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ताळगांव पठार,
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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS -NEP Engg. /2025-26/537 Date: 06.11.2025

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP Engg. /2024-25/767 dated 22.01.2025

In supersession to the above referred Circular, the syllabus of Semester III & IV of the **Master of Engineering (Industrial Engineering)** Programme approved by the Standing Committee of the Academic Council in its meeting held on 24th & 25th July 2025 is attached. The Syllabus of Semester II approved earlier by the Academic Council in its meeting held on 06th December 2024 and the Syllabus of Semester I approved by the Academic Council on 22nd August 2024 is also attached

The Dean, Faculty of Engineering and Principals of affiliated Colleges offering the **Master of Engineering (Industrial Engineering)** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.11.06 17:09:30 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of affiliated Engineering Colleges.

Copy to,

1. The Director, Directorate of Technical Education, Govt. of Goa
2. The Chairperson, BoS in Mechanical Engineering.
3. The Controller of Examinations, Goa University.
4. The Assistant Registrar Examinations (Prof.), Goa University.
5. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

MASTER OF ENGINEERING (INDUSTRIAL ENGINEERING) RC 2024-25

TWO YEAR PROGRAMME STRUCTURE						
Semester I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	MEC-500	Principles of Industrial Engineering & Management	3	1	0	4
2	MEC-501	Quality Engineering	3	0	0	3
3	MEC-502	Quality Engineering Lab	0	0	1	1
4	MEC-503	Optimization Techniques for Industrial Engineering	3	0	0	3
5	MEC-504	Optimization Techniques for Industrial Engineering Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
6	MEC-531	Materials Management	3	1	0	4
OR						
7	MEC-532	Energy Auditing	3	1	0	4
Research Specific Elective (RSE) Courses						
8	REC-561	Engineering Research & Publication	3	1	0	4
OR						
9	REC-562	Literature Review & Technical Writing for Engineers	3	1	0	4
		Total	**15**	**3**	**2**	**20**
Semester II						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	MEC-505	Data Analytics	3	0	0	3
2	MEC-506	Data Analytics Lab	0	0	1	1
3	MEC-507	Reliability Engineering	3	0	0	3
4	MEC-508	Reliability Engineering Lab	0	0	1	1
5	MEC-509	Operations and Project Management	3	0	0	3
6	MEC-510	Operations and Project Management Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
7	MEC-533	Supply Chain Management	3	0	0	3
8	MEC-534	Supply Chain Management Lab	0	0	1	1
OR						
9	MEC-535	Facility Design	3	0	0	3
10	MEC-536	Facility Design Lab	0	0	1	1
Research Specific Elective (RSE) Courses						
11	REC-563	Statistics and Data Analysis for Engineering Research	2	0	0	2
12	REC-564	Statistics and Data Analysis Lab	0	0	2	2
OR						
13	REC-565	Statistical Techniques for Engineering Research	2	0	0	2
14	REC-566	Probability and Statistical Analysis Lab	0	0	2	2
		Total	**14**	**0**	**6**	**20**

Semester III						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	MEC-600	Work System Design	3	0	0	3
2	MEC-601	Work System Design Lab	0	0	1	1
3	MEC-602	Lean Six Sigma	3	0	0	3
4	MEC-603	Lean Six Sigma Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
5	MEC-631	Industrial Safety and Occupational Health	3	0	0	3
6	MEC-632	Industrial Safety and Occupational Health lab	0	0	1	1
OR						
7	MEC-633	Soft Computing	3	0	0	3
8	MEC-634	Soft Computing Lab	0	0	1	1
Research Specific Elective (RSE) Courses						
9	MEC-661	System Modeling and Simulation	2	0	0	2
10	MEC-662	System Modeling and Simulation Lab	0	0	2	2
OR						
11	MEC-663	Advanced Optimization	2	0	0	2
12	MEC-664	Advanced Optimization Lab	0	0	2	2
Generic Elective (GE) Courses						
13	GEC-681	Sustainability Principals & Practices	3	0	0	3
14	GEC-682	Sustainability Principals & Practices Lab	0	0	1	1
OR						
15	GEC-687	Marketing Management	3	0	0	3
16	GEC-688	Marketing Management Lab	0	0	1	1
		Total	**14**	**0**	**6**	**20**
Semester IV						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Generic Elective (GE) Courses						
1	GEC-685	Financial Management	4	0	0	4
OR						
2	GEC-686	Entrepreneurship	4	0	0	4
Programme Specific Dissertation/Internship						
3	**MEC-698**	Dissertation	0	0	16	16
4	**MEC-699**	Internship	0	0	16	16
		Total	**4**	**0**	**16**	**20**

THREE YEAR PROGRAMME STRUCTURE						
Semester I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	MEC-500	Principles of Industrial Engineering & Management	3	1	0	4
Programme Specific Elective (PSE) Courses						
2	MEC-531	Materials Management	3	1	0	4
OR						
3	MEC-532	Energy Auditing	3	1	0	4
Research Specific Elective (RSE) Courses						
4	REC-561	Engineering Research & Publication	3	1	0	4
OR						
5	REC-562	Literature Review & Technical Writing for Engineers	3	1	0	4
		Total	**9**	**3**	**0**	**12**
Semester II						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	MEC-505	Data Analytics	3	0	0	3
2	MEC-506	Data Analytics Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
3	MEC-533	Supply Chain Management	3	0	0	3
4	MEC-534	Supply Chain Management Lab	0	0	1	1
OR						
5	MEC-535	Facility Design	3	0	0	3
6	MEC-536	Facility Design Lab	0	0	1	1
Research Specific Elective (RSE) Courses						
7	REC-563	Statistics and Data Analysis for Engineering Research	2	0	0	2
8	REC-564	Statistics and data Analysis Lab	0	0	2	2
OR						
9	REC-565	Statistical Techniques for Engineering Research	2	0	0	2
10	REC-566	Probability and Statistical Analysis Lab	0	0	2	2
		Total	**8**	**0**	**4**	**12**

Semester III						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	MEC-501	Quality Engineering	3	0	0	3
2	MEC-502	Quality Engineering Lab	0	0	0	1
3	MEC-503	Optimization Techniques for Industrial Engineering	3	0	0	3
4	MEC-504	Optimization Techniques for Industrial Engineering Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
5	MEC-631	Industrial Safety and Occupational Health	3	0	0	3
6	MEC-632	Industrial Safety and Occupational Health lab	0	0	1	1
OR						
7	MEC-633	Soft Computing	3	0	0	3
8	MEC-634	Soft Computing Lab	0	0	1	1
		Total	**9**	**0**	**3**	**12**
Semester IV						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	MEC-507	Reliability Engineering	3	0	0	3
2	MEC-508	Reliability Engineering Lab	0	0	1	1
3	MEC-509	Operations and Project Management	3	0	0	3
4	MEC-510	Operations and Project Management Lab	0	0	1	1
Generic Elective (GE) Courses						
5	GEC-681	Sustainability Principals & Practices	3	0	0	3
6	GEC-682	Sustainability Principals & Practices Lab	0	0	1	1
OR						
7	GEC-687	Marketing Management	3	0	0	3
8	GEC-688	Marketing Management Lab	0	0	1	1
		Total	**9**	**0**	**3**	**12**

Semester V						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	MEC-600	Work System Design	3	0	0	3
2	MEC-601	Work System Design Lab	0	0	1	1
3	MEC-602	Lean Six Sigma	3	0	0	3
4	MEC-603	Lean Six Sigma Lab	0	0	1	1
Research Specific Elective (RSE) Courses						
5	MEC-661	System Modeling and Simulation	2	0	0	2
6	MEC-662	System Modeling and Simulation Lab	0	0	2	2
OR						
7	MEC-663	Advanced Optimization	2	0	0	2
8	MEC-664	Advanced Optimization Lab	0	0	2	2
		Total	**8**	**0**	**4**	**12**
Semester VI						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Generic Elective (GE) Courses						
1	GEC-685	**Financial Management**	4	0	0	4
OR						
2	GEC-686	**Entrepreneurship**	4	0	0	4
Programme Specific Dissertation/Internship						
3	**MEC-698**	**Dissertation**	0	0	0	16
OR						
4	**MEC-699**	**Internship**	0	0	0	16
		Total	**4**	**0**	**0**	**20**

Semester – I

Programme Specific Core (PSC) Courses

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-500
Title of the Course : Principles of Industrial Engineering & Management
Number of Credits : 4
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. The course employs a strategic structure that identifies and illustrates the concepts of industrial engineering in order to help students understand industrial engineering. 2. The course provides insights to the students for implementing productivity improvement procedures at their workplace. 3. The course will help students, in revisiting the management theories being practiced in the industry at their workplace. 4. The course conforms to the immediate requirements of aspirants for post graduate studies in Industrial Engineering and Management Colleges.	
Content:		**No of hours**
Unit - I	Need of optimization of resources. Evolution of industrial Engineering Concept of Production, Types of Production, Concept of Productivity, Types of Productivity, Production vs Productivity, Factors influencing Productivity, Productivity Measures Work Study, Work content, Method Study, Procedure of Method Study, Advantages and Limitations, Work Measurement, Techniques of Work Measurement (Work Sampling, Time Study, PMTS	**12**
Unit - 2	Value Engineering and Value Analysis, Value Engineering Phases, FAST diagram Job Evaluation, Qualitative and Quantitative Methods of Job Evaluation (Ranking by paired comparison, Grade description, Point system, Factor Comparison)	**12**
Unit - 3	Management, Management theories, Manager V/S Leader Organisation, Organisational structure, Span of control, Authority Responsibility and Delegation Leadership, theories of leadership, Leadership styles, Blake Mouton grid, Case studies on Leadership	**12**
Unit - 4	Motivation, Theories of Motivation (Maslow's Theory, Herzberg Theory, McGregor's Theory, Vroom's Expectancy theory) Communication, Communication process model, Barriers, Case	**9**

	studies on Communication
Pedagogy:	Constructivist, Collaborative, Integrative
References/ Readings:	Textbooks 1. Introduction to Work study by ILO, Universal Book Corporation, 3rd edition, 1988 2. Mundel Marvin E., Measuring and enhancing productivity of service and government organization, Asian Productivity Organization, 1975 3. Harold G. Tuffy, Compendium on Value Engineering, The Indo American Society, Bombay, 1983 4. Koontz, Harold and Weihrich Heinz, Essentials of Management, Tata McGraw Hill, New Delhi, 1998 5. Management, Stoner James Freeman, Edward R and Gilbert R Daniel, Prentice Hall, New Delhi, 1999 6. Rasberry R W and Lemoine L F, Kent, Effective Managerial Communication, Publishing Company, 198 7. M. Telsang; Industrial Engineering and Production Management; S. Chand, New Delhi; 2015 References 1. R. M. Barnes; Motion and Time study - Design and Measurement of Work; Wiley and Sons; New York; 1980 2. Mundel Marvin E., Improving productivity and effectiveness, Prentice Hall, NY, 1983 3. A. P. Verma; Industrial Engineering & Management; S. K. Kataria& Sons; 2012. 4. M. Mahajan; Industrial Engineering and Production Management; Dhanpat Rai & Co.; 2014
Course Outcomes:	On completing this course students will be able to: CO 1. Understand the basic concepts of industrial engineering and management CO 2. Apply the productivity improvement techniques learnt in real life situations. CO 3. Analyze case studies on management theories. CO 4. Evaluate improvement potential of existing ways of doing work and propose improved solutions.

