structure of Robotic System:** Robot links, Joints in Robots, Robot Specification, Performance Parameters, Robot Drive Systems, Hydraulic Actuators, Pneumatic Actuators, Electric Drives, Steeper Motors, Comparison of Characteristics of robot Drive Systems, Wrist and Motions, Designs of Gripper Fingers, Gripper Mechanisms, Force Analysis of Gripper Mechanism, Selection Consideration of Gripper.

MODULE III: **Robot Sensors and Vision:** Introduction, Classification of Sensors and their functions, Touch Sensors, Binary Sensors, Analog Sensors, Tactile Sensors, Desirable Features for Sensors and Transducers, Proximity Sensors, Range Sensors, Force and Torque Sensors, Robot Vision, Block Diagram of Vision System, Constructional Features of Vidicon Camera, Analog to Digital Conversion, Image Storage, Image Processing and Analysis, Feature Extraction, Object Recognition.

MODULE IV: **Robot Programming:** Introduction, Lead through Programming, Manual, walk through, off line Programming Concepts, Requirement of Good Programming Language, VAL Commands with description, Definition and Statements of AL AND AML, Programming Languages features and applications, Program for Pick and Place Activity.

MODULE V: **Mechatronics:** Transducers, Applications and Selection, Application of Proximity Switch, Application of Photoelectric Sensor, Sensor Array, Wrist Sensors, Compliance Sensing, Range Sensing, Guidelines for Selection, Active and Passive Sensors, Basic Requirements of a Sensor/Transducer.

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Text Books

1. Groover M.P. Weiss M. Industrial Robotics, Tata McGraw Hill Publication.
2. Groover M.P. Cam and Automation, PHI Learning Publishing Ltd.
3. Ganesh S. Hegde. A Text Book on Industrial Robotics. Laxmi Publication.

References

1. Ghosal Ashitava Robotics Fundamental Concepts and Analysis, Oxford Publication.
2. Shimon K. Handbook of Industrial Robots, John Willey& Sons.
3. Fu, Gonzalez, Lee, Robots Control, Sensing, Tata McGraw Hill Publication

List Of Experiments (Expendable):

1. To Study Robot Anatomy.
2. To study Robot joints.
3. to study various types of Robots classified on degree of freedom.
4. To study gripper mechanism.
5. To study various types of sensors used in Robot arm

Course Outcomes:

At the completion of this course, students should be able to-

CO1	Illustrate the concept of robot and its motion characteristics.
CO2	Identify different types of end effectors and drive systems required for specific applications
CO3	Explain the working of various types of sensors and their applications.
CO4	Develop programming principles and languages for a robot control system
CO5	Understand Application of Proximity Switch, Photoelectric Sensor, Sensor Array, Wrist Sensors

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	2	1	0	0	1	0	1	0
CO2	1	2	1	0	2	1	0	1	0	1	0	0
CO3	1	1	1	1	2	0	1	0	0	0	0	1
CO4	1	1	1	0	2	0	0	0	0	0	0	0
CO5	1	0	1	1	2	0	0	0	0	0	0	1

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COURSE CONTENTS **w.e.f. July 2023**

Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
IP74	Computer Aided Design	End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work	150	L	T	P	4
		70	20	10	30	20		3	-	2	

Course Objective:

- To be familiar with CAD, Automation and CAD, computer software and their application.
- To creating Drawing, Various drawing commands, Editing Drawing.
- To draw Geometric modeling, wire frame model, parametric representation of synthetic curves.
- To perform 2D and 3D geometric transformations.
- To study **methods** to solve engineering problems, Computer Aided Engineering (CAE) and design.

COMPUTER AIDED DESIGN
(IP74)

MODULE- I Fundamental of CAD, Automation and CAD, Product Cycle & CAD, Introduction to computer Hardware, Design of workstation, Graphics terminal. Operator input & output devices, CPU and Secondary storage. Introduction to computer software and their application.

MODULE- II- Computer Aided Drafting - Creating Drawing: Various drawing commands: Line, Pline, Ellipse, Circle, Arc, Hatch, Text, Dimension, Limits, Scale, Grid, Layers, Fill, Snap, Trace, Modules, Ortho. Editing Drawing: c: Move, Erase, Copy, Zoom, Pan, View, Chamfer, Break, Explode, Extend, Trim, Help, Rotate, Mirror etc.
Other Utilities: Block, Array, Save, Quit, Plot Advanced Features of Auto- CAD: UCS, 3D-line, 3D-Objects, DXF & DXB files.

