Jabalpur Engineering College, Jabalpur

(Declared Autonomous by MP Govt., Affiliated to RGPV, Bhopal)

(AICTE Model Curriculum Based Scheme)

Bachelor of Technology (B.Tech.) VI 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						
				End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work		L	T	P	
1	IP61	PEC	Professional Elective Course-II	70	20	10	-	-	100	3	1	-	4
2	IP62	OEC	Open Elective Course-I	70	20	10	-	-	100	3	1	-	4
3	IP63	PCC	Operations Research	70	20	10	30	20	150	3	-	2	4
4	IP64	PCC	Manufacturing Technology	70	20	10	30	20	150	3	-	2	4
5	IP65	PCC	Turbo Machines	70	20	10	30	20	150	3	-	2	4
6	IP66	PI	Minor Project	-	-	-	60	40	100	-	-	4	2
7		MC	Industrial Training	Minimum Four weeks Duration. Evaluation will be done in 7th semester.									
			Total	**350**	**100**	**50**	**150**	**100**	**750**	**15**	2	**10**	**22**
8	IP67	DLC	Self-Learning Presentation (SWAYAM/NPTEL/MOOC)	-	-	-	-	-	-	-	-		8
9	IP68	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 IP67 for the award of Honours (Minor Specialization).									

Note: 01. Departmental BOS will decide list of three/four optional subjects those are available in MOOC,OEC as well for PEC.

02. MOOC/NPTEL subjects shall be taken with permission of HOD/Coordinator.

03. Industrial training should be apart from laboratory work unertaken in the college rather it should have industrial orientation and practical aspects/field work. Report to be sbmitted at the beginning of 7th semester and students have to give a presentation in the Department. Evaluation will be done in 7th semester.

Professional Elective Course-II		
S.No.	**Subject Code**	**Subject Name**
1	IP61A	Operation Management
2	IP61B	Industrial Psychology & Human Behaviour
3	IP61C	Finite Element Methods

Open Elective Course-I		
S.No.	**Subject Code**	**Subject Name**
1	IP62A	Applied Thermodynamics
2	IP62B	IPR (Intellectual Property Right)
3	IP62C	Product Design and Development

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, PI: Project and Internship, 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						
IP61A	Operations Management	End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work	100	L	T	P	4
		70	20	10	-	-		3	1	-	

Course Objective:

- To be familiar with Scope and Significance of Operations Management.
- To provide the knowledge to select plant location and Design of various plant layout.
- To provide the knowledge about product design and development
- To be familiar with methods of forecasting.
- To explain production planning and economic analysis.

Course content:

OPERATIONS MANAGEMENT
(IP61A)

Module 1.

Operations Management: Overview, Definition, Scope and Significance, Systems View of Operations Management, Factors of Production, Resource productivity, Productivity.

Plant Location: Issues in plant location, Plant Location Methods, Factor – Rating Systems, Transportation method, Centroid Method, Break Even Analysis, Plant Layout objectives, Types of layouts: Process layout, Systematic Layout Planning, Computerized Layout Techniques, Product Layout: Assembly line balancing, Cellular Layout, Fixed Position Layout.

Module 2

Product Design and Development: Stages in Product development, Product life cycle, Product Development Process: Generic process and its Variants, Designing for the Customer: Quality Function Deployment, House of Quality, Product analysis, Standardization, Simplification, diversification and Modular design, Measurement of Product Development Performance, Concurrent Engineering.

Module 3

Forecasting: Need of forecasting, Costs of Forecasting, Methods of Forecasting, Delphi technique, Nominal Group Technique, Simple moving average, weighted moving average, Exponential Smoothing, Linear Regression method, Forecasting error its sources and measurement.

Operation Scheduling and Control: Functions of Scheduling and Control, Production Scheduling, Machine Loading, Sequencing, Dispatching, Expediting.