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-501
Title of the Course : Quality Engineering
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable students to: 1. Understand quality with relation to statistical process control and acceptance sampling, 2. Apply the knowledge to cases in industrial applications on statistical process control and acceptance sampling. 3. Analyze the metrics in control charts and sampling plans. 4. Evaluate quality in industry-based applications.	
Content:		**No of hours**
Unit - 1	**Introduction:** Basic concepts of Quality: Definitions, philosophy and costs. Total Quality Management, KAIZEN, Quality circles, Quality Function Deployment, Six Sigma, Zero Effect Zero Defect, ISO standards, Preliminary discussions on Design of Experiments and Taguchi Methods. **Quality tools:** Introduction and Case studies: Frequency distribution and Histogram, Run chart, Stem-and-leaf plot, Pareto diagram, Cause and Effect Diagram, Scatter diagram, Check sheet, Control chart.	**12**
Unit - 2	**Variable Control Charts:** Introduction, Statistical basis of the Charts, Development, use and interpretation of Sample Mean, Range Chart and Standard Deviation Chart, Type-I and Type-II errors, Average Run Length (ARL), Average Time to Signal (ATS), Operating-Characteristic (O.C.) Curve, Process Capability studies. **Industrial case-studies:** On defect reduction and process control.	**11**
Unit - 3	**Control Charts for Attributes:** Introduction, Control charts for non-conforming items (p-chart, np-chart)- Statistical Basis, Development and Operation, Fixed sample size and Variable sample size, Type I and II errors, O.C. curve and ARL. Control charts for nonconformities (c-chart, u-chart)- Statistical Basis, Development and Operation, Fixed sample size and Variable sample size, Type I and II errors, O. C. curve and ARL. Industrial case-studies on process control.	**11**
Unit - 4	**Acceptance Sampling by Attributes:** Introduction, Advantages and Disadvantages of sampling, single, double and multiple sampling plans - Calculation of probability of acceptance, O. C. curve concept; Military Standard System- Concept and use, Designing single, double and multiple sampling plans; Dodge-Romig system- Concept and use, Designing single and double sampling plans; Sequential Sampling Plan- design and application. Industrial case-studies on setting up and use of above sampling	**11**

	plans.	
Pedagogy:	Constructivist, Integrative, Reflective and Enquiry based	
References/ Readings:	Text Books 1. A. Mitra; Fundamentals of Quality Control and Improvement; Third Edition; Wiley India; 2008. 2. D. C. Montgomery; Statistical Quality Control: A Modern Introduction; Sixth Edition, Wiley India; 2009. Reference Books 1. E. L. Grant, R. S. Leavenworth; Statistical Quality Control; Seventh Edition; McGraw Hill India; 2000. 2. R. K. Jain, H. M. Trivedi; Quality Management for Zero Defect and Zero Effect: A Compendium of Case Studies and Best Practices; American Society for Quality India; 2016.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the concepts of quality, statistical process control, acceptance sampling, CO 2. Apply the knowledge gained from statistical process control, acceptance sampling, CO 3. Analyze quality tools, control charts, sampling plans CO 4. Evaluate quality tools, performance of control charts and sampling plans.	

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-502
Title of the Course : Quality Engineering Lab
Number of Credits : 1
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable students to: 1. Understand quality tools, control charts and acceptance sampling plan and the methodology of solving using software. 2. Apply the knowledge of quality tools, control charts and acceptance sampling on industrial cases as well as software-based solutions. 3. Interpret the solutions obtained by using quality tools, control charts and acceptance sampling. 4. Recommend course of action based on the output obtained from the use of quality tools, control charts and acceptance sampling.	
Content:		**No of hours**
Unit - 1	1. Assignment on Quality tools, 2. Using software like MS Excel, MINITAB etc., solve industrial problem involving the following: A. Pareto Chart B. Cause and Effect Diagram C. Histogram	**8**
Unit - 2	1. Assignment on Variable Control Charts 2. Using software like MS Excel, MINITAB etc., solve industrial case solve industrial problem on Variable Control Charts.	**8**
Unit - 3	1. Assignment on Attribute Control Chart 2. Using software like MS Excel, MINITAB etc., solve industrial case solve industrial problem on Attribute Control Chart.	**8**
Unit - 4	1. Assignment on Acceptance Sampling Plan. 2. Using software like MS Excel, MINITAB etc., solve industrial case solve industrial problem on Acceptance Sampling Plan.	**6**
Pedagogy:	Constructivist, Integrative, Reflective and Enquiry based	
References/ Readings:	Text Books 1. C. Montgomery; Statistical Quality Control: A Modern Introduction; Sixth Edition, Wiley India; 2009. 2. A. Mitra; Fundamentals of Quality Control and Improvement; Third Edition; Wiley India; 2008.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand quality tools, control charts and acceptance sampling plan. CO 2. Apply the knowledge to cases in industrial applications on quality tools, control charts and acceptance sampling. CO 3. Analyze the metrics/output of quality tools, control charts and acceptance sampling. CO 4. Evaluate quality tools, control charts and acceptance sampling.	

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-503
Title of the Course : Optimisation Techniques for Industrial Engineering
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course	Basics mathematical concepts	
Course Objectives:	The course will enable students to: 1. To analyze real-life decision-making situations and develop the art of converting these situations into mathematical models 2. To understand the working principles of techniques to solve LPP models and solve differently styled LP problems 3. To study standard network analysis problems and apply solution techniques. 4. To solve problems wherein the dynamic decisions are made in stages and consolidated to arrive at final decision 5. To understand the concept of queuing theory and solve real life queuing problems	
Content		**No of hours**
Unit - 1	**Introduction:** Management and decision making, historical development of operations research, models and principles of modeling, techniques in operations research. **Linear Programming:** Introduction, Formulation of linear programming problems (LPP), Assumptions and guidelines in formulation of LPPs. **Techniques to solve LPP:** Graphical method, Analysis of special cases through graphical method. Simplex method, Big-M method, Analysis of special cases through simplex method	**10**
Unit - 2	**Modified Simplex method:** Working principle, advantages. **Transportation model:** Introduction, Formulation, Transportation algorithm – finding initial basic feasible solution using Northwest corner rule, Least cost cell and Vogel's approximation method. Optimizing a transportation model.	**11**
Unit - 3	**Assignment model:** Introduction, Formulation, Hungarian algorithm **Network Analysis:** Introduction, scope, definitions, Minimal spanning tree problem, Maximal-flow problems. **Game Theory:** Introduction, Two-person zero-sum game, saddle point, pure and mixed strategy, dominance rule.	**12**
Unit - 4	**Dynamic Programming:** Introduction, characteristics of dynamic programming, dynamic programming approach to Capital allocation problem, Knap Sack and Travelling Salesman problem. **Queuing Theory:** Introduction, general structure and performance measures of queuing system, cost analysis, Markovian Poisson-exponential	**12**

	single server infinite population model.	
Pedagogy:	Inquiry-Based Learning, Reflective, Integrative Learning	
References/ Readings:	Text Books 1. R. Paneerselvam; Operations Research; Prentice Hall of India Private Ltd.; 2e; 2016 2. P. K. Gupta, D. S. Hira; Operations Research; S Chand; 5e; 2015 3. Ravindran, D. Philips, J. J. Solberg; Operations Research: Principles and Practice; John Wiley & Sons Inc.; 2e; 2012 4. N. D. Vohra; Quantitative Techniques in Management; Tata McGraw-Hill Publishing Co. Ltd.; 5e; 2017 Reference Books 1. S. D. Sharma; Operations Research: Theory; Methods and Applications; Kedar Nath; 2014 2. J. K. Sharma; Operations Research; Laxmi Publications; 4e; 2012 3. S. R. Yadav, A. K. Malik; Operations Research; Oxford University Press; 1e; 2014 4. H. A. Taha; Operations Research: An Introduction; Pearson Education, Inc.; 9e; 2014 5. F. S. Hillier, G. J. Lieberman; Introduction to Operations Research; Tata McGraw Hill; 8e; 2005	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the applied concept of real life models, problem formulations and tools to solve various linear programming models CO 2. Apply the appropriate technique to solve any given real-life linear programming model CO 3. Analyze the formulation strategies of linear programming models and the complexity of solution procedures to solve linear programming problems CO 4. Evaluate the performance of various solution techniques used to solve the linear programming problems	

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-504
Title of the Course : Optimisation Techniques for Industrial Engineering Lab
Number of Credits : 1
Effective from AY : 2024-25

Pre-requisites for the Course	Basics knowledge of using Microsoft Excel/VBA/ MATLAB or any other mathematical software	
Course Objectives:	The course will enable students to use software: 1. To solve linear programming problems using simplex or modified simplex method and perform sensitivity analysis 2. To solve a transportation and assignment model 3. To solve problems wherein the dynamic decisions are made in stages and consolidated to arrive at final decision 4. To solve game theory and queuing theory problems	
Content		**No. of Hours**
List of Experiments	Perform any 5 experiments from the list given below using Microsoft Excel/VBA/ / MATLAB or any other relevant mathematical software: 1. Solve linear programming problem using simplex or modified simplex method 2. Perform sensitivity analysis to understand the effect of changes in the input data on the optimal solution 3. Solve the transportation model using northwest corner rule to find a feasible solution 4. Solve the transportation model using Least cost rule to find a feasible solution 5. Solve the transportation model using Vogel's approximation method to find a feasible solution 6. Solve the assignment model using Hungarian algorithm 7. Solve a mixed strategy game theory problem using dominance rule 8. Use dynamic programming approach to solve the capital allocation model 9. Use dynamic programming approach to solve the knap sack model 10. Analyse the output of a M/M/1/∞ queuing model	**30**
Pedagogy:	Constructivist, Integrative, Reflective and Enquiry based	
References/ Readings:	Text Books 1. Ken Bluttman, Microsoft Excel Formulas and Functions for dummies, 5th edition, Wiley, 2020 2. Manisha Nigam, Data Analysis with Excel, 1st edition, Bpb, 2019 3. Rudra Pratap, Getting Started with MATLAB, 7th edition, Oxford University Press, 2019 4. R. Paneerselvam; Operations Research; Prentice Hall of India Private Ltd.; 2e; 2016	

	5. P. K. Gupta, D. S. Hira; Operations Research; S Chand; 5e; 2015 6. N. D. Vohra; Quantitative Techniques in Management; Tata McGraw-Hill Publishing Co. Ltd.; 5e; 2017 Reference Books 1. Mike Mcgrath, Excel VBA in easy steps, 4th edition, Bpb, 2017 2. Amos Gilet, MATLAB: An introduction with Applications, 4th edition, Wiley, 2012 3. S. D. Sharma; Operations Research: Theory; Methods and Applications; Kedar Nath; 2014 4. J. K. Sharma; Operations Research; Laxmi Publications; 4e; 2012 5. H. A. Taha; Operations Research: An Introduction; Pearson Education, Inc.; 9e; 2014 6. F. S. Hillier, G. J. Lieberman; Introduction to Operations Research; Tata McGraw Hill; 8e; 2005
Course Outcomes:	After going through this course, the students will be able to perform software-based analysis to: CO 1. Understand the applied concept of real life models, problem formulations and tools to solve various linear programming models CO 2. Apply the appropriate technique to solve any given real-life linear programming model CO 3. Analyze the formulation strategies of linear programming models and the complexity of solution procedures to solve linear programming problems CO 4. Evaluate the performance of various solution techniques used to solve the linear programming problems

(Back to Index)

Programme Specific Elective (PSE) Courses
Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-531
Title of the Course : Materials Management
Number of Credits : 4
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable students to: 1. Understand the fundamental aspects of basics of materials management 2. Illustrate competency in analysis for material planning 3. Apply inventory management models 4. Develop Skills for purchasing practices and storage in warehouse	
Content:		**No of hours**
Unit - 1	**Introduction**: Operating environment-aggregate planning-role, need, strategies, costs techniques, approaches-master scheduling-manufacturing planning and control system-manufacturing resource planning enterprise resource planning-making the production plan **Materials Planning** Materials requirements planning-bill of materials-resource requirement planning manufacturing resource planning-capacity management-scheduling orders-production activity control-codification.	**13**
Unit - 2	**Inventory Management** Policy Decisions–objectives-control -Retail Discounting Model, Newsvendor Model; EOQ and EBQ models for uniform and variable demand With and without shortages –Quantity discount models. Probabilistic inventory model	**11**
Unit - 3	**Purchasing Management** Establishing specifications-selecting suppliers-price determination-forward buying-mixed buying strategy-price forecasting-buying seasonal commodities-purchasing under uncertainty-demand management-price forecasting-purchasing under uncertainty-purchasing of capital equipment-international purchasing	**11**
Unit - 4	**Warehouse Management** Warehousing functions – types - Stores management-stores systems and procedures-incoming materials control-stores accounting and stock verification-Obsolete, surplus and scrap-value analysis-material handling-transportation and traffic management –operational efficiency-productivity-cost	**11**

	effectiveness-performance measurement	
Pedagogy:	Constructivist, Integrative, Reflective and Enquiry based	
References/ Readings:	Text Books 1. J.R.Tony Arnold, Stephen N. Chapman, Lloyd M. Clive, Materials Management, Pearson, 2012. 2. P. Gopalakrishnan, Purchasing and Materials Management, Tata McGraw Hill, 2012 Reference Books 1. A.K.Chitale and R.C.Gupta, Materials Management, Text and Cases, PHI Learning, 2nd Edition, 2006 2. A.K.Datla, Materials Management, Procedure, Text and Cases, PHI Learning, 2nd Edition, 2006	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the fundamental aspects of basics of materials management CO 2. Analyse requirement of analysis for material planning CO 3. Apply inventory management models. CO 4. Create Skills for purchasing practices and storage in warehouse.	