MODULE–III Geometric modeling- introduction, wire frame model, data structures for computer graphics, Review of vector algebra, lines, circle, ellipses, parabolas, hyperbolas, conics, parametric representation of synthetic curves: Hermite cubic splines, Bezier curve, b spline curves, rational curves. Curves: Algebraic and geometric forms, tangents and normal, blending functions

MODULE–IV 2D and 3D geometric transformations, homogenous coordinates, translation, rotation, scaling, reflection, shear, and transformations between coordinate systems, affine transformations.3-D geometric transformations, 3-D viewing operations and graphics projections, visual realism, hidden line removal, shading and color models.

MODULE –V Methods to solve engineering problems- analytical, numerical, experimental, their merits and comparison, discretization into smaller elements and effect of size/ shape on accuracy, importance of meshing, boundary conditions, Computer Aided Engineering (CAE) and design, chain-bumping-stages vs concurrent-collaborative design cycles, computer as enabler for concurrent design and Finite Element Method (FEM), degree of freedom (DOF), mechanical systems with mass, damper and spring, stiffness constant K for tensile, bending and torsion; Practical applications of FEA in new design, optimization/ cost-cutting and failure analysis.

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Reference Books:

1. Inside AutoCAD by Ranker
2. CAD/CAM – principle and application By P N Rao, TMH
3. CAD/CAM – Zeid Ibrahim, TMH
4. Practical Finite Element Analysis by Gokhle Nitin
5. Finite Element Analysis, Theory and programming By Krishnamoorthy, TMH

COMPUTER AIDED DESIGN LAB

List of Experiment (Expandable):

1. Preparation of 2-D drawings using various 2-D commands.
2. Preparation of 3-D drawings for machine components.
3. 3-D modeling - solid, surface, wireframe using standard CAD packages - Assembly of standard parts created using 3-D model.
4. Parametric modeling, creating standard machine parts, connecting rod, flange coupling, bearings
5. Analysis of simple machine parts by meshing into finite elements

Course Outcomes:

At the completion of this course, students should be able to-

CO1	Calculate stresses and strain in different members of the materials.
CO2	Draw Shear force and Bending moment diagram for different types of beams with different loadings.
CO3	Find out deflection deformation and stress for different types of beams
CO4	Calculate torsion and stresses of shafts.
CO5	Calculate critical load by apply Euler's theory and Rankine's formula for column and strut.

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	0	0	2	1	1	0	1	1	1
CO2	2	2	1	1	1	0	0	1	0	1	0	1
CO3	2	1	1	1	1	0	0	1	0	1	1	1
CO4	3	3	2	2	2	2	1	0	1	1	1	1
CO5	2	1	2	2	1	2	1	0	1	1	1	1

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COURSE CONTENTS **w.e.f. July 2023**

Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
		End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work		L	T	P	
IP75	Industrial Engineering	70	20	10	30	20	150	3	-	2	4

Course Objective:

- To acknowledge industrial engineering with the aspect of Reliability Engineering.
- To provide the knowledge of Industrial Engineering and domain knowledge.
- Evaluate the sequencing model study with industrial engineering.
- Learn Human Recourse Management & marketing fundamentals and capacity calculations for industrial engineering.

Course Content:

INDUSTRIAL ENGINEERING
(IP-75)

MODULE – I: Reliability Engineering: Introduction and objectives of Reliability Engineering, System Reliability, Achieving Reliability, Failure Rate, Hazard Rate, Failure Modes and the 'Bath-tub' curve, Series Structure, Parallel Structure, Combination Structure, Design, Important Aspect of Reliability, Maintainability, Availability, Improving Reliability.

MODULE - II: Capacity Planning: Measurement of Capacity, Estimating Future capacity, Factors influencing effective capacity, Factors Favoring over capacity and under capacity, Business Process Reengineering, Definition, Characteristics of BPR, Need for Re-engineering, Steps in Re-engineering, Process of Re-engineering, Industrial Engineering and Re-engineering, Success factors in reengineering, Advantages of Re-engineering.

MODULE - III: Sequencing Models: Introduction, Assumptions, Gantt chart for Solving Sequencing Problems, Processing n jobs through 2 machines, Johnsons Algorithm, Loading, Sequencing and Scheduling, Visual load Profile, Priority Sequencing, Assignment Problems, Principles of scheduling, Inputs to scheduling, Scheduling strategies, Forward scheduling and backward scheduling, Finite Loading, Critical ratio loading, Index method.

MODULE – IV: Marketing Management: Marketing Function, Marketing Management Process and Marketing Planning, Market Research, Consumer Behavior, Product Life Cycle, Product, Product Lines and Brands, Physical Distribution Channels, Sales Promotion & advertising programs.

MODULE – V: Human Resource Management: Definition, Objective of Human Resource Management, Characteristics, Functions/Scope, Principles of Human Resource Management, and Manpower Planning –factors Affecting Manpower Planning, Steps in Manpower Planning, recruitment, and Selection procedure of Manpower. Training and Development of Manpower: Need of Training, Benefits of Training, Method of Training Workers, Foreman, or Supervisory Training, Executive/Managers Training and Development, learning curves and classifications.

