Semester: VI		
OPERATIONS RESEARCH (Theory)		
Course Code: MVJ21ME61		CIE Marks: 50
Credits: L:T:P: 2:2:0		SEE Marks: 50
Hours: 20 L+20 T		SEE Duration: 03
Course Learning Objectives: The students will be able to		
1	To enable the students to understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.	
2	To enable the students to understand the importance of various tools and techniques in finding optimal solutions to problems involving limited resources in the form of Men, Materials and machinery.	

UNIT-I	
Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as LPP. Solutions to LPP by graphical method (Two Variables). **Laboratory Sessions/ Experimental learning:** Case Studies for formulation of LLP to know the statistics for daily marketing of newspaper, banking sector, different firms. **Applications:** Formulation can be used in agriculture, financial sector, marketing. **Video link / Additional online information (related to module if any):** http://nptel.ac.in/courses/111107128/ https://nptel.ac.in/courses/111/107/111107128/ https://nptel.ac.in/courses/110/104/110104063/ https://onlinecourses.nptel.ac.in/noc21_mg43/preview	8 Hrs
UNIT-II	
Linear Programming Problems: Simplex method, Canonical and Standard form of LPP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method, Degeneracy in LPP. Solutions to L.P.P by Dual Simplex Method. **Laboratory Sessions/ Experimental learning:** Case Studies for formulation of LLP to utilize minimum resources available to achieve the target for different sectors like supply chain management, marketing. **Applications:** LPP can be used in defense, industries sectors and hospitals. Video link / Additional online information (related to module if any): http://nptel.ac.in/courses/112106134/ https://nptel.ac.in/courses/111/107/111107128/ https://nptel.ac.in/courses/110/104/110104063/ https://onlinecourses.nptel.ac.in/noc21_mg43/preview	8 Hrs
UNIT-III	
Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in	8 Hrs

Transportation problem by Modified Distribution (MODI) method, application of transportation problem. **Assignment Problem:** Formulation, Solutions to assignment problems by Hungarian method, unbalanced, Maximization assignment problems, Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Numerical Problems. **Laboratory Sessions/ Experimental learning:** Case Studies for different transportation system to obtain best optimal distance to reach the target. **Applications:** These methods can be used in transportation of goods and any other services. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/111/107/111107128/ https://nptel.ac.in/courses/110/104/110104063/	
UNIT-IV	
Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, Numerical Problems. **Queuing Theory:** Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models. **Laboratory Sessions/ Experimental learning:** Building a different network activity for financial and marketing projects management. **Applications:** Network and Queuing methods can be adopted in completing various projects within the given deadline to earn the profit and minimize the loss. Video link / Additional online information (related to module if any): http://nptel.ac.in/courses/110106062/ https://nptel.ac.in/courses/111/107/111107128/ https://nptel.ac.in/courses/110/104/110104063/ https://onlinecourses.nptel.ac.in/noc21_mg43/preview	8 Hrs
UNIT-V	
Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Formulation of games. **Sequencing:** Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. **Laboratory Sessions/ Experimental learning:** Collecting the statistical data to develop the project using Game theory and Sequencing. **Applications:** These methods give the perfect results of any production of machines.	8 Hrs

Video link : http://nptel.ac.in/courses/112106131/ https://nptel.ac.in/courses/112/106/112106134/ https://nptel.ac.in/courses/111/107/111107128/ https://nptel.ac.in/courses/110/104/110104063/	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the meaning, definitions, scope, need, phases and techniques of operations research.
CO2	Formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method and Dual Simplex method.
CO3	Formulate as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problems.
CO4	Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks. Solve waiting line problems for M/M/1 and M/M/K queuing models.
CO5	Solve problems on game theory for pure and mixed strategy under competitive environment. Determine minimum processing times for sequencing for different n jobs and m machines using Johnson's algorithm.

Reference Books	
1.	Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006
2.	Operations Research, Paneerselvan, PHI
3.	Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publications Pvt. Ltd. 2016.
4.	Operations Research, P K Gupta and D S Hira, S. Chand and Company LTD. Publications, New Delhi – 2007.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the self -study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies are added to get marks out of 100 and report CIE for 50 marks.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	1	-	-	-	2	-	1	-	2
CO3	3	3	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	1	-	-	-	2	-	2	-	2
CO5	2	3	3	2	-	-	-	2	-	1	-	2

VI Semester		
Heat Transfer (Theory and Practice)		
Course Code: MVJ21ME63		CIE Marks:50+50
Credits: L:T:P: 3:0:2		SEE Marks: 50 +50
Hours:40 L+ 26 P		SEE Duration: 03+03 Hours

Course Learning Objectives: The students will be able to	
1	Students will build a strong foundation in heat transfer basics of conduction, convection, and radiation modes, two dimensional steady and unsteady heat transfer
2	Students will be able to work on governing equations and solution procedures for the three modes along with solution of practical problems using empirical correlations
3	Students will be able to analyze and design of the heat exchangers.
4	Students will be able to understand boiling and condensation heat transfe

UNIT-I	
Introduction-Modes and mechanisms of heat transfer: Basic laws of heat transfer, General discussion about applications of heat transfer. Conduction Heat Transfer: Fourier rate equation, General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates. Simplification and forms of the field equation: steady, unsteady, and periodic heat transfer, Initial and boundary conditions. Experiential Learning: 1. Thermal conductivity experiment in HMT lab. 2. Write a code/program to estimate the intermediate temperatures in composite wall. Applications: Insulation of industrial pipelines. Video link / Additional online information: 1. https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785&index=1	8 Hrs
UNIT-II	
Lumped system approximation and Biot number, heat transfer through pin fins- Two-dimensional conduction, solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer using Heissler charts. Experiential Learning: 1. Determination of Effectiveness on a Metallic fin. 2. Experiment on Transient Conduction Heat Transfer. Applications: CPU cooling, Transformer cooling and engine cooling in automobiles. Video link / Additional online information: 1. https://www.youtube.com/watch?v=QcTr0-QrSMY&list=PL5F4F46C1983C6785&index=2	8 Hrs
UNIT-III	
Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat	8 Hrs

transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection. Experiential Learning: 1. Determination of Heat Transfer Coefficient in free Convection 2. Determination of Heat Transfer Coefficient in a Forced Convection Applications: Heat exchangers, Gas turbine and steam turbine cooling, Refrigeration and air conditioning. Video link / Additional online information: 1. https://www.youtube.com/watch?v=ACjR7MIFaFw&list=PL5F4F46C1983C6785&index=3	
UNIT-IV	
Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method Experiential Learning: 1. Determination of Emissivity of a Surface. 2. Determination of Stefan Boltzmann Constant Applications: Solar power applications, electrical bulbs, microwave oven. Video link / Additional online information: 1. https://www.youtube.com/watch?v=hjrHtAnW4Ac	8 Hrs
UNIT-V	
Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and & NTU methods, Boiling and Condensation heat transfer, Pool boiling curve, Introduction mass transfer, Similarity between heat and mass transfer. Experiential Learning: 1. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers. 2. Experiments on Boiling of Liquid and Condensation of Vapour **Applications**: Boilers, condensers, radiators, nuclear reactor cooling. **Video link / Additional online information**: 1. https://www.youtube.com/watch?v=V8Fa-b6Yx0k	8 Hrs
LABORATORY EXPERIMENTS	
Any 12 experiments to be conducted 1. Determination of Thermal Conductivity of a Metal Rod. 2. Determination of Overall Heat Transfer Coefficient of a Composite wall. 3. Determination of Effectiveness on a Metallic fin. 4. Determination of Heat Transfer Coefficient in a free Convection on a 5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe. 6. Determination of Emissivity of a Surface.	

7. Determination of Steffan Boltzmann Constant.
8. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
9. Experiments on Boiling of Liquid and Condensation of Vapour.
10. Performance Test on a Vapour Compression Refrigeration.
11. Demonstration of Air Conditioner Trainer Kit.
12. Transient and Steady State heat transfer Analysis of plane slab and cylinder using numerical approach.

Course Outcomes: After completing the course, the students will be able to	
CO1	After completing the course, the students will be able to formulate and analyse a heat transfer problem involving any of the three modes of heat transfer.
CO2	The students will be able to estimate heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.
CO3	The students will be able to calculate radiation heat transfer between surfaces using radiative properties.
CO4	The students will be able to design thermal device such as heat exchangers.
CO5	The students will be able to understand better the boiling and condensation phenomenon and study pool boiling curves.

Reference Books	
1.	Fundamentals of Heat and Mass Transfer, M. Thirumaleshwar, Pearson Education India, 2009
2.	Nag, P.K., "*Heat Transfer*", Tata McGraw Hill, New Delhi, 2002
3.	Yunus A. Cengel, "*Heat Transfer A Practical Approach*", Tata McGraw Hill, 2010
4.	Kothandaraman, C.P., "*Fundamentals of Heat and Mass Transfer*", New Age International, New Delhi, 1998.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	2	1	-	1	1	-	2
CO2	3	3	2	2	-	2	1	-	1	1	-	2
CO3	3	3	2	2	-	2	1	-	1	1	-	2
CO4	3	3	2	2	-	2	1	-	1	1	-	2
CO5	3	3	2	1	-	2	1	-	1	1	-	2

Semester: VI		
ENERGY CONVERSION TECHNOLOGIES (Theory and Practice)		
Course Code: MVJ21ME64		CIE Marks:50+50
Credits: L:T:P: 3:0:2		SEE Marks: 50 +50
Hours:40 L+ 26 P		SEE Duration: 03+03 Hours

Course Learning Objectives: The students will be able to	
1	Explain various types of Conventional & Non-conventional Energy Sources and their resources scenario in India.
2	Explain combustion phenomenon in SI and CI Engines also factors effecting combustion variations in these engines
3	Calculate mixture requirement and pollutants produced in internal combustion engines.
4	Students will be able to explain how solar radiation will be converted into Thermal Energy and working of Photovoltaic Cells.
5	Students will understand how the conversion of Biomass and wind energy in to an useful energy

UNIT-I	
Introduction: Energy sources, India's production, and reserves of commercial energy sources, need for non-conventional energy sources, energy alternatives, solar, thermal, photovoltaic. Waterpower, wind, biomass, ocean thermal, tidal and waves, geothermal, tar sands and oil shale, nuclear (Brief descriptions); advantages and disadvantages, comparison (Qualitative and Quantitative). **Laboratory Sessions/ Experimental learning**: Case Study on Different Energy Sources. Video links: 1.https://nptel.ac.in/courses/121/106/121106014/ 2.https://www.youtube.com/watch?v=e0nkkKDjY50&t=2s 3.https://www.youtube.com/watch?v=e0nkkKDjY50&t=2s 4.https://www.youtube.com/watch?v=EXcNXLv2W3A	Hrs: 8
UNIT-II	
Construction and Operation: Engine classification, Constructional details of four stroke spark ignition (SI) and compression ignition (CI) engines. Working principles. Comparison of SI and CI engines , theoretical and actual valve timing diagrams for engines. **Engine Cycles**: theoretical Otto, diesel and dual cycles, Fuel-air Cycles and Actual cycle, numericals.	Hrs: 8
UNIT-III	
Combustion in Compression Ignition Engines: Types of diesel combustion systems: Direct injection systems, indirect injection systems, comparison of different combustion systems, Analysis cylinder pressure data; combustion efficiency, DI engines, IDI engines, Fuel spray behaviour: Fuel injection, overall spray structure, atomization, spray penetration, droplet size distribution and spray evaporation, Ignition delay: definitions and discussion, fuel ignition quality, auto ignition fundamentals, physical properties affecting delay, effect of fuel properties	Hrs: 8
UNIT-IV	

Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid) (Quantitative analysis); sensible heat storage, latent heat storage, application of solar energy water heating. Space heating and cooling, active and passive systems, power generation, refrigeration. Distillation (Qualitative analysis) solar pond, principle of working, operational problems. **Photovoltaic Conversion**: Description, principle of working and characteristics, applications. Study of solar power stations in India. Limitations of solar power. **Laboratory Sessions/ Experimental learning**: Case study for design of solar panel for domestic applications & Case study on solar charging station. **Video links**: 1. https://www.youtube.com/watch?v=mpHZWYpKDJg 2. https://www.youtube.com/watch?v=GzMuLpsRY-8 3. https://nptel.ac.in/courses/121/106/121106014/	Hrs: 8
UNIT-V	
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, aerodynamic considerations of windmill design, numerical examples. **Energy from Biomass**: Photosynthesis, photosynthetic oxygen production, energy plantation, biogas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of bio-gas, problems involved with bio-gas production, application of bio-gas, application of bio-gas in engines, advantages. 1. https://nptel.ac.in/courses/121/106/121106014/ 2. https://www.youtube.com/watch?v=-f88zBS8jlg&t=2s 3. https://www.youtube.com/watch?v=sJQwJX-YysY	Hrs: 8
LABORATORY EXPERIMENTS	
1. Determination of Calorific value of fuel. 2. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus. 3. Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers 4. Valve Timing Diagram of an I.C. Engine	

5. Performance Tests on Two stroke Petrol Engine, Four Stroke Petrol Engine, Four Stroke Diesel Engines with different loading.
6. Performance test on 4-Stroke VCR(Variable Compression Ratio) Petrol Engine test rig
7. Measurements of Exhaust Emissions of Petrol engine.
8. Measurements of Exhaust Emissions of Diesel engine.
9. Demonstration of measurements of P-θ, PV plots using IC Engine test rig.

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand various types of Conventional and Non-conventional Energy Sources.
CO2	Explain combustion phenomenon in SI and CI Engines also factors effecting combustion variations in these engines
CO3	Calculate mixture requirement and pollutants produced in internal combustion engines.
CO4	Apply the knowledge of solar radiation for power generation and domestic applications.
CO5	Study and understand power generation from Wind Energy and Biomass.

Reference Books	
1.	Internal Combustion Engines, V. Ganesan Tata McGraw Hill 2007
2.	Internal Combustion Engines Ramalingam K. K. Sci-Tech Publications 2005
3.	Internal Combustion Engines Mathur and Sharma Dhanpat Rai and Sons 2002
4.	Solar energy, by Subhas P Sukhatme – Tata McGraw Hill, 2nd Edition, 1996

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	1		2	2			1			2	2	
CO3	1							2	2	2	1	
CO4	1	2				2						2

Semester: VI		
AUTOMOTIVE ENGINEERING		
Course Code: MVJ21ME621		CIE Marks:100
Credits: L:T:P:S: 3:1:0:0		SEE Marks: 100
Hours: 40L+26T		SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	The layout and arrangement of principal parts of an automobile	
2	The working of transmission and brake systems	
3	The operation and working of steering and suspension systems	
4	To know the Injection system and its advancements	
5	To know the automobile emissions and its effects on environment	

UNIT-I	
ENGINE COMPONENTS AND IT'S PRINCIPLE PARTS: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I.Engine and C.I.Engines, methods of a Swirl generation, choice of materials for different engine components, engine positioning. Concept of HCCI engines, hybrid engines, twin spark engine, electric car. COOLING AND LUBRICATION: cooling requirements, types of cooling-thermosiphon system, forced circulation water cooling system, water pump, Radiator, thermostat valves. Significance of lubrication, splash and forced feed system.	08 Hrs
UNIT-II	
TRANSMISSION SYSTEMS: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive. BRAKES: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock & Numerical	08 Hrs
UNIT-III	
STEERING AND SUSPENSION SYSTEMS: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system. IGNITION SYSTEM: Battery Ignition system, Magneto Ignition system, electronic Ignition system	08 Hrs
UNIT-IV	
SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag. FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers, Fuel mixture requirements for SI engines, types of carburetors, C.D.&	08 Hrs

C.C. carburetors, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System	
UNIT-V	
AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, controlling crankcase emissions, controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air aspirator system, Catalytic converter. EMISSION STANDARDS: Euro I, II, III and IV norms, Bharat Stage II, III, IV norms. Motor Vehicle Act	08 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	To identify the different parts of an automobile and it's working
CO2	To understand the working of transmission and braking systems
CO3	To comprehend the working of steering and suspension systems
CO4	To learn various types of fuels and injection systems
CO5	To know the cause of automobile emissions, its effects on environment and methods to reduce the emissions.

Reference Books

1.	Automotive mechanics, William H Crouse & Donald L Anglin (10th Edition) Tata McGraw Hill Publishing Company Ltd., 2007.
2.	Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc
3.	Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
4.	Automobile Engineering, R. B. Gupta, SatyaPrakashan (4th Edition) 1984.

Web links and Video Lectures (e-Resources):

https://www.motorbiscuit.com/4-types-of-car-transmissions-and-how-they-work/
https://www.youtube.com/watch?v=zA_19bHxEYg&t=6s
https://www.motorbiscuit.com/4-types-of-car-transmissions-and-how-they-work/
https://www.youtube.com/watch?v=fTnAoYBKXFU
https://www.youtube.com/watch?v=1k2aFMjRd9M

https://www.youtube.com/watch?v=V83pI7WbSpM

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three subdivisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	-	-	-	1	1	1	1
CO2	3	2	3	2	2	1	-	-	1	1	1	1
CO3	3	3	2	2	3	2	-	-	2	1	2	1
CO4	3	3	2	2	3	1	1	-	2	2	2	2
CO5	3	3	3	3	2	2	2	-	3	2	3	3

Semester: VI		
OPERATIONS MANAGEMENT (Theory)		
Course Code: MVJ21ME622		CIE Marks: 50
Credits: L:T:P: 3:0:0		SEE Marks: 50
Hours: 40 L		SEE Duration: 03
Course Learning Objectives: The students will be able to		
1	This course will give details about various engineering management system in the production industry.	
2	To study the about optimistic utility of the available resources like material and time.	