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-532
Title of the Course : Energy Auditing
Number of Credits : 4
Effective from AY : 2024-25

Pre-requisites for the Course:	**Nil**	
Course Objectives:	The course will enable students to: 1. Understand the fundamental concepts of Energy Management & Auditing 2. Illustrate competency in different methods of Energy Auditing for Energy Conservation. 3. Apply expertise in Energy Auditing for Thermal and Electrical Utilities. 4. Develop analytical and Technical skills for Energy Auditing	
Content:	**Basics of Thermodynamics and Electrical Engineering**	**No of hours**
Unit - 1	**Introduction**: Energy and environment, need for renewable and energy efficiency, need and importance of energy conservation and management Energy consumption patterns and energy conservation opportunities in Indian industry, agricultural, commercial, and residential sectors. **Energy Auditing** – methodology, analysis and reporting. Portable and online instruments used for energy auditing.	**11**
Unit - 2	**Costing of utilities**: Determination of cost of steam, compress air and electricity. Methods of financial analysis: 1) Simple payback period 2) Time value of money (future value, net present value) 3) Return on investment (ROI) 4) Internal rate of return (IRR) **Cogeneration**: Definition, Need, Application, Advantages, Classification, Saving potentials.	**11**
Unit - 3	**Energy Conservation in Thermal Utilities:** Energy conservation in refrigeration and air conditioning system, compressed air system. Energy conservation in steam generation and supply system. Boiler performance, Boiler efficiency Waste Heat Recovery: Classification, Advantages and application, commercially viable waste heat recovery devices, saving potential.	**12**
Unit - 4	**Insulation**: Materials of insulations form of insulations, desirable properties of insulations, and economic thickness of insulations. Refractories. **Electrical system**: energy conservation in motors, energy efficient motors, power factor improvement, variable speed drive. Lighting: Illumination levels, Fixtures, timers, energy-efficient illumination.	**11**

Pedagogy:	Constructivist, Integrative, Reflective and Enquiry based
References/ Readings:	Text Books 1. Energy conservation – related booklets published by National Productivity Council (NPC), New Delhi. 2. Petroleum Conservation Research Association (PCRA), New Delhi. Reference Books 1. IGC Dryden, editor: The efficient use of energy (Bitterworths) 2. W.S. Turner, Editor: Energy Management Handbook (Wiley) 3. Patrick Steven R., Patrick Dale R., Fordo Stephen: Energy conservation Guide Book, The Fairmont Press Inc.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the fundamental aspects of Energy Management. CO 2. Apply the concepts of Energy Auditing, Energy Conservation and Waste heat recovery CO 3. Analyse proficiency in Energy Auditing. CO 4. Create Analytical and Technical Skills for Energy Auditing.

(Back to Index)

Research Specific Elective (RSE) Courses

Name of the Programme : For All Master of Engineering Programmes
Course Code : REC-561
Title of the Course : Engineering Research & Publication
Number of Credits : 4
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review, defining the research objectives. 2. Explain qualitative and quantitative methods of data analyses and its importance. 3. Classify research publications, select appropriate journals based on research areas. 4. Practice ethics in publication and academic integrity	
Content:		**No of Hours**
Unit -1	**Overview of scientific research in engineering**, foundational and fundamental concepts like types of research and considerations for research in specific domains, motivation to do research, critical thinking, assumptions and hypotheses, basic and applied research, importance of formulation of broad research objectives	**11+4T**
Unit -2	**Purpose and Methodology of Literature Search and Review** of the scientific and engineering publications. Sources such as scholarly databases, public domain, open access, current literature, review articles, critical review and gap analysis, defining research objectives	**11+4T**
Unit -3	**Quantitative and qualitative Data –** importance of data in research, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**12+4T**
Unit- 4	**Preparation of Publications-** Elements of research publications, types of publications, writing for journal publications, basic requirements for publication, selection of journals, journal quality indicators, peer review, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity	**11+3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning , Constructive learning and Collaborative learning	
References/ Readings:	1. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 2. Michael Jay Katz, 'From Research to Manuscript', Springer Publication, 2009, ISBN:9781402094668.	

	3. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work', Springer Publications, 2022, ISBN:9783030900243 4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of literature review, defining the research objectives. CO 2. Explain qualitative and quantitative methods of data analyses and its importance. CO 3. Classify research publications, select appropriate journals based on research areas. CO 4. Practice ethics in publication and academic integrity

(Back to Index)

Name of the Programme : For All Master of Engineering Programmes
Course Code : REC-562
Title of the Course : Literature Review & Technical Writing for Engineers
Number of Credits : 4
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review and writing a review paper. 2. Explain the method to be followed to write a review paper. 3. Classify data for qualitative and quantitative analysis 4. Demonstrate technical writing for conference.	
Content:		**No of Hours**
Unit -1	**Overview on Literature Review**, difference between objectives of literature review and research objectives; types of literature review, qualitative and quantitative reviews, search strategies, primary and secondary sources, database search strategies, field search, root search, complimentary search, meta-analysis	**12+4T**
Unit -2	**Database management of literature reviews**, bibliometric analysis, importance of writing a review paper, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity; public domain, open access, current literature.	**11+4T**
Unit -3	**Technical writing on a specific research topic**, structure of the paper, abstract, introduction, experimental, simulation, analysis, discussion, inferences, title, acknowledgment, referencing, presentation of tables, figures, graphs, equations; comparison between technical writing for conference papers and journal paper	**11+4T**
Unit- 4	**Importance of data in research**, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**11+3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work – Multidisciplinary Guide to Systematic Approaches', Springer Publications, 2022, ISBN:9783030900243. 2. Michael Jay Katz, 'From Research to Manuscript', Springer Publication, 2009, ISBN:9781402094668. 3. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for Science and Engineering', Taylor & Francis Publications, 2022,	

	ISBN:9781003139058.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of literature review and writing a review paper. CO 2. Explain the method to be followed to write a review paper. CO 3. Classify data for qualitative and quantitative analysis CO 4. Demonstrate technical writing for conference.

(Back to Index)

Semester – II
Programme Specific Core (PSC) Courses
Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-505
Title of the Course : Data Analytics
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course:	Basics probability concepts	
Course Objectives	**The course will enable students to:** 1. To understand the pattern of randomness found in real life situations 2. To study widely used discrete and continuous distribution along with their applications. 3. To estimate the unknown parameters of the population and implement hypothesis testing 4. To understand advanced statistical analysis through goodness of fit and regression	
Content		**No of hours**
Unit - 1	**Random Variable:** Introduction, Discrete and Continuous random variables, Characteristics-Mean, Variance and Distribution function, Moment-Generating function. Applications and numericals. **Function of One Dimensional Random Variable:** Discrete and continuous case, E and V-operators. Applications and numericals.	**10**
Unit - 2	**Discrete Probability distributions:** Bernoulli trial, Binomial, Geometric, Pascal and Poisson distribution. Mean, Variance, Distribution function. Important properties. Applications and numericals. No derivations. **Continuous Probability distributions:** Uniform, Exponential and Normal distribution. Mean, Variance, Distribution function. Important properties. Applications and numericals. No derivations.	**11**
Unit - 3	**Statistic and Sampling Distributions:** Population and the Sample, Statistic, Sampling distributions- Normal, Student's t-distribution, Chi-square and F distribution. No derivations. **Parameter Estimation: Point Estimation**: Concept, unbiased estimator, standard error, method of maximum likelihood. Point estimation of standard distributions- Bernoulli, Binomial, Geometric, Exponential and Normal. Derivations, applications and numericals. **Parameter Estimation: Confidence Interval Estimation:** Concept, Confidence interval on mean and difference in means of single and two normal population, variance known and unknown. Applications and numericals.	**12**

Unit - 4	**Tests of Hypotheses:** Introduction, Type I and type II errors, significance level and power of the test. Hypothesis testing on mean and difference in means of single and two normal population, variance known and unknown. Applications and numericals. **Goodness of Fit Test:** Chi-square test- Introduction, concept, algorithm for testing of standard distributions- binomial, geometric, Poisson, uniform and exponential distributions, P-value. Test for Independence. Applications and numericals. **Simple Linear Regression:** Simple Linear Regression Concept, development of regression model, data plots, residual-computation. Applications and numericals.	**12**
Pedagogy:	Classroom Teaching, Inquiry-Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. D. C. Montgomery, C. G. Runger, Applied Statistics and Probability for Engineers, 6th Edition, n Wiley India, 2016 2. Sheldon Ross, Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press, 2014 3. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists,9th Edition, Pearson Education India, 2013 **Reference Books** 1. R. A. Johnson, Probability and Statistics for Engineers, 8e, Prentice Hall of India, 2011. 2. T. Veerarajan; Probability, Statistics and Random Processes, 3e, Tata McGraw Hill India; 2017 3. A. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the concepts of randomness, probability distributions, inferential statistics and curve fitting techniques CO 2. Analyse the characteristics of random variables, standard probability distributions, inferential statistics and curve fitting techniques CO 3. Compute the probabilities associated with random variable, probability distributions, parameters estimation and curve fitting techniques CO 4. Evaluate the behaviour of randomness for the probability distributions parameters estimation and curve fitting techniques	

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC- 506
Title of the Course : Data Analytics Lab
Number of Credits : 1
Effective from AY : 2024-25

Pre-requisites for the Course:	Basics knowledge of using Microsoft Excel/VBA/SPSS/ MATLAB or any other statistical software	
Course Objectives:	The course will enable students to: 1. To perform statistical analysis of randomness and evaluate the probabilities of standard discrete and continuous random variables 2. To estimate the unknown parameters of the population 3. To perform hypothesis test, goodness of fit test and test for independence 4. To perform linear regression analysis	
Content		**No of hours**
List of Experiments	Perform any six experiments from the list given below using Microsoft Excel/VBA/SPSS/ MATLAB or any other statistical software: 1. Understand the randomness of the different random variables graphically and analyse its characteristics 2. Evaluate the probabilities of standard discrete distributions 3. Evaluate the probabilities of standard continuous distribution 4. Calculate the point estimates of standard discrete distribution and continuous distributions 5. Calculate confidence interval on mean and difference in means of single and two normal population, variance known and unknown 6. Perform hypothesis testing on mean and difference in means of single and two normal populations, variance known and unknown 7. Perform goodness of fit test for standard discrete and continuous distributions 8. Perform test for independence of the given data 9. Perform simple linear regression analysis and compute the residuals	**30**
Pedagogy:	Software-based Learning	
References/ Readings:	**Text Books** 1. Lavine David M., Statistics for Managers, using Microsoft Excel, 8th edition, Pearson Education, 2017 2. Manisha Nigam, Data Analysis with Excel, 1st edition, Bpb, 2019 3. Rudra Pratap, Getting Started with MATLAB, 7th edition, Oxford University Press, 2019 4. D. C. Montgomery, C. G. Runger, Applied Statistics and Probability for Engineers, 6th Edition, n Wiley India, 2016 **Reference Books**	

	1. Ken Bluttman, Microsoft Excel Formulas and Functions for dummies, 5th edition, Wiley, 2020 2. Joseph Schmuller, Statistical Analysis with Excel for Dummies, 4th edition, Wiley, 2020 3. Mike Mcgrath, Excel VBA in easy steps, 4th edition, Bpb, 2017 4. R. A. Johnson, Probability and Statistics for Engineers, 8e, Prentice Hall of India, 2011. 5. T. Veerarajan; Probability, Statistics and Random Processes, 3e, Tata McGraw Hill India; 2017 6. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010
Course Outcomes:	CO 1. Understand the concepts of randomness, probability distributions, inferential statistics and curve fitting techniques CO 2. Analyse the characteristics of random variables, standard probability distributions, inferential statistics and curve fitting techniques CO 3. Compute the probabilities associated with random variable, probability distributions, parameters estimation and curve fitting techniques CO 4. Evaluate the behaviour of randomness for the probability distributions parameters estimation and curve fitting techniques

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-507
Title of the Course : Reliability Engineering
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of mathematics	
Course Objectives:	The course will enable students to: 1. learn reliability engineering and Life Testing concepts. 2. use reliability engineering and life testing knowledge to apply on different industrial cases. 3. perform reliability analysis on components/systems along with working with life testing models. 4. evaluate the product/system reliability and life testing model.	
Content:		**No of hours**
Unit - 1	**Reliability Engineering:** Need for Reliability, definition of reliability and its various measures, reliability analysis- Exponential, Normal, Lognormal and Weibull distribution. Derivation restricted only to only reliability and hazard function.	**12**
Unit - 2	**System Reliability:** Series, Parallel and Combined Series-Parallel systems, Complex systems, Three-State Devices. **Reliability Allocation:** Equal Apportionment technique, ARINC Apportionment technique, AGREE Allocation method	**12**
Unit - 3	**Probability Plotting:** Exponential, Normal, Lognormal and Weibull. **Fault Tree Analysis and Failure Mode Effect Analysis:** Concepts and applications.	**12**
Unit - 4	**Life Testing:** Life tests with censoring and without censoring, tests with and without replacement, burn-in testing, environmental test, temperature tests, humidity tests. Mechanical shock tests. **Accelerated Life Testing:** Concepts, Methods for ALT data quantification, Temperature stress and failure rates, Erying model power model/stress scale model. **Highly Accelerated Life Testing:** Advantages, goal and plan.	**12**
Pedagogy:	Constructivist, Integrative, Reflective and Enquiry based	
References/ Readings:	**Text Books** 1. E. Ebeling; An Introduction to Reliability and Maintainability Engineering; Tata McGraw Hill; 2000. 2. K. C. Kapur, L. R. Lamberson; Reliability in Engineering Design; Wiley India; 1997. 3. V. N. A. Naikan, Reliability Engineering and Life Testing, PHI Learning Pvt. Ltd., 2009 **Reference Books** 1. S. S. Rao; Reliability Engineering, Pearson Education; 2016 2. E. A. Elsayed; Reliability Engineering, Wiley; 2021	
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Understand the concepts of Reliability Engineering and Life Testing.	