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Module 4

Production Planning: Introduction to Aggregate Production Planning and Master Scheduling, Materials Requirement Planning (MRP), MRP Structure and Output, Applications. Manufacturing Resource Planning (MRP II), Just-In-Time production System, Waste and waste elimination, Kanban System and Conwip shop floor control, Kaizan.

Module 5

Economic Analysis: Capital budgeting, meaning and significance, types of capital expenditure, analysis, interest and present value concept, depreciation, Capital investment evaluation techniques - pay back period, Rate of return on investment, Net Present value method, Internal rate of return method.

Reference Books:

1. Elements of Production Planning & Control by Eilon McMillan
2. Production and Operations Management by R.Mayer, McGraw Hill
3. Production and Operations Management by Buffa, McGraw Hill]
4. Product Design and Process Engineering by Niebel and Draper, McGraw Hill
5. Operations Management, Schaum's Outlines, TMH
6. Operations Management by Richard B. Chase, McGraw Hill
7. Production and Operations Management by Adam & Ebert, PHI.

Course Outcomes:

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

CO1	Understand Significance of Operations Management.
CO2	Optimize Plant Layout and factors affecting it
CO3	Analyze Stages in Product development and Product life cycle
CO4	To apply methods of forecasting such as Delphi technique, Nominal Group Technique,
CO5	To do production planning and economic analysis.

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	
IP61 B	Industrial Psychology & Human Behavior	70	20	10	-	-	100	3	1	-	4

Course Objective:

- To be familiar with Industrial Psychology.
- To enhance the knowledge about human resource & human behavior
- To provide the knowledge about Industrial relation.
- To be familiar with methods of forecasting.
- To explain production planning and economic analysis.

Course content:

INDUSTRIAL PSYCHOLOGY AND HUMAN BEHAVIOUR
(IP61 B)

Module -I

Industrial Psychology: Basic concepts, Role and Application, Discipline, Fatigue, Accidents, Labor welfare, Supervision.

Module –II

Maintenance of Human Resource: Health, Safety, Labor welfare, Welfare measures, Human Relations, Personnel audit, Industrial Safety, Safety efforts by government, Safety programs.

Module – III

Industrial Relations: Objective, Industrial unrest, Industrial peace, Parties in industrial relations, Organizational conflicts, Industrial disputes and their settlement, Impact of Conflicts, Sources of conflicts, Labor policy, Worker's grievances, Suggestion system

Module - IV

Human Behavior: Attitudes and Job satisfaction, Emotions and Moods, Personality and values, Perception and Decision making.

Module –V

Group Behavior: Foundation of group behavior, Understanding work teams, Communication, power and Politics, Conflicts and Negotiations

Reference Books:

1. Industrial Organization and Engineering Economics – T.R. Banga and S.C. Sharma
2. organizational Behavior – Stephen P. Robbins, Timathy A. Judge and Neharika Vohra
3. organizational Behavior part-1 and Part-2 –John B. Miner

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Course Outcomes:

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

CO1	To build-up the knowledge about Industrial Psychology
CO2	To get the knowledge about maintenance of human resource.
CO3	To enhance the knowledge about industrial relation.
CO4	To acquire the knowledge about human behavior.
CO5	To acquire the knowledge about group behavior.

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						
IP61 C	Finite Element Methods	End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work	100	L	T	P	4
		70	20	10	-	-		3	1	-	

Course Objective:

- To get the knowledge of finite element methods.
- To enhance the knowledge about coordinates and matrices and various approaches of FEM.
- To provide the knowledge of high order & iso parametric formulation.
- To gain the knowledge about solid and structural mechanisms.

Course content:

FINITE ELEMENT METHODS
(IP61 C)

Module -I
GENERAL PROCEDURE OF FINITE ELEMENT METHOD
Basic concept of FEM, Engineering applications, Comparison of FEM with other methods of analysis, Discretization of the domain-Basic element shapes, discretization process, Interpolation polynomials, Selection of the order of the interpolation polynomial, Convergence requirements, Linear interpolation

Module -II
polynomials in terms of global and local coordinates, Formulation of element characteristic matrices and vectors-Direct approach, variational approach, weighted residual approach, Assembly of element matrices and vectors and derivation of system equations together with their solution.

