

OPEN ELECTIVE COURSES-I (SIXTH SEMESTER)		
Course code	Subjects	Credits
21MET6051	Operations Research	3
21MET6052	Energy and Environment Engineering	3
21MET6053	Engineering Economics	3
21MET6054	Product Design And Development	3

ADMISSION YEAR : 2021-22
SEMESTER : SIXTH

ACADEMIC YEAR: 2023-24

Course Title	OPERATIONS RESEARCH (OPEN ELECTIVE COURSES – I)	
Sub.Code: 21MET6051	No. of Credits: 03 = 3:0:0 (L-T-P)	No. of Lecture Hours/Week: 03
Exam Duration: 03 Hrs.	Max. Marks Assigned: CIE+Asmt+GA+SEE= 40+5+5+50=100	Total No.of Contact Hours: 40
Category	OEC	
Pre-requisites	Engineering Mathematics	

COURSE OBJECTIVES:

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.

#	CONTENTS	Hrs.
UNIT-1	INTRODUCTION & SOLUTION OF LINEAR PROGRAMMING PROBLEMS	08
	Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. The simplex method-canonical and standard forms of an LP problem, slack, surplus and artificial variables (Numerical problems).	
UNIT-2	TRANSPORTATION PROBLEM	08
	Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem, maximization cases (online)	
UNIT-3	ASSIGNMENT PROBLEM & SEQUENCING	08
	Assignment Problem-formulation balanced and unbalanced types, application to maximization cases and travelling salesman problem (Numericals). Basic assumptions, sequencing using Johnson's algorithm, 'n' jobs 2 machines, 'n' jobs 3 machines, 'n' jobs 'm' machines without passing sequence, graphical solutions. ∴	
UNIT-4	PERT-CPM TECHNIQUES	08

	Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	
UNIT-5	GAME THEORY & REPLACEMENT	08
	Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. Replacement items deteriorating with time, when money value remains same Replacement of items which fail suddenly; Individual replacement policy, Group replacement policy.	

TEXT BOOKS

1. Operations Research, P K Gupta and D S Hira, Chand Publications, New Delhi - 2007
2. Operations Research, Taha H A, Pearson Education

REFERENCE BOOKS

1. Operations Research, A P Verma, S K Kataria & Sons, 2008
2. Operations Research, Paneerselvan, PHI
3. Operations Research, A M Natarajan, P Balasubramani, Pearson Education, 2005
4. Introduction to Operations Research, Hiller and Liberman, McGraw Hill.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Define models for linear programming and convert the linear variable problems to a mathematical model and depict by graphical method.

CO2: Compute the minimum cost of transportation by NWCR, LCM and VAM method and then to find optimum solution by MODI method.

CO3: Find optimal assignment by Hungarian method.

CO4: Design a project network diagram and schedule the project activities and duration using PERT and CPM.

CO5: Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method.

MAPPING OF COs WITH POs												
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	0	1	0	2	1	3	2	2
CO2	3	3	1	2	1	1	0	2	1	3	2	2
CO3	3	3	1	2	1	1	0	2	1	3	2	2
CO4	3	3	1	2	3	1	0	2	2	3	3	3
CO5	3	3	1	2	3	1	1	3	3	3	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										

2. Student shall answer five full questions selecting one full question from each unit.

ADMISSION YEAR : 2021-22
SEMESTER : SIXTH

ACADEMIC YEAR: 2023-24

Course Title	ENERGY AND ENVIRONMENTAL ENGINEERING (OPEN ELECTIVE COURSE – I)	
Sub.Code: 21MET6052	No. of Credits: 03 = 3:0:0 (L-T-P)	No. of Lecture Hours/Week: 03
Exam Duration: 03 Hrs.	Max. Marks Assigned: CIE+Asmt+GA+SEE= 40+5+5+50=100	Total No.of Contact Hours: 40
Category	OEC	
Pre-requisites	Elements of Mechanical Engineering	

COURSE OBJECTIVES:

1. To understand the fundamentals of energy resources, energy systems, energy efficiency and energy storage.
2. To understand the ecosystem and energy flow in ecosystem.
3. To understand Biodiversity, Conservation, threats to biodiversity and endemic species.
4. To introduce various aspects of environmental pollution and its control.
5. To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc.