	CO 2. Apply the knowledge gained to reliability engineering and life testing on different industrial cases. CO 3. Analyze reliability measures and life testing models. CO 4. Evaluate the product/system reliability, life testing model.

(Back to Index)

Name of the Programme : **Master of Engineering (Industrial Engineering)**
Course Code : **MEC- 508**
Title of the Course : **Reliability Engineering Lab**
Number of Credits : **1**
Effective from AY : **2024-25**

Pre-requisites for the Course	Knowledge of MS-EXCEL	
Course Objectives:	The course will enable students to: 1. Perform probability plotting. 2. Determine probability distribution of failure times. 3. Compute reliability for failure distributions. 4. Perform FMEA 5. Estimate life using Accelerated life testing	
Content:		**No of hours**
Practical	Perform the following experiments using standard software like MS-EXCEL, MINITAB, ISOGRAPH, etc 1. Probability plotting for data having Exponential, Normal, Lognormal and Weibull distribution. 2. Determination of Statistical Distribution of failure times. 3. Reliability computation for Exponential, Normal, Lognormal and Weibull distribution. 4. Failure Mode Effect Analysis 5. Accelerated Life Testing	**30**
Pedagogy:	Constructivist, Integrative, Reflective and Enquiry based	
References/ Readings:	**Text Books** 1. K. S. Stephens ; Reliability Data Analysis with Excel and Minitab; ASQ Press; 2011. 2. K. K. Pochampally, S. M. Gupta, Reliability Analysis with Minitab, CRC Press, 2016. **Reference Books** 1. C. E. Ebeling; An Introduction to Reliability and Maintainability Engineering; Tata McGraw Hill; 2000. 2. S. S. Rao; Reliability Engineering, Pearson Education; 2016	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the basic functions available in standard software like MS-EXCEL, MINITAB, ISOGRAPH, etc CO 2. Apply the programming function on failure times. CO 3. Analyze the failure time distributions, FMEA and ALT using standard software. CO 4. Evaluate the failure time distributions, FMEA and ALT using standard software.	

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-509
Title of the Course : Operations and Project Management
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course	Knowledge of MS-EXCEL	
Course Objectives:	The course will enable students to: 1. Comprehend the important concepts of operations and project management 2. Demonstrate the use of techniques of operations and project management for effective planning and control of projects and operations 3. Investigate real life situations using techniques in operations and project management. 4. Evaluate situations to provide solutions to industrial problems related to operations and project management.	
Content:		**No of hours**
Unit - 1	**Concepts of operations planning and control:** Concept in Operation Planning and concepts for various operational system in manufacturing and service sectors. **Demand forecasting:** Need and importance of Forecasting, Input-Output of forecasting Model, Techniques: Delphi Method, Simple and Moving average, Exponential Smoothing, Correlation and Regression Analysis, Minimizing forecasting errors - MAD, Tracking Signal. **Facility Location**: Concept and quantitative methods in Plant Location and Layout-Nature of location decision, situations that influence location decision, Location of facilities for service businesses, Location models - Factor rating method, Weighted factor rating method, Centre of gravity method, Break-even analysis.	**12**
Unit - 2	**Plant Layout**- Layout and its objectives, Types of plant layout-Product layout, process layout, fixed position layout, cellular manufacturing layouts, and Hybrid layouts. **Assembly line balancing and Material Handling:** -Concept and importance -Objectives -Techniques	**11**
Unit - 3	**Sequencing and Scheduling** -Scheduling operations - Scheduling in low volume systems -Sequencing Concept -Single, Two and Three processor system **Inventory control:**	**11**

	-Dependent and independent demand -Need for inventory control -Methods of inventory analysis - EOQ models for purchasing and manufacturing situation without shortages.	
Unit - 4	**Project management:** -Use of network techniques in Project management. -Concepts in project management - CPM, PERT - -Slack and Float -Crashing -Gantt Charts -Use of computers in project planning and monitoring	**11**
Pedagogy:	Inquiry-Based, Reflective, Integrative, collaborative Learning	
References/ Readings:	**REFERENCE TEXT BOOKS:** 1. Schaum's Outline of Operations Management Joseph Monks, McGraw Hill,1996 2. Operations Management, Roger G. Schroder, International Students Edition, McGraw Hill, 3rd edition, 2009 3. The Management of Operations, Jack P. Meredith, John Wiley and Sons, 5th edition. 4. Production and Operations Management, S. N. Chary, Tata McGraw Hill, 5th edition, 2012 5. Supply Chain Management, Chopra Sunil and Peter Meindl, Pearson Education Inc., 5th edition, 2012 6. Operations Management, William J. Stevenson, McGraw-Hill, 2010 7. Production and Operations management, R. Pannerselvam, Prentice Hall of India, 3rd edition, 2012	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the objectives and techniques of operations and project management CO 2. Apply techniques of operations and project management for effective management of operations CO 3. Analyze situations using qualitative and quantitative techniques in operations and project management. CO 4. Evaluate situations to provide solutions to industrial problems.	

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-510
Title of the Course : Operations and Project Management Lab
Number of Credits : 1
Effective from AY : 2024-25

Pre-requisites for the Course	Knowledge of MS-EXCEL	
Course Objectives:	The course will enable students to: 1. Develop problem-solving and group-working skills, and to gain a deep understanding of operations management. 2. Identify the various dimensions of production planning and control and their inter- linkages with forecasting. 3. Explain the use of techniques of operations and project management for effective planning and control of projects and operations 4. Analysis real life situations using techniques in operations and project management.	
Contents:		**No of hours**
	1. Introduction to the Operation and Project Management Laboratory session: Discussion on operations management in a broader context, and present the issues of competition, strategy and productivity. 2. Industrial case study that outlines (both internal and External) reasons for demise, and whether operations management played a significant role in the demise. 3. Using the Excel template demonstrate the forecasting quantitative techniques used in the industry. 4. Study any type of Store and identify an area of the store that has the characteristics of each of these processing types: job shop, batch, repetitive and continuous. 5. Developing Project Activities through AI [ChatGPT] 6. Produce a Gantt chart, using established tools and techniques, to Schedule the completion of all work elements.	**30**
Pedagogy:	Inquiry-Based, Reflective, Integrative, collaborative Learning	
References/ Readings:	**REFERENCE TEXT BOOKS:** 1. Schaum's Outline of Operations Management Joseph Monks, McGraw Hill,1996 2. Operations Management, Roger G. Schroder, International Students Edition, McGraw Hill, 3rd edition, 2009 3. The Management of Operations, Jack P. Meredith, John Wiley and Sons, 5th edition.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Identify the objectives and techniques of operations and project management CO 2. Apply techniques of operations and project management for	

	effective management of operations CO 3. Analyze situations using qualitative and quantitative techniques in operations and project management. CO 4. Evaluate situations to provide solutions to industrial problems.

(Back to Index)

Programme Specific Elective (PSE) Courses
Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-533
Title of the Course : Supply Chain Management
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course	Basic knowledge of materials Management	
Course Objectives:	1. The course employs a strategic structure that identifies and illustrates facilities, inventory, transportation, and information as the key drivers of supply chain performance in order to help students understand what creates a competitive advantage. 2. The course provides guidelines for the students for implementing SCM initiatives to learn basically the "why, what and how" of supply chain management. 3. The course will help students, in revisiting the management policies being practiced in the industry. 4. The course conforms to the immediate requirements of aspirants for post graduate studies in Industrial Engineering, Mechanical Engineering and Management Colleges.	
Content:		**No of hours**
Unit – 1	History, Product Life Cycle, Manufacturing and Service Supply Chains, Flow of Material Information and Funds, Push & Pull System, Mass Production, Mass Customization, Customization, Localization, Responsive & Efficient Supply Chain, Zone of Strategic Fit, Supply Chain Surplus Predictable Variability, Managing Supply & Demand in predictable variability situation, Forward Buying Quantitative and qualitative Supply chain performance measures	**12**
Unit – 2	Types of facilities, Role of Network Design in Supply Chain, Factors influencing network design decisions, Framework for Facility Location Decisions, Gravity Location Model Basic EOQ Model, Quantity Discounts (All unit), Cycle Service Level, Safety Inventory, Evaluating Safety inventory in Demand uncertainty, Evaluating safety inventory in Supply uncertainty, Impact of aggregation on safety Inventory, Bullwhip Effect, Vendor Managed Inventory	**12**
Unit – 3	Key Players in Transportation, Modes of Transportation, Design Options, Transportation- Inventory Trade-off, Transportation-Responsiveness Trade-off, Savings Matrix Method, Vehicle Routing by Sweep, Nearest Neighbour, Nearest Insert, Farthest Insert Role of Distribution in Supply Chain, Factors Influencing Distribution Network Design, Design Options for a Distribution Network.	**12**

	Role of Information Technology in Supply Chain, Typical IT Solutions, EBusiness, B2B, B2C, Logistics, Reverse Logistics, 3PL, 4PL.	
Unit – 4	Supplier Relationship Management Strategy, Critical Dimension of Relationship, Typology of Relationship, Relationship Path, Relationship Matrix. Customer Relationship Management Strategy, Elements of Strategic Supply Chain Environmental, Social and Governance (ESG) in Supply Chain	**9**
Pedagogy:	Constructivist, Integrative, Reflective and Enquiry based	
References/ Readings:	**TEXTBOOKS** 1. S. Chopra, P. Meindl, D. V. Kalra; Supply Chain Management – Strategy; Planning and Operation; Pearson Education; 6e; 2016 2. R. P. Mohanty, S. G. Deshmukh; Supply chain Management - Theories and Practices; Biztantra; 2005 3. J. Shah; Supply Chain Management Text and Cases; Pearson Education; 2009 **REFERENCES** 1. G. Raghuram, N. Rangaraj; Logistics and Supply Chain Management: Cases and Concepts; Macmillan India Ltd; New Delhi; 2000 2. K. S. Bhat; Logistics Management; Himalaya Publishing house; 2009 3. T. D. Chaudhuri, I. Ghosh; Application of Multi Criteria Decision Making in Management; Lambert Academy publishing; 2015 4. Rear Admiral Sanjay Roye, Decoding ESG - A Comprehensive Guide to Environmental, Social and Governance Principles, Whitehouse publishing, 1st Edition, 2024 5. Vipul Arora, Essence of ESG, Pendown press, 1st Edition, 2024	
Course Outcomes:	On completing this course students will be able to: CO 1. Understand the basic concepts and role of drivers, customer & supplier relationships and performance measures associated with supply chain CO 2. Apply the supply chain and network design concepts in real life situations. CO 3. Analyze case studies on supplier selection, various business models and tourism business in Goa CO 4. Evaluate economics of scale and cost trade-offs pertaining to drivers of supply chain.	