Module -III
HIGH-- ORDER AND ISO-PARAMETRIC ELEMENT FORMULATIONS
Introduction, Higher order one-dimensional element, Higher order elements in terms of natural coordinates and in terms of classical interpolation polynomials, Continuity conditions, Iso-parametric elements, Numerical integration in one, two and three-dimensions.

Module -IV
SOLID AND STRUCTURAL MECHANICS
Introduction, Basic equations of solid mechanics, Static analysis-Formulation of equilibrium equations, analysis of trusses and frames, analysis of plates, analysis of three-dimensional problems, analysis of solids of revolution, Dynamic analysis-Dynamic equations of motion, consistent and lumped mass matrices, consistent mass matrices in global coordinate system, Dynamic response calculation using FEM

Module -V
APPLICATIONS AND GENERALISATON OF THE FINITE ELEMENT METHOD
Energy balance and rate equations of heat transfer, Governing differential equation for the heat conduction in three-dimensional bodies, Derivation of finite element equations for one-dimensional, two-dimensional, unsteady state and radiation heat transfer problems and their solutions, Solution of Helmholtz equation and Reynolds equation, Least squares finite element approach.

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RECOMMENDED BOOKS:

1. The Finite Element Method in Engineering – S.S. Rao, Pub.- Pergamon Press.
2. Numerical Methods in Finite Element Analysis—Klaus-Jurgen Bathe and Edwar L. Wilson, Pub.-PHI.
3. The Finite Element Method – O.C. Zienkiewicz – McGraw-Hill
4. The Finite Element Methods for Engineers – K.H. Huebner – Wiley, New York

Course Outcomes:

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

CO1	To acquire the knowledge about general procedures of FEM.
CO2	To enhance the knowledge about coordinates and matrices and various approaches of FEM.
CO3	To provide the knowledge of high order & iso parametric formulation.
CO4	To gain the knowledge about solid and structural mechanisms.
CO5	To acquire the knowledge about applications and generalization of FEM.

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						
IP62A	Applied Thermodynamics	End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work	100	L	T	P	4
		70	20	10	-	-		3	1	-	

Course Objective:

- To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment.
- To understand the principles of refrigeration and air conditioning.
- To calculate the cooling load for different applications.
- To design and implement refrigeration and air conditioning systems using standards

Course content:

APPLIED THERMODYNAMICS
(IP62A)

MODULE I: Conduction: Basic concepts, Conduction, Convection and Radiation, Electrical Analogy, Fourier's law of conduction, Conduction of heat transfer through slabs, hollow cylinder, Sphere, Composite systems, Critical radius of insulation for Pipes/cables.
Convection: Natural & forced convection. Simple problems on correlations based on horizontal Pipe and Plate.

MODULE II: Heat exchangers: Logarithmic Mean Temperature difference for Parallel and Counter flow Heat **Exchanger**. LMTD correction factor & Fouling factor, Effectiveness of Heat Exchanger. Simple problems based on LMTD method.

MODULE III: Radiation: Basic introduction to radiation heat transfer. Black body laws, Emissivity, solid angle, Intensity of Radiation, Shape factor, Heat transfer by radiation for simple configurations.
Refrigeration: Methods of refrigeration, Module of refrigeration and COP, Carnot refrigeration cycle, Air refrigeration cycle, Bell Coleman air refrigeration cycle, Introduction to air craft refrigeration system. Simple and Boot strap air craft refrigeration system, Simple problems on air refrigeration cycle.