UNIT-I	
Production and Operations Management: Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity, contemporary issues and development **Decision Making**: The decision process, characteristics of operations decisions, use of models, decision making environments, graphical linear programming, analysis and trade-offs.	8 Hrs
UNIT-II	
Forecasting: Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, accuracy and control of forecasts, choosing a forecasting technique, elements of a good forecast. **Capacity & Location Planning**: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives, need for location decisions, nature of locations decisions, general procedure for making locations decisions, evaluating locations decisions, facilities layout - need for layout decisions, types of processing.	8 Hrs
UNIT-III	
Aggregate Planning and Master Scheduling: Aggregate planning - Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning - graphical and charting techniques, mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods. **Inventory Management**: Types of Inventories, reasons for holding inventory, objectives of inventory control, requirements for effective inventory management - information, cost, priority system.	8 Hrs
UNIT-IV	
Material Requirement Planning (MRP): Dependent versus independent demand, an overview of MRP - MRP inputs and outputs, MRP processing, An overview of MRP-II and ERP capacity requirement planning, benefits and limitations of MRP. **Purchasing and Supply Chain Management (SCM)**: Introduction, Importance of purchasing and SCM, The procurement process, Concept of tenders, Approaches to SCM, Vendor development, Measures of purchasing and SCM, Make or buy decision, Types of buying, E-procurement.	8 Hrs

UNIT-V	
Introduction to Quality: The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement). **Methods And Philosophy of Statistical Process Control**: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length-ARL).	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Students will be able to acquire the decision-making ability in the production industry
CO2	Students will be able to visualize the future industrial demand in terms of product
CO3	Students will be able to control the inventory based on forecasting the demand
CO4	Students will be able to order the material based on the requirement and use it optimistically
CO5	Students will learn the quality tool like various charts to use in the industry

Reference Books	
1.	**William J Stevenson, "Production and Operations Management",** 9th Ed., Tata McGraw Hill, **ISBN:9789355322647**
2.	**B Mahadevan "Operations Management-Theory and Practice",** Pearson Education, 2007. **ISBN:81-7758-564-9**
3.	**R.B.Chase, N.J.Aquilino, F. Roberts Jacob "Operations Management for Competitive Advantage"** McGraw Hill Companies Inc., Ninth Edition. **ISBN: 007126048X**
4.	**Everett E.Adams, Ronald J.Ebert, "Production & Operations Management",** Prentice Hall of India Publications, Fourth Edition.**ISBN:81-203-083**

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=DVEbZ_FNRg
2. https://www.youtube.com/watch?v=1AN_L_8-x84
3. https://www.youtube.com/watch?v=Ic_El2DkpjA
4. https://www.youtube.com/watch?v=VjSgga4E6VY
5. https://www.digimat.in/nptel/courses/video/110105095/L01.html
6. https://www.youtube.com/watch?v=E4OYh890IRE
7. https://www.youtube.com/watch?v=Z1zi7fMLmV4
8. https://www.youtube.com/watch?v=TbPUiJKyxqw

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated

for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the self -study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies are added to get marks out of 100 and report CIE for 50 marks.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	3	3	3	3
CO2	2	2	-	-	-	3	-	-	3	3	3	3
CO3	-	-	-	-	-	-	-	-	3	2	3	2
CO4	1	1	-	-	-	2	-	-	3	3	3	3
CO5	2	-	-	-	-	-	-	-	3	3	3	3

Semester: VI		
ENGINEERING ECONOMICS		
Course Code: MVJ21ME623		CIE Marks: 50
Credits: L:T:P: 3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Explain the importance of engineering economics, Law of demand and supply in engineering decision making.
2	Describe various interest rate factors and implement the same for economic decision making.
3	Discuss different component of costs, methods of cost estimation and different methods of computing depreciation.
4	Discuss taxation concepts-income, corporate taxes and financial functions.
5	Explain the importance of engineering economics, Law of demand and supply in engineering decision making.

UNIT-I	
Introduction: Engineering Decision-Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy. Engineering Economic Decision. 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 calculation with flexible interest rates, Exercises and Discussion.	08 Hrs
UNIT-II	
Present-Worth Comparisons: Conditions for present worth comparisons, Basic Present worth comparisons, Present-worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Future-worth comparison, Future-worth equivalence, Pay-back comparison, Exercises, Discussions and problems.	08 Hrs
UNIT-III	
Equivalent Annual-Worth Comparisons: Equivalent Annual-Worth Comparison methods, Situations for Equivalent Annual-Worth Comparisons, Consideration of asset life, Comparison of assets with equal and unequal lives, Use of shrinking fund method, Annuity contract for guaranteed income, Exercises, Problems.	08 Hrs
UNIT-IV	
Costing and Depreciation: Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, sum of years method, sinking fund method, taxation concepts, personal income taxes and corporate taxes, Discussions, and problems.	08 Hrs

UNIT-V	
Introduction, Scope of Finance, Finance Functions: 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 Numerical. *Financial Ratio Analysis:* Introduction, Nature of ratio analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Evaluation of a firm's earning power. Comparative statements analysis. Simple Numerical.	08 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand engineering economics demand supply and its importance in economics decision making and problem solving.
CO2	Calculate present worth, annual worth and IRR for different alternatives in economic decision making.
CO3	Understand the procedure involved in estimation of cost for a simple component, product costing and depreciation, its methods.
CO4	Examine the different economic analysis methods for decision making.
CO5	Understand the procedure of financial statements and balance sheets.