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-534
Title of the Course : Supply Chain Management Lab
Number of Credits : 1
Effective from AY : 2024-25

Pre-requisites for the Course	Basic knowledge of materials Management	
Course Objectives:	1. The course employs a strategic structure that identifies and illustrates facilities, inventory, transportation, and information as the key drivers of supply chain performance in order to help students understand what creates a competitive advantage. 2. The course provides guidelines for the students for implementing SCM initiatives to learn basically the "why, what and how" of supply chain management. 3. The course will help students, in revisiting the management policies being practiced in the industry. 4. The course conforms to the immediate requirements of aspirants for post graduate studies in Industrial Engineering, Mechanical Engineering and Management Colleges.	
Content:		**No of hours**
	Lab Sessions (15 sessions / sem): 1. Case Study on Tourism Supply Chain in Goa (02 sessions) 2. Case Study on global business (02 sessions) 3. Case study on local business (02 sessions) 4. Case study on online business (02 sessions) 5. Supplier Selection Case Study using AHP / TOPSIS (02 sessions) 6. Business Plan ideation / Business Plan selection / Business Plan Feasibility study / Business Plan Presentation (05 sessions)	**30**
Pedagogy:	Constructivist, Integrative, Reflective and Enquiry based	
References/ Readings:	1. S. Chopra, P. Meindl, D. V. Kalra; Supply Chain Management – Strategy; Planning and Operation; Pearson Education; 6e; 2016 2. R. P. Mohanty, S. G. Deshmukh; Supply chain Management - Theories and Practices; Biztantra; 2005 3. J. Shah; Supply Chain Management Text and Cases; Pearson Education; 2009	
Course Outcomes:	On completing this course students will be able to: CO 1. Understand the basic concepts and role of drivers, customer & supplier relationships and performance measures associated with supply chain CO 2. Apply the supply chain and network design concepts in real life situations. CO 3. Analyze case studies on supplier selection, various business models and tourism business in Goa CO 4. Evaluate economics of scale and cost trade-offs pertaining to drivers of supply chain.	

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-535
Title of the Course : Facility Design
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course	Basic knowledge of Facility layout	
Course Objectives:	The course will enable students to: 1. Understand the fundamental concepts of Facility Design 2. Illustrate competency in Plant location analysis and design 3. Apply expertise to generate computerized layout solutions for plant layout design problem. 4. Develop analytical and Technical skills for Material Handling	
Content:		**No of hours**
Unit - 1	**Introduction:** Facilities design function- Scope, Objectives, need for layout study, types of layout problem, Types of flow pattern, Types of plant layout, Nature, Significance and Scope of Facilities Layout Planning, Facility design procedure **Plant location:** Facility location: Single facility location problem, Multiple facility location problem, Gravity facility location problem, Euclidean distance location problem.	**11**
Unit - 2	**Layout design:** Design cycle - SLP procedure manpower, machinery requirements – Computer algorithms - ALDEP, CORELAP, CRAFT. **Quantitative methods:** Group technology-Production Flow analysis (PFA), ROC (Rank Order Clustering), Quantitative analysis in cellular manufacturing.	**12**
Unit - 3	**Manual Assembly Lines:** Assembly workstations, Analysis of Single model assembly lines, Line, balancing problems, Line balancing algorithm: i) Largest candidate rule ii) Kilbridge and wester method iii) Ranked positional weight method iv) COMSOAL, Mixed model assembly lines, Line of balance. **Auxiliary Services Requirement Space:** Receiving and shipping, Storage, Warehousing, Maintenance and Tool room, Utilities. **Employee Services-Space requirements:** Parking lot, Employee entrances, Locker rooms, Toilets and Restrooms, Lunch room, Recreation, Drinking fountains, Aisles, Medical facilities.	**12**
Unit - 4	**Materials handling:** Cost justification, Goals of material Handling, Principles of material handling, MH problem solving procedure, Unit load concept, and Material handling system design. **Material Handling Equipment:** Receiving and shipping, Stores, Fabrication, Assembly, Shop floor, Warehousing, Packaging. Computer integrated material handling system.	**10**
Pedagogy:	Inquiry-Based Learning, Reflective, Integrative Learning	

References/ Readings:	**Text Books** 1. Plant layout & Material Handling, G. K. Agrawal, Jain Publishers, New Delhi. 2. Facilities Layout and Location: An analytical approach, Richard Francis L. and John A. White, Prentice Hall Inc., 1984. 3. Facilities planning, J. A. Tompkins and J. A. White, John Wiley, 1984. **Reference Books** 1. Facility layout and location –an analytical approach, Francis R.L and J.A. White Prentice Hall Inc, 1974 2. Facilities Planning and Materials Handling, Vijay Sheth, Marcle Decker, New York. 3. Practical Plant layout, Richard Muther, McGraw Hill Book Company, New York
Course Outcomes:	After going through this course, the students will be able to: CO 1. Describe the fundamental aspects of Energy Management. CO 2. Illustrate the concepts of Plant location analysis and design CO 3. Demonstrate proficiency in generating computerized layout solutions for plant layout design problem. CO 4. Create Analytical and Technical Skills for Material Handling.

(Back to Index)

Name of the Programme : Master of Engineering (Industrial Engineering)
Course Code : MEC-536
Title of the Course : Facility Design Lab
Number of Credits : 1
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Facility layout	
Course Objectives:	The course will enable students to: 1. Identify the facilities Design process steps using the traditional engineering design process 2. Understand how facility design for operations like warehouses, manufacturing and commercial facilities. 3. Apply expertise to generate computerized layout solutions for plant layout design problem. 4. Understand concepts for techniques of material handling and layout approaches used for facility design.	
Content:		**No of hours**
Unit - 1	Students can have hands on practices on plant layout optimization techniques and also evaluate the cases computerized layout improvements from research papers. Complete the lab titled: (Any Six) 1. Designing Layout for Just-in-Time Manufacturing. 2. Designing Layout for Warehouse Operations. 3. Facility Evaluation. 4. Product, Process, and Schedule Designing. 5. Determining Space Requirements. 6. Solving Layout Problem Using Systematic Layout Planning. 7. Plant location and its problems. 8. Computerized layout design. 9. Material handling equipment's. 10. Quantitative analysis in cellular manufacturing. 11. Service facilities	**30**
Pedagogy:	Inquiry-Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. Plant layout & Material Handling, G. K. Agrawal, Jain Publishers, New Delhi. 2. Facilities Layout and Location: An analytical approach, Richard Francis L. and John A. White, Prentice Hall Inc., 1984. 3. Facilities planning, J. A. Tompkins and J. A. White, John Wiley, 1984.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Design layouts within facilities, i.e., organize processes, departments and products within a facility using mathematical models, algorithms and heuristics. CO 2. Illustrate the concepts of Plant location analysis and design CO 3. Demonstrate proficiency in generating computerized layout	

	solutions for plant layout design problem. CO 4. Create Analytical and Technical Skills for Material Handling.

(Back to Index)

Research Specific Elective (RSE) Courses

Name of the Programme : Electronics Communication and Instrumentation Engineering
Course Code : REC-563
Title of the Course : Statistics and Data Analysis for Engineering Research
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic Knowledge of Statistics	
Course Objectives:	The course will enable the students to 1. Explain the different types of data and parameter estimations 2. Explain standard probability distributions 3. Select the appropriate parameter estimation & distribution method 4. Co-relate different Hypotheses	
Content:		**No of Hours**
Unit -1	**Data Analysis:** Types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, experimental data, Qualitative data collection, questioners, rating scale, conducting survey. Statistical Modeling and Graphical Diagnostics - Scatter Plot, Stem-and-Leaf Plot, Histogram, Box Plot **Correlation and Regression Modeling:** Basic concept and numericals.	**9**
Unit -2	**Probability distributions and Sampling distributions:** Basic introduction to Bernoulli, Binomial and Normal distribution. Basic introduction to Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Unit -3	**Parameter estimation:** Point Estimation – Concept, unbiased estimator, method of maximum likelihood. Parameter estimation of standard distributions- Binomial and Normal. Confidence Interval Estimation - Concept, Confidence interval on mean of single normal population with variance known, Confidence interval on the ratio of variances of two normal distributions	**7**
Unit- 4	**Tests of Hypotheses:** Introduction, Type I and type II errors, significance level and power of the test, Test of hypotheses - on mean of single normal population with variance known, on variance of single normal population.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488 2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4	

	4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1 5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Explain the different types of data and probability distributions. CO 2. Select the appropriate parameter estimation & distribution method CO 3. Apply estimators for the given situations. CO 4. Evaluate Hypotheses based on the statistical considerations.

(Back to Index)

Name of the Programme : **Electronics Communication and Instrumentation Engineering**
Course Code : **REC-564**
Title of the Course : **Statistics and Data Analysis Lab**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic Knowledge of Statistics	
Course Objectives:	The course will enable the students to 1. Apply the different types of data and parameter estimations 2. Analyze standard probability distributions 3. Demonstrate parameter estimation & distribution methods 4. Co-relate different Hypotheses	
Content:		**No of Hours**
	Using open-source software like libreoffice or any proprietary software perform following experiments: 1. Obtain measures of central tendency and dispersion. 2. Obtain Quartiles, Percentiles and prepare Box-and-Whisker Diagram 3. Develop Pie chart, Bar Chart, Histogram and Stem-and-Leaf Plot, 4. Develop_correlation using Pearson's Correlation Coefficient and showing Scatter Diagrams and Trendlines 5. Develop Linear and Nonlinear Regression Models 6. Obtain probability values involving probability distributions – Binomial and Normal 7. Obtain values of Normal, t-distribution, Chi-square and F-statistic. 8. Develop confidence interval for single population and two populations with variance known. 9. Develop confidence interval on the ratio of variances of two normal distributions. 10. Perform test of hypotheses on mean/variance of single/ two population(s).	**60**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488 2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4 4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1 5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,	

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply the different types of data and parameter estimations CO 2. Analyze standard probability distributions CO 3. Demonstrate parameter estimation & distribution methods CO 4. Co-relate different Hypotheses

(Back to Index)

Name of the Programme : **Electronics Communication and Instrumentation Engineering**
Course Code : **REC-565**
Title of the Course : **Statistical Techniques for Engineering Research**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of Statistics and Probability	
Course Objectives:	The course will enable the students to 1. Understand the importance of statistical methods for research 2. Select the appropriate factorial design method for a given set of experimental plan. 3. Apply basic probability theorems and draw relevant inferences. 4. Analyze suitable probability model for given set of data	
Content:		**No of Hours**
Unit-1	**Overview on Statistical methods**, collection of data, one dimensional and two-dimensional statistical analysis, computation of central tendency and dispersion for grouped and ungrouped data, correlation preliminary, understanding variability in data.	**6**
Unit-2	**Design of Experiments**, Preparation of experimental plan, full factorial design, fractional factorial design, identification of parameters and levels, randomization, replication, blocking, interaction; numerical; Optimization methods for two parameters.	**9**
Unit-3	**Probability Preliminary**: Introduction to Probability, definition, Sample Space, Events, Conditional Probability, Theorem on total probability, Bayes' theorem. Random Variable: Introduction, Discrete and Continuous distribution, Characteristics- Mean, Variance and distribution function.	**8**
Unit-4	**Probability and Sampling Distribution**: Bernoulli, Binomial, Exponential, Normal, distribution. Mean, variance and distribution function, important properties, approximations and applications. Statistic and Sampling Distribution: Population and Sample. Statistic, Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Tahvir Mustafy, Tauhid U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 2. Jiju Antony, 'Design of Experiments for Engineers & Scientists', Elsevier, 2023, ISBN 978-044-315-1736 3. Douglas Montgomery, 'Design and Analysis of Experiments', Wiley India, Eighth Edition, 2013, 9788126540501 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504	

	5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7 6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of statistical methods for research CO 2. Select the appropriate factorial design method for a given set of experimental plans. CO 3. Apply basic probability theorems and draw relevant inferences. CO 4. Analyze suitable probability model for given set of data

(Back to Index)

Name of the Programme : **Electronics Communication and Instrumentation Engineering**
Course Code : **REC-566**
Title of the Course : **Probability and Statistical Analysis Lab**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of Statistics and Probability	
Course Objectives:	The course will enable the students to 1. Apply basic probability theorems and draw relevant inferences. 2. Analyze suitable probability model for given set of data 3. Demonstrate factorial design methods 4. Synthesize fractional and full factorial experimental design data	
Content:		**No of Hours**
	Using open-source software like libreoffice or any proprietary software perform following experiments: 1. Obtain probability values involving discrete probability distributions - Bernoulli, Binomial. 2. Obtain probability values involving continuous probability distributions - Exponential and Normal distributions. 3. Obtain values of Normal, t-distribution, Chi-square and F-statistic. 4. Obtain values of Mean, Variance and distribution function of Bernoulli and Binomial distribution. 5. Obtain values of Mean, Variance and distribution function of Exponential and Normal distributions. 6. Obtain values of central tendency of grouped and ungrouped data. 7. Obtain values of dispersion of grouped and ungrouped data. 8. Analyse experimental output using full factorial design. 9. Analyse experimental output using fractional factorial design. 10. Analyse a full case study in involving full factorial design or fractional factorial design.	**60**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Tahvir Mustafy, Tauhid U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 2. Jiju Antony, 'Design of Experiments for Engineers & Scientists', Elsevier, 2023, ISBN 978-044-315-1736 3. Douglas Montgomery, 'Design and Analysis of Experiments', Wiley India, Eighth Edition, 2013, 9788126540501 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504 5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7 6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,	