MODULE IV: Refrigerants: Classification, Nomenclature, Desirable properties of Refrigerants, Comparative study of Refrigerant, Leak detection, Future Refrigerants.
Simple vapour compression refrigeration cycle: P-H, T-S and H-S diagrams for vapour compression refrigeration system, Analysis of simple saturated cycle, Effect of Condenser and Evaporator pressure, Sub-cooling and Super heating. Simple problems.

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MODULE V: Air Conditioning: Psychometric properties & relations. Psychometric chart, Psychometric processes, Sensible heat factor, Bypass factor, Infiltrated air, and Ventilation. Requirement of comfort air conditioning, Simple problems based on Psychrometry, Psychrometric processes and cooling load calculations.

References:

1. Heat transfer - J.P. Holmon
2. Engineering Heat transfer - Gupta & Prakash
3. Fundamental of Engineering Heat and Mass transfer- P.K.Nag
4. Refrigeration & air conditioning - Stoecker & Jones
5. Refrigeration & air conditioning - C.P. Arora

Course Outcomes:

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

CO1	Ability to understand and solve conduction convection and radiation problems.
CO2	Ability to analyze the performance of heat exchangers.
CO3	Illustrate the basic concepts of refrigeration system.
CO4	Analyze the vapour compression cycle and interpret the usage of refrigerants.
CO5	Explain the components of vapour compression 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	3	1	1	1	2	1	2	0	1	0	1	0
CO2	2	2	1	2	2	1	1	1	0	1	0	0
CO3	3	1	1	1	2	0	1	0	0	0	0	1
CO4	2	1	1	2	2	0	2	0	0	0	0	0
CO5	3	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	
IP62 B	IPR (Intellectual Property Right)	70	20	10	-	-	100	3	1	-	4

Course Objective:

- To Explore the various theories, approaches, view and functional mechanism of IPR across the world and legal response to the same;
- To analyze the juris prudential analysis of IPR regime.
- To examine the protection mechanism of Intellectual Property Rights;
- To analyze the National and International perspectives of legal regime of IPR protection.
- To focus upon the Monopolistic approaches to Patents under Indian Legal system.
- To focus upon the Trademarks, Copyright and GI, Design, legislations

Course content:

INTELLECTUAL PROPERTY RIGHTS
(IP 62 B)

MODULE-1: Introduction to intellectual property rights (IPRs):

a. Meaning, nature and basic concepts of intellectual property
b. Main forms of intellectual property
c. Commercial exploitation of intellectual property
d. Anti-competitive practices/abuse of Intellectual property rights
e. International protection of IPR

MODULE -2: Law of patents (The Patents Act,1970)

a. Meaning and nature of patent
b. Subject matter of patents
c. Procedure for obtaining patents
d. Process and product patent
e. Transfer of patent rights
f. Assignment and licensing of patents
g. Powers of central government to acquire and use patents for public purpose
h. In fringe men to f patents
i. Evergreen in go f patents

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MODULE -3: Copyrights laws (the Indian Copyright Act,1957)

a. meaning and nature of copyright
b. subject matter of copyright
c. authorship and ownership of copyright
d. rights conferred by copyright
e. registration of copyright
f. assignment, licensing of Copyright
g. infringement of copyright and remedies
h. emerging new trends in copyright
i. International conventions and agreements relating to copyright-WTO/TRIPS agreement, the BERNE convention, Universal Copyright Convention, WIPO copyright Treaty,1996-copyright protection on internet.

MODULE -4: Law of Trade Marks (Trade Marks Act,1999)

a. Meaning and nature of trademarks
b. Property in trademarks-how acquired?
c. Conditions and procedure for registration of trademark and effect of registration
d. Registerable and non-registerable trademark
e. Similar, nearly resembling and deceptively similar trademarks
f. Assignment and licensing of trademarks
g. Infringement and passing off
h. Action for in fragment
i. Passing of faction
j. Emerging new trends in trademarks
k. International conventions and agreements relating to trademark-Paris Convention, Madrid Agreement, Nice Agreement and TRIPS Agreement