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Text Books

1. Khanna O. P., "Industrial Engineering and Management", DhanpatRai and sons, 2007.
2. Banga T. R. and Sharma S. C., "Industrial Organization & Engineering economics", 23ed., Khanna Publishers, 2001, ISBN 81-7409-078-9.
3. Mahajan M., "Industrial Engineering and Production Management" Dhanpatrai and Sons Publishers, 2005, ISBN-81-7700-047-0
4. Chabra T. N., "Principles & Practices of Management", Dhanpatlal & company.
5. Srinath N., "Reliability Engineering", East West Publication Ltd.

Reference Books

1. Koontz Harold and Weinrich Heinz, "Essentials of management", 7ed, Tata McGraw - Hill publishing, 2008, ISBN 0-07-0623030-x.
2. Luthans f., "Organizational Behavior", McGraw-Hill Company, 2008, ISBN 81-317- 05021.
3. Kotler Philip & Keller K.L., "Marketing Management. Dorling Kindersley pvt.Ltd.,2008, ISBN-978-81-317-1683-0
4. Cynthia L.Greene , "Entrepreneurship: Ideas In Action", Thomson, ISBN-981-243-257-1.
5. Mamoria C.B. and Gankar S.V., "Personnel Management", Himalaya Publishing House, 20

INDUSTRIAL ENGINEERING LAB

List Of Experiments (Expandable):

1. To Study Failure rate and Hazard rate of Component (Industry supported case study).
2. To Construct Gantt Chart for the given Scheduling Problems.
3. Estimate Future capacity of the given plant (Industry supported case study).
4. To find the Training needs of the given plant (Industry supported case study).
5. To study Physical Distribution Channels, Sales Promotion & advertising programs of the given product (Industry supported case study

Course Outcomes:

At the completion of this course, students should be able to-

CO1	Illustrate the concept of reliability engineering.
CO2	To gain the knowledge of capacity planning.
CO3	Acquire the knowledge of sequencing models.
CO4	Learn capacity building of fundamentals of industrial marketing.
CO5	Create the learning aspects of human resource management & key functions of training modules.

Mapping of Course outcomes (COs) with Program Outcomes (POs):

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	2	1	0	0	1	0	1	0
CO2	1	2	1	0	2	1	0	1	0	1	0	0
CO3	1	1	1	1	2	0	1	0	0	0	0	1
CO4	1	1	1	0	2	0	0	0	0	0	0	0
CO5	1	0	1	1	2	0	0	0	0	0	0	1

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Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
IP76	Industrial training Evaluation	End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work	100	L	T	P	2
		-	-	-	60	40		-	-	4	

INDUSTRIAL TRAINING EVALUATION
(IP-76)

SCHEME OF STUDIES

Duration: 2 weeks after the VI semester in the summer break, Assessment in VII semester.

1.1 OBJECTIVE OF INDUSTRIAL TRAINING

The objective of undertaking industrial training is to provide work experience so that student's engineering knowledge is enhanced and employment prospects are improved. The student should take this course as a window to the real World of Work and should try to learn as much as possible from real life experiences by involving and interacting with industry staff. Industrial training also provides an opportunity to students to select an engineering problem and possibly an industry guide for their Major Project in final semester. Industrial training of the students is essential to bridge the wide gap between the classroom and industrial environment. This will enrich their practical learning and they will be better equipped to integrate the practical experiences with the classroom learning process.

1.2 LEARNING THROUGH INDUSTRIAL TRAINING

During industrial training students must observe following to enrich their learning: - Industrial environment and work culture. - Organizational structure and inter personal communication. - Machines/ equipment/ instruments - their working and specifications. - Product development procedures and phases. - Project planning, monitoring and control. - Quality control and assurance. - Maintenance system. - Costing system. - Stores and purchase systems. - Layout of Computer/ EDP/MIS centers. - Roles and responsibilities of different categories of personnel. - Customer services. - Problems related to various areas of Work etc. Faculty and TPO are supposed to plan industrial training in such a manner that students get exposure on most of the above arena in the field (world of work). Students are supposed to acquire the knowledge on above by -

1. Observation,
2. Interaction with officials at the workplace
3. Study of Literature at the workplace (e.g. User Manual, standards, maintenance schedules, etc.)
4. "Hand's on" experience
5. Undertaking / assisting project work.
6. Solving problems at the work place.
7. Presenting a seminar.
8. Participating in-group meeting/ discussion.

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9. Gathering primary and secondary data/ information through various sources, Storage, retrieval and analysis of the gathered data.
10. Assisting officials and managers in their working.
11. Undertaking a short action research work.
12. Consulting current technical journals and periodicals in the library.
13. Discussions with peers.

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