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply basic probability theorems and draw relevant inferences. CO 2. Analyze suitable probability model for given set of data CO 3. Demonstrate factorial design methods CO 4. Synthesize fractional and full factorial experimental design data

(Back to Index)

Semester III

Programme Specific Core (PSC) Courses

Name of the Programme : M.E. (Industrial Engineering)
Course Code : MEC-600
Title of the Course : Work System Design
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of ergonomics and human comfort	
Course Objectives:	The course will enable students to: 1. Understand the fundamental concepts of work system design 2. Understand ergonomics with human comfort point of view. 3. Understand the concept of anthropometry and work system for ergonomic design of work systems. 4. Apply the concepts of learning curves, PMTS & MTM to reveal the existence of ineffective time.	
Content:		**No of hours**
Unit - 1	**Introduction** - general approach to the man-machine relationship-workstation design-working position and posture. An approach to industrial design - elements of design structure for industrial design in engineering applications in manufacturing systems. **Control and Displays**: configurations and sizes of various controls and displays; - design of controls in automobiles, machine tools etc., - design of furniture, design of instruments.	**12**
Unit - 2	**Predetermined Motion and Time standards:** Elemental motions, THERBLIGS, Principles of Motion economy **MTM system:** Application of MTM to office and Maintenance work Standard data	**11**
Unit - 3	**Ergonomics:** Fundamental Concepts, Issues in Work system Design, Measuring Work by Physiological means, Muscle Physiology, Muscle Metabolism, Work Posture, Fatigue Measurement and Evaluation, Work rest cycles, Applied Anthropometry and work space design, Biomechanics of Human Motion, Sensorimotor responses.	**12**
Unit - 4	**Job evaluation and incentive scheme:** Job description and job analysis - Job evaluation - different methods - Individual and group incentive concepts and implications - Different types of incentive schemes.	**10**
Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	

References/ Readings:	**Text Books** 1. R.S. Bridger, Introduction to Ergonomics, 2nd Edition, CRC Press, 2003, ISBN-10 : 0415273773 2. Mayall W.H, Industrial Design for Engineers, 2nd Edition, Hiffee books Ltd, 2008, ISBN-13: 9780592042053 **Reference Books** 1. Karger D.W and Bahar F.H, Engineered work measurement, 3rd edition, Industrial Press INC. NY, 1977, ISBN 13: 9780831111182 2. Saunders M.S. and McCormic E.J., 5th Edition, Human Factor Engineering and Design, McGraw Hill, 1987, ISBN-13:9780070549012 3. Mark Sanders, Ernest Mccormick, Human Factors In Engineering and Design, 7th Edition, McGraw-Hill Education, 1992, ISBN-13: 978-0070549012
Course Outcomes:	CO 1. Remember the fundamental aspects of work system design. CO 2. Understand the physical and social requirements of the workplace design along with the use of anthropometric data in ergonomics study. CO 3. Apply proficiency in generating incentive scheme. CO 4. Analyse the concepts of learning curves, PMTS & MTM to reveal the existence of ineffective time.

(Back to Index)

Name of the Programme : M.E. (Industrial Engineering)
Course Code : MEC-601
Title of the Course : Work System Design Lab
Number of Credits : 1
Effective from AY : 2024-25

Pre-requisites for the Course:	Theory of Work System Design	
Course Objectives:	**The course will enable students to:** 1. Understand the fundamental concepts of work system design 2. Understand ergonomics with human comfort point of view. 3. Understand the concept of anthropometry and work system for ergonomic design of work systems. 4. Apply the concepts of learning curves, PMTS & MTM to reveal the existence of ineffective time.	
Content:		**No of hours**
	Students can have hands on practices to design the work system and also evaluate the cases designing a new method that reduces or eliminates ineffective motions. Complete the lab titled: Video based time study. MTM practice. Work Sampling. Stop Watch time study. Graphic tools for method study - Outline Process Chart - Flow Process Chart - Two Handed Process Chart Design of Physical Environment: Human thermoregulation, measuring thermal environment, measurement of light, lighting design considerations, measurement of sound, industrial noise control, vibration, principles for the design of visual displays, design of control, work organization and worksystem design. Case Studies on: Office Chair, Tower Crane Cabin, Car Seat, Computer System, Assembly Line Design of any one Incentive scheme.	**30**
Pedagogy:	The teaching-learning process shall combine instructional learning, constructive thinking, inquiry-based and collaborative learning, experiential learning, and problem-solving approaches.	
Course Outcomes:	CO 1. Remember the fundamental aspects of work system design. CO 2. Understand the physical and social requirements of the workplace design along with the use of anthropometric data in ergonomics study. CO 3. Apply proficiency in generating incentive scheme. CO 4. Analyse the concepts of learning curves, PMTS & MTM to reveal the existence of ineffective time.	

Name of the Programme : **M.E. (Industrial Engineering)**
Course Code : **MEC-602**
Title of the Course : **Lean Six Sigma**
Number of Credits : **3**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of Six Sigma Management	
Course Objectives:	The course aims to 1. Make students understand the fundamental concepts Lean Six Sigma. 2. Expose students to tools and techniques in Lean Six Sigma 3. Build capability among students in aligning the organizational activities and problems in terms of lean six sigma framework. 4. Demonstrate ability to implement a structured approach for process, product or service improvement.	
Content:		**No of hours**
Unit - 1	**Introduction to Lean Methodology:** Lean introduction, principles of lean, lean culture, terminologies in lean, 8 wastes. **Introduction to Six Sigma Management:** Overview of six sigma, timeline of six sigma, voice of customer and voice of process, technical and non-technical definitions of six sigma. **Lean Six Sigma Approach:** Introduction to lean six sigma, combined approach of lean strategy and six sigma tools and techniques.	**12**
Unit - 2	**Lean Six Sigma Belt Levels:** Roles and responsibilities, different lean six sigma belt levels. **Data Analysis:** Measures of central tendency, measures of dispersion, skewness, measurement system analysis, gauge R&R. **Data Representation tools:** Box plot, notched box plot, histogram, stem and leaf plot.	**12**
Unit - 3	**Lean Six Sigma Tools and Techniques:** SIPOC, value stream mapping, takt time, process mapping, Kaizen, cause & effect analysis, pareto chart, FMEA, normal probability plots. **Hypothesis Testing:** Simple Regression, DoE, ANOVA	**12**
Unit - 4	**Lean Six Sigma Phases:** DMAIC, Tools and techniques used in various phases. **Case studies:** Case studies on applications of above tools and techniques.	**09**
Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	
References/ Readings:	**Text Books** 1. H. S. Gitlow, D. M. Levine; Six Sigma for Green Belts and Champions; Prentice Hall; 1st Edition; 2004, ISBN: 9780131172623 2. A. Mitra; Fundamentals of Quality Control and Improvement; Wiley;	

	3rd edition; 2013, ISBN-10. 8126544090 **Reference Books** 1. D. C. Montgomery; Design and Analysis of Experiments; Wiley; 8th Edition; 2013, ISBN No.: 978-1-118-14692-7 2. K Krishnaiah; Applied Design of Experiments and Taguchi Methods; PHI Learning; 1st Edition, 2012, ISBN : 9788120345270 3. R. Panneerselvam; Design and Analysis of Experiments; PHI Learning; 5th Edition, 2012, ISBN-13. 978-8120344990
Course Outcomes:	CO 1. Understand various terminologies, tools and techniques of lean six sigma management. CO 2. Apply lean six sigma concepts to practical problems CO 3. Analyse case studies using lean six sigma methodologies. CO 4. Evaluate real-life situations for design and continual improvement of product and processes

(Back to Index)

Name of the Programme : **M.E. (Industrial Engineering)**
Course Code : **MEC-603**
Title of the Course : **Lean Six Sigma Lab**
Number of Credits : **1**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Theory of Lean Six Sigma	
Course Objectives:	The course aims to 1. Make students understand the fundamental concepts hypothesis testing. 2. Expose students to tools and techniques used in hypothesis testing. 3. Gain knowledge of statistical software for testing of hypothesis 4. Demonstrate ability to use statistical software for testing of hypothesis.	
Content:	**List of experiments**	**No of hours**
	1. Design of Experiments: a. Introduction and applications b. Case studies c. 2^2 Factorial Design using statistical software d. 2^3 Factorial Design using statistical software **2. Taguchi Methods:** a. Introduction and applications b. Case studies c. L_8 Orthogonal array d. L_9 Orthogonal array **3. Regression Analysis** a. Introduction and applications b. Case studies c. Simple linear regression d. Multiple linear regression **4. Six Sigma Methodology** a. DMAIC case studies in service and manufacturing industry b. DFSS case studies in service and manufacturing industry	**30**
Pedagogy:	The teaching-learning process shall combine instructional learning, constructive thinking, inquiry-based and collaborative learning, experiential learning, and problem-solving approaches.	
Course Outcomes:	CO 1. Understand various tools and techniques in hypothesis testing in lean six sigma management. CO 2. Apply full factorial, fractional factorial and regression analysis for practical problems using statistical software CO 3. Analyse case studies using lean six sigma methodologies. CO 4. Evaluate hypothesis for design and continual improvement of product and processes	

(Back to Index)

Programme Specific Elective (PSE) Courses

Name of the Programme : M.E. (Industrial Engineering)
Course Code : MEC-631
Title of the Course : Industrial Safety and Occupational Health
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Occupational health and safety	
Course Objectives:	**The course will enable students to:** 1. Understand the concepts related to industrial safety and occupational health. 2. Illustrate competency in identifying hazards and assessing risk. 3. Apply techniques and methods for prevention of industrial accidents and occupational diseases. 4. Develop Risk Assessment and Control Programmes to address practical, real-world challenges.	
Content:		**No of hours**
Unit - 1	**Introduction to Industrial Safety:** Concept of safety, Need for safety, Safety and productivity, Safety and plant layout, Safety and equipment design, Safety and work environment. **Safety in Organization:** objectives, functions, role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety Officer- responsibilities & authority. Safety committee-need, advantages. **Planning for Safety:** Planning procedure, Safety policy-Elements of safety policy, formulation and implementation of safety policy. **Safety in Engineering Industry:** Manual Material Handling, working on cranes, forklift and machines. **Safety Education:** Training, Accident Report and Insurance Coverage, Personal Safety, Welfare provisions and role of Factory Inspector. Factories Act	**12**
Unit - 2	**Industrial Hazards and Prevention:** Hazards and Risk, Types of industrial hazards- Mechanical hazards and Machine safeguarding, Chemical Hazards, Fire hazard, prevention of fire, Fire detection and control, Extinguishers, Electrical hazards and safety requirements, Confined Space Hazards. Safety precautions in boilers, Noise and noise control, Dust control. **Accident Theories:** The domino theory, Multiple causation theory, The pure chance theory, Biased liability theory, Accident proneness theory, The energy transfer theory (HADDON THEORY) , The "symptoms versus causes" theory. **Industrial Accidents:** Definition of Accidents, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Nature, Causes, Classification. Accident costs, Measurement, Prevention.	**11**

	Investigation and analysis of accidents. Accident measurement. **Accident Prevention:** Method-Engineering, Education and Enforcement.	
Unit - 3	**Hazard Identification Techniques:** Failure mode and effect analysis (FMEA) technique, Hazard and operability review technique, Technique of operation review, fault tree analysis, Safety Audit. Job Safety Analysis (JSA's) and job hazard analysis **Risk Assessment:** Necessity, Framing Risk Assessment programme, Risk Estimation, Developing Risk Matrix, Risk Tolerance and Control Plan. **Recognizing and Controlling Hazards:** Engineering hazard control, work practice control, administrative control, and personal protective equipment. First Aid, Artificial respiration.	**11**
Unit - 4	**Occupational Health:** Concept and Significance of Industrial Health, Occupational safety and Health Act. **Occupational Ergonomics:** Classification of workload. Work capacity and man-job alignment. Fatigue and Rest allowances. Musculoskeletal Disorders, Ergonomics, Anthropometry. Application of ergonomics in safety and health management. **Occupational and Work Related Diseases:** Types of Occupational diseases, Industrial toxicology, dangerous properties of chemicals and their health effects, routes of entry of toxic material into human body, permissible exposure limits, Threshold limit value, lethal dose and lethal concentration. First Aid and Occupational health Services in an industrial establishment and its functions.	**11**
Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	
References/ Readings:	**Text Books** 1. Prathibha Garg; "Industrial Safety and Environment", 3rd Edition, S, K, Kataria & Sons, , 2019, ISBN – 978-. 0984999392 2. L. M. Deshmukh; Industrial Safety Management; 1st Edition, McGraw Hill Education (India) Pvt.Ltd. 2013, ISBN-13: 978-0-07-133152-4, 3. K. T. Kulkarni; Introduction to Industrial safety; 1st Edition, K.T. Kulkarni Publishers; 2002, ISBN 0-444-51616-6 **Reference Books** 4. C. Ray Asfahl, David W. Rieske, Industrial Safety and Health Management, 6th Edition, Prentice Hall New York, 2010, ISBN-13: 978-0-13-236871-1 5. R. K. Jain, S. S. Rao, Industrial Safety, Health and Environment Management Systems, 4th Edition, Khanna Publication India, 2000, , ISBN-13: 978-81-7409-210-6	
Course Outcomes:	CO 1. Understand the fundamental aspects of Industrial Safety. CO 2. Apply techniques and methods for prevention of industrial accidents and occupational diseases.	