MODULE -5: Law of industrial designs (The Designs Act,2000)

a. Meaning and Nature of industrial designs
b. Subject matter of industrial designs
c. Registration of designs
d. Rights conferred by designs
e. Infringement to f copyright in design
f. Remedies for infringement

REFERENCES:

1. Intellectual Property (1999) edition) by W.R. Cornish (Sweet & Maxwell)
2. Intellectual Property Right sunder the TRIPs Text–Dr. Nilima Chandiramani
3. Intellectual Property Rights–P. Narayan
4. Patent Law by P. Narayanan
5. Taxman's Trade Marks Act & amp; Geographical Indications of Goods & Copy right Act.

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References:

1- Daft R; The new era of management; Cengage.

2- Bhat Anil, Arya Kumar; Management: Principles, Processes and Practices; Oxford higher Edu.

3- Davis & Olson; Management Information System; TMH.

4- Steven Alter; Information systems, Pearson, www.stevenalter.com

5- Kotler P; Marketing management;

6- Khan, Jain; Financial Management;

7- ILO; Work study; ILO.

8- Mohanty SK; Fundamental of Entrepreneurship; PHI.

Course Outcomes:

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

CO1	Understand management its characteristics and clarify management as science or profession.
CO2	Understand intellectual property system, copyrights, trademark, and intellectual property rights.
CO3	Understand marketing concept and advertising CRM and marketing research.
CO4	Make balance sheet and calculate breakeven point.
CO5	Understand need for Entrepreneurship and Benefits of Self-Employment

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

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

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Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
IP62 C	Product Design & Development	End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work	100	L	T	P	4
		70	20	10	-	-		3	1	-	

Course Objective:

- To introduce the objectives of product design and the requirements of a good product design.
- To expose the students to different design principles like designing for function, production, installation and handling, maintenance, packaging etc.
- To expose them to the latest CAD/CAM/CAE software for different design and development functions.

Course content:

PRODUCT DESIGN AND DEVELOPMENT
(IP62 C)

Module I
Introduction: Characteristics of successful product development, Design & development of products, duration, & cost of product development, the challenge of product development.
Development Processes & Organization: Generic development processes, concept development, the front-end process, adopting the generic product development process.

Module II
The Process of Product Design: Design by evolution, Limitations of evolutionary method in modern design situation, Structure of design process, Morphology of design, Specifications and Standards of performance, Environmental factors, Creativity techniques in design problem.

Module III
Strategies for Search of Design Concepts: Physical realizability, Economic and financial feasibility, designing for function, designing for production, Tolerance analysis, Use, Maintenance, designing for handling and installing.

Module IV
Economics of design: Human factors in design, Optimization of design, Reverse engineering of ergonomic shape designs, Visual design.

Module V
Use of CAD / CAM /CAE: Software for concurrent engineering design. Case studies in design of products for manufacture, Aesthetics, Surface styling and shaping tools in modern CAD software, Exercises in design, Reverse engineering and surface design and review software.

Recommended Books:

1. Gupta, V. and Murthy, P.N., Introduction to Engineering Design Method, McGraw Hill (1980).
2. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, Prentice Hall of India (2004).

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Course Outcomes:

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

CO1	To learn basics of product design.
CO2	To learn process of product design.
CO3	To learn strategies for search of design.
CO4	To learn economics of design.
CO5	To learn use of CAD/CAM/CAE.

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	
IP63	Operations Research	70	20	10	30	20	150	3	-	2	4

Course Objective:

- Identification and developing operational research models from the verbal description of the real system.
- Explain the mathematical tools that are needed to solve optimization problems.
- Provide knowledge of mathematical software to solve the proposed models.
- Analyze the results to learn about Linear Programming.
- Explain network analysis, Game theory

Course content:

OPERATIONS RESEARCH
(IP63)

MODULE 1: Linear Programming: Introduction, History and development of Operations Research, Model building, Linear programming-formulation, Graphical method, Conical and standard forms of linear programming problems, Theory of simplex method, Big-M method, Two-phase method, Degeneracy in linear programming problems, Revised simplex, Sensitivity analysis.