#	CONTENTS	Hrs.
UNIT-1	Introduction to Energy Science	08
	Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment; Overview of energy systems, sources, transformations, efficiency, and storage; Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) - past, present & future, Remedies & alternatives for fossil fuels - biomass, wind, solar, nuclear, wave, tidal and hydrogen; Sustainability and environmental trade-offs of different energy systems; possibilities for energy storage or regeneration (Ex. Pumped storage hydro power projects, superconductor-based energy storages, high efficiency batteries)	
UNIT-2	Ecosystems	08
	Concept of an ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of the following ecosystem (a.)Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	
UNIT-3	Biodiversity and its conservation	08
	Introduction – Definition: genetic, species and ecosystem diversity; Bio-geographical classification of India; Value of biodiversity: consumptive use, productive use, social,	

	ethical, aesthetic and option values; Biodiversity at global, National and local levels; India as a mega-diversity nation; Hot-spots of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	
UNIT-4	Environmental Pollution	08
	Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards; Solid waste Management: Causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies; Disaster management: floods, earthquake, cyclone and landslides	
UNIT-5	Social Issues and the Environment	08
	From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its problems and concerns. Case Studies Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies Wasteland reclamation; Consumerism and waste products; Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.	

GROUP ASSIGNMENTS:

Assignments related to e-waste management; Municipal solid waste management; Air pollution control systems; Water treatment systems; Wastewater treatment plants; Solar heating systems; Solar power plants; Thermal power plants; Hydroelectric power plants; Biofuels; Environmental status assessments; Energy status assessments etc.

TEXT BOOKS

1. Textbook for Environmental Studies for Undergraduate Courses, Erach Bharucha, University Grants Commission (UGC), January 2013.
2. Energy Management Audit & Conservation, De Barun Kumar, Vrinda Publications, 2007.

REFERENCE BOOKS

1. Energy Management Hand book, W.C. Turner and S. Doty, Fairmont Press, 7th Edition, 2009.
2. Energy Management, W.R. Murphy and G. McKay, Elsevier India, 2003.

COURSE OUTCOME (CO): After completion of the course, students will be able to:

CO1: Understand energy scenario, energy sources and their utilization.

CO2: Understand various methods of energy storage, energy management and economic analysis.

CO3: Analyse the awareness about environment and eco system.

CO4: Understand the environmental pollution and its management along with some case studies.

CO5: Analyse the social issues related to environmental changes and understand the various environmental protection and conservation Acts.

MAPPING OF COs WITH POs												
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	0	0	0	2	1	1	1	0	1
CO2	3	3	2	0	0	0	2	1	1	1	0	1
CO3	3	3	3	0	0	0	2	1	1	1	0	1
CO4	3	3	3	0	0	0	2	1	1	1	0	1
CO5	3	3	3	0	0	0	2	1	1	1	0	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22
SEMESTER : SIXTH

ACADEMIC YEAR: 2023-24

Course Title	ENGINEERING ECONOMICS (OPEN ELECTIVE COURSE – I)	
Sub.Code: 21MET6053	No. of Credits: 03 = 3:0:0 (L-T-P)	No. of Lecture Hours/Week: 03
Exam Duration: 03 Hrs.	Max. Marks Assigned: CIE+Asmt+GA+SEE= 40+5+5+50=100	Total No.of Contact Hours: 40
Category	OEC	
Pre-requisites	Engineering Mathematics	

COURSE OBJECTIVES:

1. Helping decision making
2. Calculation of interest
3. Arriving at break-even point
4. Feasibility study from economic point of view
5. Preparation of budget
6. Understanding financial statements
7. Arriving at the product cost.

UNIT	CONTENTS	Hrs.
UNIT-1	INTRODUCTION	08
	Elements of engineering economics, engineering decision- makers, engineering and economics, problem solving and decision making, intuition and analysis, tactics and strategy. Engineering economic decision, maze. Law of demand and supply, law of returns, interest and interest factors: interest rate, simple interest, compound interest, cash - flow diagrams, personal loans and EMI payment, exercises and discussion.	
UNIT-2	PRESENT-WORTH COMPARISONS	08
	Conditions for present worth comparisons, basic present worth comparisons, present-worth equivalence, net present-worth, assets with unequal lives, infinite lives, future-worth comparison, pay-back comparison, exercises, discussions and problems.	
UNIT-3	RATE-OF-RETURN CALCULATIONS AND DEPRECIATION	08
	Rate of return, minimum acceptable rate of return, IRR, IRR misconceptions, cost of capital concepts. Causes of depreciation, basic methods of computing depreciation charges, tax concepts, and corporate income tax.	
UNIT-4	INTRODUCTION, SCOPE OF FINANCE, FINANCE FUNCTIONS	08
	Statements of financial information: introduction, source of financial information, financial statements, balance sheet, profit and loss account,	

	relation between balance sheet and profit and loss account. Simple Numericals.	
UNIT-5	FINANCIAL AND PROFIT PLANNING	09
	<p>Introduction, financial planning, profit planning, objectives of profit planning, essentials of profit planning, budget administration, type of budgets, preparation of budgets, advantages, problems and dangers of budgeting. Introduction to bench marking of manufacturing operation.</p> <p>ESTIMATING AND COSTING: Components of costs such as direct material costs, direct labor costs, fixed over-heads, factory cost, administrative overheads, first cost, marginal cost, selling price, estimation for simple components.</p>	

TEXT BOOKS:

1. Engineering Economy, Riggs J.L., McGraw Hill, 2002
2. Engineering Economy, Thuesen H.G. PHI , 2002

REFERENCE BOOKS:

1. Engineering Economy, Tarachand, 2000.
2. Industrial Engineering and Management, OP Khanna, Dhanpat Rai & Sons. 2000
3. Financial Management, Prasanna Chandra, TMH, 2004
4. Financial Management, IM PANDEY, Vikas Publisahing House, 2002

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1: Take the right financial decision.