	CO 3. Analyze situations involving industrial accidents and occupational diseases. CO 4. Evaluate various parameters of Industrial Safety.

(Back to Index)

Name of the Programme : **M.E. (Industrial Engineering)**
Course Code : **MEC-632**
Title of the Course : **Industrial Safety and Occupational Health Lab**
Number of Credits : **1**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Undergraduate level knowledge of any branch of engineering	
Course Objectives:	The course will enable students to: 1. To investigate accidents, identify causes, and recommend preventive measures using hazard analysis and fault tree methods. 2. To recognize workplace hazards, recommend safety measures, and understand occupational diseases and prevention. 3. To conduct mock drills, perform first aid, and understand emergency procedures like fire safety and evacuation. 4. To create safety posters, analyze plant layouts, and assess safety measures in workplace design.	
Content:	**List of experiments**	**No of hours**
	1. Investigation and reporting of an industrial accident, including root cause analysis and preventive measures. 2. Analyze the plant layout of any industrial set up and draw the sketch of the plant layout. Visit any industrial set up and prepare the report on safety measures followed in the industry. 3. To conduct a Preliminary Hazard Analysis (PHA) to identify and categorize risks in a selected workplace. 4. Measurement and analysis of noise levels in various workplace environments using a sound level meter. 5. Application of Fault Tree Analysis (FTA) to assess the causes and outcomes of an industrial accident. 6. Analyze and report Industrial Safety measures adopted for the protection of workers and employees involved in any one type of activity/job. 7. To carry out survey of different types of firefighting facilities available at workplace and draw a layout plan of the location and type of firefighting equipment. To demonstrate the use of First Aid and standard procedure to carry out Artificial Respiration. 8. A study on occupational diseases and the preventive measures implemented in a selected industry. 9. To conduct a Job Hazard Analysis and suggest appropriate controls to avoid Musculoskeletal Disorders. 10. To conduct a safety audit, identify hazards, assess existing safety measures, and recommend improvements to enhance workplace safety.	**30**
Pedagogy:	The teaching-learning process shall combine instructional learning,	

	constructive thinking, inquiry-based and collaborative learning, experiential learning, and problem-solving approaches.
Course Outcomes:	CO 1. Analyse and Investigate accidents, identify causes, and recommend preventive measures using hazard analysis and fault tree methods. CO 2. Apply workplace hazards, recommend safety measures, and understand occupational diseases and prevention. CO 3. Evaluate mock drills, perform first aid, and understand emergency procedures like fire safety and evacuation. CO 4. Create safety posters, analyze plant layouts, and assess safety measures in workplace design.

(Back to Index)

Name of the Programme : Second Year M.E. (Industrial Engineering)
Course Code : MEC-633
Title of the Course : Soft Computing
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course:	foundation in mathematics, particularly linear algebra and calculus	
Course Objectives:	The main objective of the course is to expose the students to soft computing, various types of soft computing techniques, and applications of soft computing.	
Content:		**No of hours**
Unit - 1	**Soft Computing:** Introduction to soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing. **Neural Network:** Structure and Function of a single neuron: Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural net, Difference b/w ANN and human brain, characteristic and applications of ANN, single layer network	**12**
Unit - 2	**Perceptron:** Perceptron training algorithm, Linear separability , Widrow & Hebb's learning rule/Delta rule, ADALINE, MADALINE, AI v/s ANN. **Fuzzy Logic:** Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, Fuzzy systems: crisp logic, fuzzy logic, introduction & features of membership functions.	**11**
Unit - 3	**Fuzzy rule base system :** Fuzzy propositions, formation, decomposition & aggregation of fuzzy Rules, fuzzy reasoning, fuzzy inference systems, fuzzy decision making & Applications of fuzzy logic.	**11**
Unit - 4	**Genetic algorithm:** Fundamental, basic concepts, working principle, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator ,Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional methods.	**11**
Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	
References/ Readings:	**Text Books** 1. S.N. Sivanandam & S.N. Deepa, Principles of Soft Computing, 2nd Edition, Wiley Publications, 2011, ISBN-13:978-8126527410 2. S, Rajasekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications, 1st Edition, PHI Publication, 2009, ISBN-13: 9788120353343. 3. Bart Kosko, Neural Network & Fuzzy System, 1st Edition, PHI	

	Publication, 2009, ISBN-13: 9788120308688 **Reference Books** 4. Kumar S. Ray, Soft Computing and Its Applications Volume II, 1st Edition, CRC Press, 2021, ISBN-13:978-1774630877 5. Pradip Debnath, Oscar Castillo, Poom Kumam, Soft Computing, 1st Edition, CRC Press, 2023, ISBN-13: 978-1032318318
Course Outcomes:	After going through this course, the students will be able to: CO 1. Remember about soft computing techniques and their applications CO 2. Understand various neural network architectures CO 3. Analyze the fuzzy systems CO 4. Evaluate the genetic algorithms and their applications.

(Back to Index)

Name of the Programme : **M.E. (Industrial Engineering)**
Course Code : **MEC-634**
Title of the Course : **Soft Computing Lab**
Number of Credits : **1**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Knowledge of MATLAB	
Course Objectives:	The main objective of the course is to expose the students to soft computing, various types of soft computing techniques, and applications of soft computing.	
Content:	**LIST OF EXPERIMENTS**	**No of hours**
	1. Solution of single objective optimization problem using MATLAB Optimization Toolbox (linprog, quadprog, fmincon). 2. Solution of single objective optimization using OCTAVE sqp and GAMS solvers. 3. Implementation of fuzzy tool box to solve optimization problem. 4. Design of Fuzzy rule base and Fuzzy Inference System to solve an optimization problem. 5. Implementation of Genetic Algorithms to solve an optimization problem. 6. Implementation of Artificial Neural Networks to solve optimization problems. 7. Implementation of Particle Swarm Optimization to solve optimization problems.	**30**
Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Remember about soft computing techniques and their applications CO 2. Understand various neural network architectures CO 3. Analyze the fuzzy systems CO 4. Evaluate the genetic algorithms and their applications.	

(Back to Index)

Research Specific Elective (RSE) Courses

Name of the Programme : M.E. (Industrial Engineering)
Course Code : MEC-661
Title of the Course : System Modeling and Simulation
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of mathematics and Programming	
Course Objectives:	The course will enable students: 1. To understand fundamental concepts of system modeling and simulation. 2. To understand discrete and continuous simulation. 3. To learn about simulation languages and programming.	
Content:		**No of hours**
Unit – 1	System Simulation and Modeling Definition, need, modeling concepts. Types of system studies. Random numbers: Need, Importance and desirable properties, Generation of random numbers with Bernoulli's Trial, Binomial, Geometric. Exponential, Normal distribution.	**8**
Unit – 2	Testing the random numbers for the various distributions. Estimation of parameters. Next event approach, Fixed time increment approach and Process oriented approach for system simulation. Simulation of inventory system, queuing system, project network and other discrete system.	**8**
Unit – 3	GPSS: Introduction to various block statements and control statements: GENERATE, ADVANCE, SEIZE, RELEASE, QUEUE, DEPART, ENTER, TRANSFER, TERMINATE, START, RESET, JOB, SIMULATE. Modeling of systems using GPSS.	**7**
Unit – 4	Introduction to continuous simulation and CSMP. Analysis of simulation output: determining the length of simulation, effect of initial bias, effect of auto-correlation, Variance Reduction techniques.	**7**
Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	
References/ Readings:	**Text Books** 1. G. Gordon; System Simulation; 2nd Edition, Pearson Education, lnc., 2015, ISBN-13. 978-8120301405 2. N. Deo; System Simulation with Digital Computer; 1st Edition, Prentice-Hall of India Pvt. Ltd., 2013, ISBN : 9788120300286 3. S. M. Ross; Simulation; 5th Edition, Academic Press, Elsevier, 2013, ISBN 9780124158252 **Reference Books**	

	1. Robert L. Woods, Kent L. Lawrence, Modeling and Simulation of Dynamic Systems, 1st Edition, Prentice Hall, 1997. ISBN-13: 978-0133373790 2. Katsuhiko Ogata, System Dynamics, 4th Edition, Pearson Prentice Hall, 2004, ISBN-13: 978-0131424623
Course Outcomes:	CO 1. Understand the concepts of modelling and simulation of dynamic systems using variety of formalisms. CO 2. Apply random number generation techniques and statistical tests CO 3. Analyze the ability to apply the techniques of modelling and simulation to a range of problems. CO 4. Evaluate and validate randomness in simulation models.

(Back to Index)

Name of the Programme : **M.E. (Industrial Engineering)**
Course Code : **MEC-662**
Title of the Course : **System Modeling and Simulation Lab**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Theory of System Modeling and Simulation	
Course Objectives:	The course will enable students: 1. To understand fundamental concepts of system modelling and simulation. 2. To understand discrete and continuous simulation. 3. To learn about simulation languages and programming.	
Content:	**LIST OF EXPERIMENTS**	**No of hours**
	1. Generate random variates for different distributions: Bernoulli, Binomial, Geometric, Exponential and Normal. 2. Implement Kolmogorov-Smirnov tests to check the randomness of generated numbers. 3. Develop a simulation model for a basic inventory system with reorder levels and lead times. 4. Model and simulate a single-server and multi-server queuing system 5. Simulate a simple project network using Monte Carlo simulation to estimate project completion time. 6. Simulation for solving definite integral 7. Simulation finding square root 8. Simulation for finding area of a circle 9. Simulation of simple management games. 10. Simulate a basic discrete event system using the Next Event approach. 11. Simulate a continuous system using a fixed time increment approach. 12. Simulate a queue-based system using GPSS. 13. Analyze the effect of initial bias, simulation run length, and variance reduction techniques in a given simulation model. 14. Chi square goodness of fit test.	**60**
Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	
Course Outcomes:	CO 1. Understand the concepts of modelling and simulation of dynamic systems using variety of formalisms. CO 2. Analyze random number generation techniques and statistical tests CO 3. Demonstrate the ability to apply the techniques of modelling and simulation to a range of problems. CO 4. Evaluate and validate randomness in simulation models.	