MODULE II: Allocations in Linear Programming Problem: Assignment model-Hungarian method, Travelling salesman and miscellaneous problem, Assumptions in Transportation model, Optimality test, Degeneracy in Transportation Problem, Unbalanced Transportation Problem and Transshipment Problem.

MODULE III: Decision and Game theory: Decision tree, Decision making models under certainty, Risk and uncertainty, Hurwicz criteria, Game theory, two persons zero sum games, maximin and minimax principles, Saddle point, Dominance rule, Graphical and algebraic methods of solution.

MODULE IV: Dynamic Programming: Characteristics of dynamic Programming, Bellman principal, Typical problems, Salesmen problem, Forward and backward recursion, Use of software to solve linear programming and Dynamic programming.

MODULE V: Queuing Theory Network Analysis: Characteristics of queuing system, Poisson formula, birth-death system, equilibrium of queuing system, Analysis of M/M/1 queues, Project Planning, Project scheduling, Project controlling, Basic tools and technique of project management, AOA and AON diagrams, Critical path method, Program evaluation and review technique.

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References:

1. Taha. H.A. Operations Research, PHI, Publications.
2. Hiller and Liberman Introduction to Operations Research, TMH Publications.
3. Sharma. J.K. Operations Research Theory and Applications, Macmillan Publications.
4. Ramamurthy. P. Operations Research, New Age Publications.
5. Banerjee. B. Operations Research, Business Publicity, Bombay.
6. Hira and Gupta. Operations Research, S. Chand Publication.

OPERATIONS RESEARCH LAB

List Of Experiments (Expendable):

1. To Solve L.P.P. (Maximization Problem) by graphical method Using Operations Research software.
2. To Solve L.P.P. (Minimization Problem) by graphical method Using Operations Research software.
3. To Solve L.P.P. (Maximization Problem) by simplex method Using Operations Research software.
4. To Solve L.P.P. (Minimization Problem) by simplex method Using Operations Research software.
5. To find Initial basic feasible Solution of the given Transportation Problem.
6. To find Initial Optimal Solution of the given Transportation Problem.
7. To find optimal Solution of the given Assignment Problem.
8. To find optimal solution of two-person zero sum game.

Course Outcomes:

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

CO1	Understand methodology of Operations Research.
CO2	Analyze the results to learn about Linear Programming.
CO3	Solve optimization problems
CO4	Develop a report that describes the model and the solving technique.
CO5	To carry out network analysis.

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

Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Hours/Week			Total Credits
		Theory			Practical						
IP64	Manufacturing Technology	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 learn about working procedure of arc welding, gas welding, special welding process, soldering, brazing, surface finishing process, press working, their process parameters and working principle.

Course content:

MANUFACTURING TECHNOLOGY
(IP64)

MODULE I: Arc welding: Arcing phenomenon, Metal transfer in arc welding, Arc blow, Types of electrodes, Carbon Arc Welding, Flux Shielded Metal Arc Welding, Submerged Arc Welding, TIG Welding, MIG Welding, Plasma Arc Welding, Arc Welding equipments.
Gas welding: Oxy Acetylene Welding, Welding flames, Leftward and Rightward welding, filler metals and rods, Gas Welding equipments, Oxy Hydrogen and other Fuel gas welding, Air acetylene welding. Pressure welding; Spot, Seam and Butt welding, Thermo Chemical welding.

MODULE II: Resistance welding: Electric resistance welding, Variables in resistance welding, Spot welding: procedure, spot welding methods, Heat balance in spot-welding, Spot-welding equipment, Seam welding: Seam welding equipments, Principle of operation, Applications, Projection welding, Resistance butt welding, Flash butt welding, Percussion welding.
Special welding process: Cold pressure welding; Diffusion welding, ultra sonic welding, Explosive welding, Friction welding and Inertia welding, Forge welding, Electron beam welding, laser beam welding, atomic hydrogen welding, Thermit welding, Under water welding process, Thermal spraying & Metal-addition.