Reference Books	
1.	Leland Blank & Anthony Tarquin, *"Basics of Engineering Economy"*, McGraw Hill Publication (India) Private Limited.
2.	R.Paneerselvam, *"Engineering Economics"*, PHI publication.
3.	N. M. Fraser and E. M. Jewkes, Engineering Economics: Financial Decision Making for Engineers, 5th edition, Pearson, Toronto, Ontario, 2013
4.	J. A. White, K. E. Case and D. B. Pratt, Principles of Engineering Economic Analysis, 5th edition, Hoboken, NJ, USA, 2010.

Web links and Video Lectures (e-Resources):

- http://nptel.ac.in/courses/112107209/
- https://youtu.be/WYbC1-TsGis
- https://onlinecourses.nptel.ac.in/noc20_mg53/
- https://youtu.be/OqHEseiXcbg
- https://nptel.ac.in/courses/110/106/110106135/
- http://nptel.ac.in/courses/105103023/

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks

obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three subdivisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	2	-	-	-	2	-	2	-	2
CO3	3	2	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	2	-	-	-	2	-	2	-	2
CO5	3	2	1	1	-	-	-	2	-	1	-	1

Semester: VI		
Non-Conventional Energy Sources (Theory)		
Course Code: MVJ21ME624		CIE Marks:100
Credits: L:T:P:S: 3:1:0:0		SEE Marks: 100
Hours: 40T		SEE Duration: 3 Hrs

Course Learning Objectives: The students will be able to	
1	Students will be able to understand various types and utilization of Non-conventional Energy Sources.
2	Students will gain the knowledge about the utilization and applications of solar energy.
3	Students will be able to explain how solar radiation will be converted into Thermal Energy and working of Photovoltaic Cells.
4	Students will understand how the Biomass (Natural Waste) is converted in useful energy and Geothermal Energy.
5	Students will gain the knowledge about the generation of power from Wind Energy, Ocean Thermal Energy Conversion and Tidal Energy.

UNIT-I	
Introduction: Energy sources, India's production, and reserves of commercial energy sources, need for non-conventional energy sources, energy alternatives, solar, thermal, photovoltaic. Waterpower, wind biomass, ocean temperature difference, tidal and waves, geothermal, tar sands and oil shale, nuclear (Brief descriptions); advantages and disadvantages, comparison (Qualitative and Quantitative). **Laboratory Sessions/ Experimental learning**: Case Study on Different Energy Sources. **Applications**: Energy Sector **NPTEL Link**: https://nptel.ac.in/courses/121/106/121106014/ **Video link**: https://www.youtube.com/watch?v=e0nkkKDjY50&t=2s https://www.youtube.com/watch?v=e0nkkKDjY50&t=2s https://www.youtube.com/watch?v=EXcNXLv2W3A	08
UNIT-II	
Solar Radiation: Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data. **Solar Radiation Geometry**: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time. Apparent motion of sum, day length, numerical examples. Radiation Flux on a Tilted Surface. Solar radiation measurement devices. **Laboratory Sessions/ Experimental learning**: Analysis of solar radiation data in different places across the country. **Applications**: Solar Power Generation. **NPTEL Link**: https://nptel.ac.in/courses/121/106/121106014/	08

Video link: https://www.youtube.com/watch?v=CRFpoZjeWa4 https://www.youtube.com/watch?v=E4S02rc9AvM https://www.youtube.com/watch?v=ur5muGY5Gy4	
UNIT-III	
Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid) (Quantitative analysis); sensible heat storage, latent heat storage, application of solar energy water heating. Space heating and cooling, active and passive systems, power generation, refrigeration. Distillation (Qualitative analysis) solar pond, principle of working, operational problems. **Photovoltaic Conversion**: Description, principle of working and characteristics, applications. Study of solar power stations in India. Limitations of solar power. **Laboratory Sessions/ Experimental learning**: Case study for design of solar panel for domestic applications & Case study on solar charging station. **Applications**: Solar power stations. **NPTEL Link**: https://nptel.ac.in/courses/121/106/121106014/ **Video link**: https://www.youtube.com/watch?v=mpHZWYpKDJg https://www.youtube.com/watch?v=GzMuLpsRY-8	08
UNIT-IV	
Energy from Biomass: Photosynthesis, photosynthetic oxygen production, energy plantation, biogas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of bio-gas, problems involved with bio-gas production, application of bio-gas, application of bio-gas in engines, advantages. **Geothermal Energy Conversion**: Principle of working, types of geothermal station, geothermal plants in the world, scope of geothermal energy and challenges associated with geothermal energy conversion. **Laboratory Sessions/ Experimental learning**: Visit to Biomass Gas Production Plant. Case study on design of bio-gas plant for 1Mw. **Applications**: Production of Gas and Power Generation. **NPTEL Link**: https://nptel.ac.in/courses/121/106/121106014/ **Video link**: https://www.youtube.com/watch?v=sJQwJX-YysY https://www.youtube.com/watch?v=JInatzTBiKA https://www.youtube.com/watch?v=adSkrlyd2rQ&t=1s	08
UNIT-V	
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, aerodynamic considerations of windmill design, numerical examples. **Tidal Power**: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations.	08

Ocean Thermal Energy Conversion (OTEC): Principle of working, Rankine cycle, OTEC power stations in the world, limitations of OTEC. **Laboratory Sessions/ Experimental learning**: Assignments on making models of windmills. **Applications**: Power Generation and Low heat Applications. **NPTEL Link**: https://nptel.ac.in/courses/121/106/121106014/ **Video link**: https://www.youtube.com/watch?v=-f88zBS8jlg&t=2s, https://www.youtube.com/watch?v=WZBiznycjns **https://www.youtube.com/watch?v=F2YsrxpQPwE**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand various types and utilization of Non-conventional Energy Sources.
CO2	To understand the impact of solar collector geometry.
CO3	Apply the knowledge of solar radiation for power generation and domestic applications.
CO4	Understand the Biomass (Natural Waste) conversion to useful energy and principles of geothermal Energy.
CO5	Gain the knowledge about the generation of power from Wind Energy, Ocean Thermal Energy Conversion and Tidal Energy.