CO2: Help in calculating the financial factors.

CO3: Arrive at feasibility study of the project.

CO4: Training the students for preparing the budget.

MAPPING OF COs WITH POs												
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22
SEMESTER : SIXTH

ACADEMIC YEAR: 2023-24

Course Title	PRODUCT DESIGN & DEVELOPMENT (OPEN ELECTIVE COURSE – I)	
Sub.Code: 21MET6054	No. of Credits: 03 = 3:0:0 (L-T-P)	No. of Lecture Hours/Week: 03
Exam Duration: 03 Hrs.	Max. Marks Assigned: CIE+Asmt+GA+SEE= 40+5+5+50=100	Total No.of Contact Hours: 40
Category	OEC	
Pre-requisites	CAED	

COURSE OBJECTIVES:

1. Blends the perspectives of marketing, design and manufacturing into single approach to product development.
2. Provide a set of product development methods that can be put into immediate practice on developments projects.
3. Methods provide a concrete approach to solving a product development problem effectively.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Seeds for the creation of their own development methods, uniquely suited for their personalities, talents and company environments

#	CONTENTS	Hrs.
UNIT-1	INTRODUCTION	08
	Characteristics of successful product development, who designs and develops products? Duration and cost of product development, The challenges of product development. Development process and organizations: A generic development process, Concept development: the front end process, Adapting the generic product development process, Product development process flows and product development organizations.	
UNIT-2	PRODUCT PLANNING	07
	The product planning process, identify opportunities, Evaluate and prioritize projects, allocate resources and plan timing, Complete pre-project planning, Reflect on the results and the process. Identifying customer needs: gather raw data from customers, Interpret the raw data in terms of customer needs, Organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Product Specifications: What are specifications? When are specifications established? Establishing target specifications and setting the final specifications.	
UNIT-3	CONCEPT GENERATION	07

	<p>The activity of concept generation, Clarify the problem, Search externally, search internally, explore systematically, reflect on the solutions and the process.</p> <p>Product Architecture: What is product architecture? Implications of the architecture, establishing the architecture, Platform planning and Related system level design issues.</p> <p>Industrial Design : What is industrial design?, Assessing the need for industrial design, The impact of industrial design, The industrial design process, Management of industrial design process and assessing the quality of industrial design.</p>	
UNIT-4	DESIGN FOR MANUFACTURING	09
	<p>Overview of the DFM process, estimate the manufacturing costs, reduce the costs of components, assembly, supporting production, and impact of DFM decisions on other factors.</p> <p>Prototyping: Prototyping basics, principles of prototyping, technologies and planning for prototypes.</p> <p>Robust Design: What is Robust Design? , design of experiments and the robust design process.</p>	
UNIT-5	PATENTS AND INTELLECTUAL PROPERTY	09
	<p>What is intellectual Property? Overview of Patents, Utility Patents, Preparing a Disclosure and its steps</p> <p>Product development economics: Elements of economic analysis, base case financial mode, sensitive analysis, project trade – offs, influence of qualitative factors on project success and qualitative analysis.</p> <p>Managing Projects: Understanding and representing task, base line project planning, accelerating projects, project execution and postmortem project evaluation.</p>	

TEXT BOOKS:

1. Karl. T. Ulrich, Steven D Eppinger, Anita Goyal, Product Design and Development, Tata McGraw Hill Edition 2009

REFERENCES:

1. Kevin Otto, Kristin Wood Product Design, pearson Education in South Asia.
2. Timjones, Butterworth Heinmann, New Product Development, Oxford, UCI, 1997.
3. GeofferyBoothoyd, peter Dewhurst and Winston Knight, Product Design for Manufacture.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Understand the characteristics of product development and challenges; concept development processes and different types of organisations.

CO2: Prepare Plan for new product development based on the opportunities & allocation of Resources identification of customer needs and specification of product.

CO3: Generate the concept for the new product and establish the product architecture. Fulfil the aesthetic and ergonomic needs based on industrial design concept.

CO4: Estimation of product cost based on DFM concepts & prepares the prototype of new product.

CO5: Economic analysis of the product to manage different product development projects.

MAPPING OF COs WITH POs												
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1

CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
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