MODULE III: Soldering & Brazing: Soldering: Definition. Principles of soldering process, Soldering alloys, Soldering fluxes, Soldering methods.
Brazing: Principle of operation, Brazing procedure, Brazing fluxes, Constituents of fluxes, Brazing processes, limitations in brazing.
Surface finishing process: Super finishing, Lapping, Honing, Tumbling, Electroplating, Metal spraying.

MODULE IV: Press working: Press operations, Classification of Presses, Press working terminology, Types of dies, drawing dies, bending dies, Punch design, Pilots, Types of pilots, shearing operations: Piercing, Blanking, Notching, Drawing, Spinning, Bending, Stretch Forming, Embossing and Coining.
Powder Metallurgy: Process, Method of production of powder, Metal powder characteristics, Application of powder metallurgy.

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MODULE V: Distortion & discontinuities in weld-jobs: Weld-jobs distortion and its control, various discontinuities in welds, Residual stresses in weld-jobs residual stresses-distortion-relieving of stresses. **Automation in welding**: Structure analysis; Basic operations, Robotic welding, Types of welding robots.

Non-Destructive Testing and inspection of weld-jobs: Non destructive methods of testing weld-jobs; stages of weld inspection and testing, visual inspection, leak test; stethoscopes test; X-ray and γ-ray radiography, magnetic particle inspection; liquid(dye) penetrate test; fluorescent penetrate inspection; ultrasonic inspection and Eddy current testing.

References

1. Malhotra; Handbook on Non-destructive Testing of Concrete; CRC Press,
2. Henrique L M; Non-Destructive Testing and Evaluation for Mfg, Hemisphere Pub NY,
3. Rao PN; Manufacturing Technology Vol 1; TMH
4. Groover MP; Fundamentals of Modern mfg; Wiley India
5. Kaushish JP; Manufacturing Processes; PHI Learning
6. Oswald PF; Mfg Processes and Systems; Wiley India
7. Parmar, R.S; Welding Processes and Technology
8. Srinivasan. N.K.; Welding Technology; Khanna Pub.

Manufacturing technology Lab

List of experiments (Expendable):

1. Study of tools used for various manufacturing process (it includes application, use and live demonstration.
2. Perform on welding of simple workpiece (arc or resistance welding)
3. Demonstration of process like shearing, punching, piercing, blanking, trimming, drawing.
4. Study of soldering and brazing operations.
5. To perform metal arc welding and prepare lap and butt joint.
6. To study powder metallurgy.

Course Outcomes:

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

CO1	Understand Principles and working procedure of arc welding and gas welding.
CO2	Understand soldering, brazing, surface finishing process.
CO3	Find out Distortion & discontinuities in weld-jobs.
CO4	Perform non destructive testing and inspection of weld jobs.
CO5	Understand Application of powder metallurgy.

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

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	0	1	1	0	0	1	0	1	0
CO2	2	2	1	0	2	1	0	1	0	1	0	0
CO3	1	3	1	2	2	0	1	0	0	0	0	1
CO4	1	2	1	1	2	0	0	0	0	0	0	0
CO5	1	0	1	0	1	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						
IP65	Turbo Machines	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:
The course aims at giving an overview of different types of turbo machinery used for energy transformation, such as pumps, compressors, as well as hydraulic, steam and gas-turbines.

Course content:

TURBO MACHINES
(IP65)

Module 1: Basics of turbo machines, Principles of impulse and reaction machines. **Steam turbines:** Impulse staging, Velocity and Pressure Compounding, Utilization factor, Analysis for optimum U.F Curtis stage, and Rateau stage, includes qualitative analysis, Effect of Blade and Nozzle losses on Vane Efficiency, Stage efficiency, Analysis for Optimum Efficiency, Mass Flow and Blade Height.