Reference Books	
1.	Non-Conventional Energy Sources by G.D Rai K, Khanna Publishers, 2003, ISBN : 9788174090737
1.	Renewable Energy Sources and Conversion Technology by N.K.Bansal, Manfred Kleeman & Mechael Meliss, Tata McGraw Hill, 2001. ISBN : 9780074600238
3.	Renewable Energy Resources, John W.Twidell Anthony D. Weir El, BG 2001. ISBN 13: 9780415584388
4.	Solar energy, by Subhas P Sukhatme – Tata McGraw Hill, 2nd Edition, 1996, ISBN : 9789352607112

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1				2	3					2
CO2	2	1				2	3					2
CO3	2	1				2	3					2
CO4	2	1				2	3					2
CO5	2	1				2	3					2

Semester: VI		
TOTAL QUALITY MANAGEMENT (Theory)		
Course Code: MVJ21ME625		CIE Marks: 50
Credits: L:T:P: 3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Understand various approaches to TQM and framework of TQM
2	Understand the importance of commitment and involvement of leadership and management in TQM.
3	Develop feedback and suggestion systems for quality management.
4	Enhance the knowledge in Tools and Techniques of quality management
5	Understand the role of SQC and Experimental Design in TQM

UNIT-I	
Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements. Leadership : Definitions, Characteristics of Quality Leaders, Leadership concepts, the seven habits of highly effective people, ethics, The Deming Philosophy, Role of TQM Leaders, Implementation, Quality Council, Core Values, Concepts and Framework, Quality Statements, Strategic Planning, Communications, Decision Making, Leadership Survey, TQM Exemplary Organization. **Experiential Learning: (Experiments which can be conducted on the concepts of contents)** Leadership activities for setting a great workplace climate, for better decision making, exercises for improving team collaboration, games for inspiring others, activities for personal development, exercises for setting team values, games for team building, activities for better communication, activities for resolving team conflicts **Applications**: It guides to know about quality-based production. **Video Links/Any other special information(Papers)**: (For additional study on the concepts of contents) 1. https://nptel.ac.in/courses/110104080/ 2. https://studentsfocus.com/ge6757-tqm-notes-total-quality-management 3. https://pec.ac.in/programmes/pg/structure/tqm. https://www.scribd.com/document/354054705/Total-Quality-Management 4. https://www.youtube.com/watch?v=uJ_dX7gL5hk	8Hrs

UNIT-II	
Customer Satisfaction : Introduction, Customer perception of Quality, Feedback, Using Customer Complaints, Service Quality, Translating needs into	8Hrs

requirements, Customer Retention, Additional Comments, Employee Involvement : Motivation, Employee Surveys, Empowerment, Teams, Suggestion Systems, Recognition and Reward, Gain Sharing, Performance Appraisal, Unions and Employee involvement, benefits of Employee involvement, Case Studies. **Continuous Process Improvement** : Process, The Juran Trilogy, Improvement Strategies, Types of Problems, The PDSA Cycle, Problem solving Method, Kaizen, Reengineering, Six Sigma, Supplier Partnership : Principles of Customer / Supplier Relations, Partnering, Sourcing, Supplier Selection, Supplier Certification, Supplier Ratting, Relationship Development, Performance Measures : Basic Concepts, Strategy Performance Measure Presentation, Cost of Quality, Analysis, Improvement Action Strategy and Plan, Limitations of Quality Cost, Awards, Balanced Score Card, Case Studies. Experiential Learning: (Experiments which can be conducted on the concepts of contents) Laboratory Sessions/ Experimental learning: • Customer Satisfaction through TQM Approach: A case study **Applications**: It helps in reaching the customer related to queries of the product. Video link / Additional online information: https://studentsfocus.com/ge6757-tqm-notes-total-quality-management	
UNIT-III	
Tools and Techniques: Benchmarking, definition, Reasons to Benchmark, Process, Deciding what to Benchmark, Understanding Current Performance, Planning, Studying Others, Learning from the Data, Using the findings, Pitfalls and Criticisms of Benchmarking, Case Studies. Information Technology: Computers and the Quality Function, the Internet and other Electronic Communication, Information Quality Issues, Technologies of Future, Case Studies. **Quality Management Systems** : Benefits of ISO Registration, ISO 9000 Series of Standards, Sector Specific Standards, ISO 9001 Requirements, Implementation, Documentation, Writing the Documents, Internal Audits, Registration, Closing Comments. Environment Management Systems: ISO 1400 Series Standards, Concepts of ISO 14001, Requirements of ISO 14001, Benefits of EMS, Integrating ISO 1400 with ISO 9000, Relationship to Health and Safety. , Case Studies Laboratory Sessions/ Experimental learning: • A case study on Continuous Improvement Process **Applications**: It is used in quality control of the product to improve the productivity. Video link / Additional online information: https://nptel.ac.in/courses/110104080/	8Hrs
UNIT-IV	