Module 2: Reactions staging: Parson's stages, Degree of reaction, Nozzle Efficiency, Velocity Coefficient, Stage Efficiency, carry over efficiency, Vane Efficiency, Conditions for Optimum Efficiency, Speed Ratio, Axial thrust, Reheat Factor in Turbines, Governing and Performance Characteristics of Steam Turbines.

Module 3: Water turbines: Classification, Pelton, Francis and Kaplan turbines, Vector diagrams and Work-done, Draft tubes, Governing of Water Turbines.
Centrifugal Pumps: Classification, Advantage over Reciprocating Type, Definition of Mano-metric head, Gross head, Static head, Vector diagram and work done.

Module 4 Rotary Compressors: **(a) Centrifugal Compressors** – Vector diagrams, Work done, Temp. and Pressure ratio, Slip factor, Work input factor, Pressure Coefficient, Dimensions of Inlet eye, Impeller and Diffuser.
(b) Axial flow Compressors- Vector Diagrams, Work done factor, Temperature Dimensional Analysis, Characteristics, Surging, Polytrophic and Isentropic Efficiencies.

Module 5: Gas Turbines: Introduction, Classification, Application. Gas turbine & its components. Closed and open cycle Gas turbines, Optimum Pressure ratio for maximum specific & thermal efficiency in actual Gas Turbine Cycle. Effect of operating variables on thermal efficiency.

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2. Hill G Philip and Peterson RC; Mechanics and thermodynamics of propulsion; Pearson.
3. Kadambi V Manohar Prasad; An introduction to EC Vol. III-Turbo machinery; New age Delhi
4. Ganeshan V; Gas Turbines; TMH
5. Yahya SM; Turbines, Compressors and Fans; TMH
6. Shepherd DG; Principles of Turbo machinery; McMillan
7. Bansal R. K; Fluid Mechanics & Fluid Machines; Laxmi Pub
8. Sarvanmulto HIH, Rogers GFC &; Cohen Henry Gas Turbine Theory; Pearson

TURBO MACHINE LAB

List of Experiments (Expandable)

1. To study various parameters of steam turbine.
2. To study various Performance parameters of Pelton wheel.
3. To study various Performance parameters of Francis Turbines.
4. To study various Performance parameters of Kaplan turbines.
5. To study various Performance parameters of Centrifugal Pumps.
6. To study various Performance parameters of Rotary Compressors.
7. To study various Performance parameters of Gas Turbines.

Course Outcomes:

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

CO1	Explain the working principles of turbo machines and apply it to various types of machines.
CO2	Explain the working principle of various types of hydro turbines and know their application
CO3	Explain the working and governing of gas turbines.
CO4	Recognize and discuss todays and tomorrow's use of turbo machines for enabling a sustainable society.
CO5	Explain the working principles of Centrifugal compressors, Axial flow compressors

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	1	2	1	0	1	1	0	1	0	1	0	0
CO3	1	1	1	1	2	0	1	0	0	0	0	1
CO4	1	1	0	0	1	0	0	0	0	0	0	0
CO5	1	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						
IP66	Minor Project	End Sem	Mid-sem Exam	Quiz/ Assignment	End sem	Lab work	100	L	T	P	2
		-	-	-	60	40		-	-	4	

Minor Project

The Project Work provides students an opportunity to do something on their own and under the supervision of a guide. Each student shall work on an approved project, which should be selected from some real life problem as far as possible, which may involve fabrication, design or investigation of a technical problem. The project work involves sufficient work so that students get acquainted with different aspects of manufacturing, design or analysis. The students also have to keep in mind that in final semester they would be required to implement whatever has been planned in the major project in this semester. It is possible that a work, which involves greater efforts and time, may be taken up at this stage and finally completed in final semester, but partial completion report should be submitted in this semester and also evaluated internally. At the end of semester, all students are required to submit a synopsis.

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