Quality Function Deployment: The QFD Team, Benefits of QFD, The voice of the Customer, Organization of Information, House of Quality, Building a House of Quality, QFD Process, Quality by Design: Rationale for Implementation, Benefits, Design for Six Sigma, Teams, Communication Models, Implementation, Tools, Misconceptions and Pitfalls, **Total Productive Maintenance**: The Plan, Learning the New Philosophy, Training, Improvement Needs, Goal, Developing Plans, Autonomous Work Groups. **Failure Mode and Effect Analysis** : Reliability, Reliability Requirements, Failure Rate, Intent of FMEA, FMEA Team, FMEA Documentation, Stages of FMEA, The Design FMEA Document, the process FMEA Document, Other types of FMEA, Products Liability : Product Safety Law, Products Liability Law, Defenses, Proof and the expert Witness, Financial Loss, The Future of Products Liability, Prevention, **Management Tools** : Forced Field Analysis, Nominal Group Technique, Affinity Diagram, Interrelationship Digraph, Tree Diagram, Matrix Diagram, Prioritization Matrices, Process Decision Program Chart, Activity Network Diagram. Laboratory Sessions/ Experimental learning: • Exercises related to FMEA and QFD in daily life **Applications**: It guides to learn more skills related to Reliability and Quality function and total productivity qualities. **Video link / Additional online information**: https://www.youtube.com/watch?v=jHe5sezJ0cY	8Hrs
UNIT-V	
Statistical Process Control : Introduction, Pareto Diagram, Process Flow Diagram, Cause and Effect Diagram, Check Sheets, Histogram, Statistical Fundamentals, Introduction to Control Charts, Variable Control Charts, State of Control, Out of Control Process, Process Capability, Process, Performance, Different Control Charts of Variables, Control Charts for Attributes, Measurement System Analysis, Scatter Diagram, Case Studies. **Experimental Design** : Basic Statistics, Hypotheses, t Test, F Test, One Factor at a Time, Orthogonal Design, Point and interval Estimate, Two Factors, Full Factorials, Fractional Factorials, Taguchi's Quality Engineering: Loss Function, Orthogonal Arrays, Signal to Noise Ratio, Parameter Design, Tolerance Design, Case Studies. Laboratory Sessions/ Experimental learning: • Importance of SPC and Engineering Design in engineering projects **Applications**: Applied to companies to get the standards of the product. **Video link / Additional online information**: https://studentsfocus.com/ge6757-tqm-notes-total-quality-management	8Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain and illustrate the various approaches of TQM and Leadership in TQM
CO2	Infer and develop the customer perception of quality and continuous process improvement

CO3	Apply the tools and technique for effective implementation of TQM
CO4	Analyze and apply FMEA, QFD and TPM for improvement of TQM.
CO5	Apply and correlate statistical tools for continuous improvement of systems and Experimental Design

Reference Books	
•	Total Quality Management, Dale H. Besterfield, Pearson Education India, Edition 03. ISBN: 8129702606,
•	Total Quality Management for Engineers M. Zairi, Wood head Publishing, ISBN:1855730243
3.	Engineering Optimization Methods and Applications A Ravindran, K, M. Ragsdell Willey India Private Limited 2nd Edition,2006 ISBN-13 978-8126509331
4.	Managing for Quality and Performance Excellence James R. Evans and William M Lindsay Cengage Learning. 9th edition ISBN-10 1538800993

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	-	1	-	3	-	2	-	2
CO2	2	1	1	-	-	2	2	-	2	3	-	2
CO3	2	1	2	1	2	1	-	-	-	-	-	2
CO4	2	1	1	-	-	1	-	2	2	2	-	2
CO5	2	1	1	-	-	3	2	3	2	1	-	2

Semester: VI		
Design Thinking, AI and ML for Mechanical Engineers (Theory)		
Course Code: MVJ21MEA66		CIE Marks:50
Credits: L:T:P: 1:0:0		SEE Marks: 50
Hours: 15L		SEE Duration: 2 Hrs

Course Learning Objectives: The students will be able to	
1	Explain Need, Want, Demand, Customer Value, Product and Service.
2	Explain Innovation, understand creativity, barriers to creativity, skills for creativity.
3	Explain the principles of design thinking and its approaches.
4	Identify the empathy, define phases in human centred design problems.
5	Understand the idea generation, prototype and testing in design thinking context

UNIT-I	
INTRODUCTION TO DESIGN THINKING: An insight into Engineering design, Design, Human centered Design, Design Thinking. Origin of Design thinking, importance of Design thinking, understanding Design thinking and its process models (Stanford Model, Double Diamond Model), application of Design thinking.	3 Hrs
UNIT-II	
EXPLORE, EMPATHIZE AND DEFINE: Human-Centred Design (HCD) process – Problem Space: Empathize, define; Solution Space: Ideate, Prototype and Test and Iterate. Role of Empathy in design thinking, methods and tools of empathy, understanding empathy tools. Explore define phase, state users' needs and problems using empathy methods.	3Hrs
UNIT-III	
IDEATION, PROTOTYPING AND TESTING: Ideation Phase, Ideation methods: Random Word Technique, SCAMPER, brain storming, Analogy, Biomimicry. PROTOTYPE AND TESTING: Prototyping: Role of prototyping in DT. Build to learn, Prototyping principles, and Approaches. Low Fidelity, models, High Fidelity Models. Models using different mediums. Rapid prototyping; user testing methods, Advantages and limitations of user Testing, Feedback, Design Iteration.	3 Hrs
UNIT-IV	
Introduction to AI for Mechanical Engineers: Basics of AI for Mechanical Engineers Applications of AI in Mechanical Engineering, Advanced search, Constraint satisfaction problems, Knowledge representation & reasoning, Non-standard logics, Uncertain and probabilistic reasoning. Case Studies on Application of AI in Smart Manufacturing.	3 Hrs
UNIT-V	
Conceptual introduction to Machine Learning for Mechanical Engineers: Introduction to Neural Networks, Supervised, Unsupervised, and Semi-Supervised Learning, Deep Learning, Reinforcement Learning, Linear	3 Hrs

Regression, Case Studies on Machine Learning for Industrial Robotics and Automation.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the Need, Want, Demand, Customer Value, Product and Service.
CO2	Understand the Innovation, creativity, barriers to creativity, and skills for creativity.
CO3	Able to identify the empathy, define phases in human centered design problems.
CO4	Able to identify the significance of AI for Mechanical Engineering Applications.
CO5	Apply the machine learning algorithms to find the solutions for a given mechanical engineering problem.

Reference Books	
1.	Innovation by Design, Thomas Lockwood, New Page Books, 2017.
2.	Change by design, Tim Brown, Harper Collins, Harper Collins, 2009
3.	The Design Thinking Playbook, Michael Lewrick, Wiley, 2019.
4.	Chandra S.S.V, Artificial Intelligence and Machine Learning, Prentice Hall India Learning Private Limited; Standard Edition, ISBN-13 : 978-8120349346.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	2	1	-	-	-	-	1
CO2	3	2	2	2	2	-	1	-	-	-	-	1
CO3	3	2	1	-	2	-	-	-	-	-	-	1
CO4	3	2	1	3	3	-	2	-	-	-	-	1
CO5	2	2	3	3	2	2	2	-	-	-	-	1

Semester: VI		
Mini project (Theory and Practice)		
Course Code: MVJ21MEP67		CIE Marks:50
Credits: L: T:P:S: 0:0:4:0		SEE Marks:50
Hours: 3		SEE Duration:

Course Learning Objectives: The students will be able to	
1	To ensure graduates will be proficient in utilizing the fundamental knowledge of basic sciences, mathematics and Information Technology for the applications relevant to various streams of Engineering and Technology.
2	To enrich graduates with the core competencies necessary for applying knowledge of computers and telecommunications equipment to store, retrieve, transmit, manipulate and analyze data in the context of business enterprise.
3	To enable graduates to think logically, pursue lifelong learning and will have the capacity to understand technical issues related to computing systems and to design optimal solutions.
4	To enable graduates to develop hardware and software systems by understanding the importance of social, business and environmental needs in the human context.
5	To enable graduates to gain employment in organizations and establish themselves as professionals by applying their technical skills to solve real world problems and meet the diversified needs of industry, academia and research.

Sl. No	PHASES FOR PROJECT WORK
1	Introduction and Problem Definition
2	Summary of literature survey
3	Formulation of revised project objectives
4	Proposed Methodology and implementation
5	Results and discussion
6	Project report documentation
7	Oral presentation

Course outcomes:	
CO1	Perform literature review on par with international journal standards
CO2	Identify literature gap and define the problem.
CO3	Design experiments scientifically/perform numerical analysis/develop analytical models and interpret the results and apply advanced tools/techniques for solving the problem.
CO4	Compile the results, discuss the findings and draw the conclusions for the project.
CO5	Prepare quality document of project work.

Reference Books:	
1.	J. P. Holman, "*Experimental Methods For Engineers*", McGraw-Hill Companies, Eighth edition, 2012.
2.	Prasanna Chandra, "*Projects- Appraisal, Preparation, Budgeting and Implementation*", McGraw-Hill Companies, 1987.
Scheme of Examination:	

1.	Relevance of the topic: 10 marks
2.	Report: 20 marks
3.	Evaluation by Guide: 25 marks
4.	Presentation: 30 marks
5.	Viva – Voce: 15 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	2	1	1	1	2	2	2
CO2	2	2	2	2	3	2	1	1	1	2	2	2
CO3	2	2	2	3	3	2	1	1	1	2	2	2
CO4	2	2	2	3	3	2	2	1	1	2	2	2
CO5	2	2	3	3	3	2	2	1	1	2	2	2

High-3, Medium-2, Low-1

Semester: VI		
SUMMER INTERNSHIP-II		
Course Code: MVJ21INT68		CIE Marks:50
Credits: 2		SEE Marks: 50
Hours:		SEE Duration: 3

Course Learning Objectives: The students will be able to	
1	Get an inside view of an industry and organization/company
2	Gain valuable skills and knowledge
3	Make professional connections and enhance student's network
4	Get experience in a field to allow the student to make a career transit
5	To build a record of work experience and construct a good relationship with the employers.

Guidelines
➢ Students have to undergo this training for a period of 6 weeks (minimum) during the vacation between even and odd semesters. ➢ Those students who are unable to complete during these periods will have to undergo the internship after VIII semester and VIII semester grade card will be issued only after the successful completion of internship by that student ➢ The department shall nominate a faculty as a mentor for a group of students to prepare and monitor the progress of the students ➢ The students shall report the progress of the internship to the mentor/guide at regular intervals and may seek his/her advice. ➢ After completion of Internship, students shall submit a report to the department with the approval of both internal and external guides/mentors. ➢ Evaluation of Internship shall be conducted during VIII semester by internal and external examiners for 100 marks. ➢ The external examiner shall be from the industry where the student carried out the internship. In case of non-availability of external examiner, the concerned head of the department shall appoint an external examiner from the nearby college or a senior faculty member from outside the department in consultation with respective BOE and approved by Principal ➢ The internship carries three credits. A student has to get a minimum of 40% marks for a pass. If the student fails to complete the same then internship has to be repeated in its entirely ➢ The breakup of marks for the evaluation of training is as in table.

Evaluation by the supervisor under whom the training was carried out	25 Marks
Evaluation by DSEC	
1. Relevance of the Field training/Industrial Internship	10 Marks
2. Report	25 Marks
3. Evaluation	40 Marks
Total	100
Course outcomes:	

CO1	To experience a 8 weeks' internship training, enabling the student for onsite visits, study projects and practical training.
CO2	To develop a skill for handling multiple situations, practical problems, analyzing teamwork and communication abilities
CO3	To integrate theory with practice and carry out performance objectives on strong work ethics, persistence, adaptability and critical
CO4	To analyze work environment and create solution to problems.
CO5	To build a record of work experience and construct a good relationship with the employers.

Reference Books:	
1	T1. Pamela Myers Kiser, "Human Services Internship: Getting the Most From Your Experience", Cengage Learning, 4th Edition, 2016. (ISBN13: 978-1305087347)

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	2	1	1	1	2	2	2
CO2	2	2	2	2	3	2	1	1	1	2	2	2
CO3	2	2	2	3	3	2	1	1	1	2	2	2
CO4	2	2	2	3	3	2	2	1	1	2	2	2
CO5	2	2	3	3	3	2	2	1	1	2	2	2

High-3, Medium-2, Low-1