(Back to Index)

Name of the Programme : **M.E. (Industrial Engineering)**
Course Code : **MEC-663**
Title of the Course : **Advanced Optimization**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basics of optimisation	
Course Objectives:	1. To understand the advanced topics in linear programming like duality theory and post optimal analysis 2. To analyse single variable non-linear optimisation problems and the techniques used to solve these problems 3. To analyse multi variable unconstrained and constrained non-linear optimisation problems and the techniques used to solve these problems 4. To understand the computational complexity of the heuristics used to solve non-linear problems 5. To understand the working and application of evolutionary algorithms	
Content:		**No of hours**
Unit - 1	**Duality theory in linear programming:** Dual linear programs, comparison of primal and dual solutions, economic interpretation of dual problem, Dual simplex method **Post Optimal Analysis:** Modified simplex method, post optimal analysis on the cost vector, right hand side vector and the constraint matrix. Introduction of additional variable and constraint.	**8**
Unit - 2	**Non-linear optimisation:** Introduction, local and global optima, convexity, heuristics, applications, classification of optimization methods. **Single variable optimization:** Classical technique, Bracketing and locating methods, Unrestricted search, Dichotomous search, Interval Halving method, Golden Section method, Fibonacci search. Interpolation methods: Bisection method, Secant method, Newton Raphson method, Quadratic Interpolation	**8**
Unit - 3	**Multi-variables optimization without constraints:** Classical method, Powell's Conjugate direction method, Steepest Ascent Descent method, Newton's method. **Complexity of algorithms:** Introduction, space and time computational complexity of algorithms, notations, performance measurement.	**7**
Unit - 4	**Multi-variables optimization with constraints:** KTC conditions, Lagrange's method. **Evolutionary algorithms:** Introduction to other evolutionary algorithms like Genetic algorithm, Simulated Annealing, and Jaya algorithm.	**7**

Approved by: Standing Committee of the Academic Council on 24th & 25th July 2025

Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills
References/ Readings:	**Text Books** 1. Ravindran, D. Philips and J. J. Solberg, Operations Research: Principles and Practice, 2nd edition John Wiley & Sons Inc., 2012, ISBN-13: 978-0471086086 2. S. R. Yadav and A. K. Malik, Operations Research, 1st edition, Oxford University Press, 2014, ISBN-13: 978-0198096184 3. Singiresu S Rao, Engineering Optimisation Theory and Practice, 4th edition, John Wiley & Sons Inc., 2009, ISBN:10. 0470183527 **Reference Books** 1. Kalyanmoy Deb, Optimisation for Engineering Design Algorithms and Examples, 4th edition, Prentice Hall India Learning Pvt. Ltd., 2005, ISBN-10. 8120346785 2. S. N. Sivanandam and S. N. Deepa, Introduction to Genetic Algorithms, 1st edition, Springer, 2007, ISBN-13: 978-3-540-73189-4
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the applied concept of real life linear and non-linear models, problem formulations, algorithmic complexity and tools to solve these models CO 2. Apply the appropriate technique to solve specific linear and non-linear programming model CO 3. Analyze the complexity of solution procedures used to solve specific non-linear programming model CO 4. Evaluate the performance of various traditional and recent solution techniques used to solve the linear and non-linear programming model

(Back to Index)

Name of the Programme : M.E. (Industrial Engineering)
Course Code : MEC-664
Title of the Course : Advanced Optimization Lab
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basics of optimisation	
Course Objectives:	1. To solve linear programming problem using modified simplex method and perform post optimal analysis 2. To graphically identify local and global optima of a single variable non-linear optimisation problem and apply bracketing techniques to get the optima 3. To apply locating and gradient based methods to find optima of a single variable non-linear optimisation problem 4. To solve unconstrained and constrained multi variable optimisation problems 5. To apply evolutionary algorithm in solving multi variable optimisation problems	
Content:		**No of hours**
	Perform the experiments given below using Microsoft Excel/VBA/ / MATLAB or any other relevant optimisation software: 1. Solve linear programming problem using modified simplex method 2. Perform post optimal analysis to understand the effect of changes in the input data on the optimal solution 3. Identify the local and global minima of a single variable function through function plot and confirm the same using classical method 4. Perform unrestricted search with constant and accelerated step size 5. Solve and compare the solution obtained using dichotomous search and interval halving method 6. Solve and compare the solution obtained using golden section method and Fibonacci method 7. Solve and compare the solution obtained using bisection and secant method 8. Apply Newton Raphson's method to solve a single variable NLP 9. Solve a multivariable problem using classical method 10. Solve a multi variable optimisation problem using any one evolutionary algorithm	**60**
Pedagogy:	The teaching-learning process shall combine instructional learning, constructive thinking, inquiry-based and collaborative learning, experiential learning, and problem-solving approaches.	

Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the applied concept of real life linear and non-linear models, problem formulations, algorithmic complexity and tools to solve these models CO 2. Apply the appropriate technique to solve specific linear and non-linear programming model CO 3. Analyze the complexity of solution procedures used to solve specific non-linear programming model CO 4. Evaluate the performance of various traditional and recent solution techniques used to solve the linear and non-linear programming model

(Back to Index)

Generic Elective (GE) Courses

Name of the Programme : M.E in Information Technology and Engineering (RC 2024-25)
Course Code : GEC-681
Title of the Course : Sustainability - Principles & Practices
Number of Credits : 03
Effective from AY : 2024-25

Pre-requisites for the Course:	Undergraduate level knowledge of any branch of engineering	
Course Objectives:	The course aims to provide the student with an: 1. Understanding of importance of Sustainability Practices 2. Explanation of Assessment, Planning and Implementation of Sustainability Principles 3. Description of the steps involved in implementing sustainable solutions 4. Apply the knowledge of sustainability practices to real life situations.	
Content:		**No. of Hours**
Unit-1	**Overview on Global Sustainability Goals (SDGs):** Industry-Innovation-Infrastructure, Health & Well Being, Clean Water & Sanitation, Education, Responsible Consumption and production, Climate Action, Quality Education, Economic growth, sustainable community living,	**10**
Unit-2	**Sustainability:** Requirements for Sustainability, Approaches towards Sustainable Engineering, Sustainability Challenges, Environmental Challenges; **Reasons for Un-sustainability** – Economics and Environment, Corporate View of Sustainability, Social Attitude, Approach, Cultural Narratives, Political Aspects, Ethics and Morals. Steps in life cycle impact assessment	**13**
Unit-3	**Sustainability Assessment:** Steps in assessing life cycle, data availability, process network analysis, Input-Output Analysis, Hybrid Models; Carbon footprint, Water footprint, Energy analysis of technologies, processes and its economics; Concept of Exergy and Emergy Analysis; Ecosystem Services in Sustainability Assessment; Case Studies	**10**
Unit-4	**Solutions for Sustainability:** Designing sustainable processes and products; Techno-Economic Analysis; Energy Ecosystem and its dynamic characteristics; Circular Economy; Nature based solutions, Green infrastructure, Techno-ecological synergy; Economic Policies, Societal Developments; Case Studies.	**12**
Pedagogy	Interactive learning, reflective thinking, critical analysis, and problem-	

	solving.
References/ Readings:	1. Raj Gaurang Tiwari, 'Sustainability Principles and Applications in Engineering Practices', Nova Science Publishers, 2024, ISBN:9798891136403 2. Bhavik R Bakshi, 'Sustainable Engineering', Cambridge University Press, 2019, ISBN:9781108420457 3. Margaret Robertson, 'Sustainability – Principles & Practices', Routledge Publishers, 2017, ISBN: 97811138650244
Course Outcomes:	After going through this course, student will be able to: CO 1. Understand the importance of sustainability practices CO 2. Assess, Plan and Suggest basic sustainability practices CO 3. Explain the steps involved in implementing sustainable solutions CO 4. Prepare a plan for sustainability practices to real life situations.

(Back to Index)

Name of the Programme : **M.E in Information Technology and Engineering (RC 2024-25)**
Course Code : **GEC-682**
Title of the Course : **Sustainability - Principles & Practices Lab**
Number of Credits : **01**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Undergraduate level knowledge of any branch of engineering	
Course Objectives:	The course aims to provide the student with an: 1. Understanding of importance of Sustainability Development Goals (SDG) 2. Explanation on Assessment, Planning and Implementation of SDG 3. Description of the steps involved in order to achieve the SDG. 4. Apply the knowledge of sustainability practices to real life situations.	
Content:		**No. of Hours**
	The United Nations has promulgated Sustainable Development Goals (SDG)s. Every student has to prepare a detail report and presentation, based relevant literature, field visits and data collection, interaction with experts, on ANY TWO topics of SDG as applied to the local region or State of Goa. (1) No Poverty (2) Zero Hunger (3) Good Health & Well Being (4) Quality Education (5) Gender Equality (6) Clean Water & Sanitation (7) Affordable & Clean Energy (8) Decent Work and Economic Growth (9) Industry, Innovation and Infrastructure (10) Reduce Inequalities (11) Sustainable Cities & Communities (12) Responsible Consumption and Production (13) Climate Action (14) Life Below Water (15) Life on Land (16) Peace, Justice & Strong Institutions	**30**
Pedagogy	Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving	
References/ Readings:	1. Raj Gaurang Tiwari, 'Sustainability Principles and Applications in Engineering Practices', Nova Science Publishers, 2024, ISBN:9798891136403 2. Bhavik R Bakshi, 'Sustainable Engineering', Cambridge University Press, 2019, ISBN:9781108420457	

	3. Margaret Robertson, 'Sustainability – Principles & Practices', Routledge Publishers, 2017, ISBN: 97811138650244
Course Outcomes:	After going through this course, student will be able to: CO 1. Understand the importance of sustainability Development Goals (SDGs) CO 2. Assess, Plan and Suggest basic sustainability practices CO 3. Explain the steps involved in order to achieve the SDG CO 4. Prepare a plan for sustainability practices to real life situations.

(Back to Index)

Name of the Programme : M.E. (Industrial Engineering)
Course Code : GEC-687
Title of the Course : Marketing Management
Number of Credits : 3
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Sales and Marketing	
Course Objectives:	The main objectives of the course are to: 1. To understand the changing business environment and the fundamental premise that market driven strategies 2. To identify the indicators of marketing thoughts and practices. 3. To understand and explore new opportunities in Indian contemporary marketing.	
Content:		**No of hours**
Unit - 1	**Introduction:** Marketing Management Philosophies – What is marketing- The concepts of marketing- E- Marketing – Social Media Marketing – Current marketing challenges **Strategic Planning** – Marketing Management Process – Analysis of Marketing opportunities, Selecting Target Consumers, developing Marketing Mix Analysis of Macro and Micro environment Marketing Research as an Aid to Marketing	**12**
Unit - 2	**Marketing Research Process** – Sales Forecasting –Techniques. Marketing Tactics, The Mix Service and Retail Marketing **Buyer Behaviour** - Factors Influencing Consumer Behaviour – Buying situation – Buying Decision Process – Industrial Buyer Behaviour. Market Segmentation: Targeting and Positioning – Competitive Marketing Strategies.	**11**
Unit - 3	**Customer Life Cycle**- Customer Life time Value, Portfolio Management. **Product Policies** – Consumer and Industrial Product Decisions, Branding, Packaging and Labelling – New Product Development and Product Life Cycle Strategies, Pricing – Pricing Strategies and approaches.	**11**
Unit - 4	**Promotion Decisions** - Promotion Mix – Advertising – Sales Promotion – Sales Force Decisions, Selection, Training, Compensation and Control – Publicity and Personal Selling – Channel Management: Selection, Co- operation and Conflict Management – Vertical, Horizontal and Multi-channel Systems Consumer Protection – Awareness of Consumer Rights in the Market Place	**11**
Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	

Approved by: Standing Committee of the Academic Council on 24th & 25th July 2025

References/ Readings:	**Text Books** 1. Pillai, R. S. N. and Bhagavathy, Marketing Management, 1st edition, S. Chand Publishing, 2012, ISBN-13. 978-8121932448 2. Kotler Pand Keller, K, L., Marketing Management, 14th Edition, Pearson Education, 2011, ISBN-10. 0132102927 3. Kotler, P., Agnihotri, P.S. and Haque, E.U., Principles of Marketing: A South Asian Perspective, 13th Edition, Pearson, 2010, ISBN: 978-81-317-3101-7 **Reference Books** 1. Marketing Management: Indian Cases, 2nd Edition by Pearson, ISBN-13. 978-9361599743 2. S. Ramesh Kumar , Case Studies in Marketing Management, 1st edition, Pearson Education India 2012 ISBN-13: 978-8131785003
Course Outcomes:	CO 1. Remember basics of Marketing Management CO 2. Understand mechanisms behind Marketing Management CO 3. Analyse different case studies of Marketing Management CO 4. Apply skills studied under Marketing Management

(Back to Index)

Name of the Programme : M.E. (Industrial Engineering)
Course Code : GEC-688
Title of the Course : Marketing Management Lab
Number of Credits : 1
Effective from AY : 2024-25

Pre-requisites for the Course:	Theory of Marketing Management	
Course Objectives:	Marketing case studies can be categorized by purpose, subject, and the level of analysis. Broadly, they include explanatory, descriptive, and exploratory studies.	
Content:		**No of hours**
	By Purpose: 1. Explanatory: Explains the mechanisms behind a successful or unsuccessful marketing initiative. 2. Descriptive: Provides a comprehensive account of a specific marketing campaign or strategy. 3. Exploratory: Used to discover and understand a phenomenon or trend. **By Subject:** 1. New Product Launches: Analyzing the marketing strategies used to introduce a new product. 2. Digital Marketing Campaigns: Examining online advertising, social media, or email marketing efforts. 3. Branding Initiatives: Investigating how companies build and manage their brand identity. 4. Customer Relationship Management (CRM): Analyzing strategies to build and maintain customer relationships. **By Level of Analysis:** 1. Intrinsic: The case itself is of primary interest, and the study focuses on understanding its unique aspects. 2. Instrumental: The case is used as a lens to understand a broader issue or phenomenon. 3. Collective: Multiple cases are analyzed to identify common patterns or trend	**30**
Pedagogy:	The teaching-learning process shall combine instructional learning, constructive thinking, inquiry-based and collaborative learning, experiential learning, and problem-solving approaches.	
Course Outcomes:	CO 1. Remember basics of Marketing Management CO 2. Understand mechanisms behind Marketing Management CO 3. Analyse different case studies of Marketing Management CO 4. Apply skills studied under Marketing Management	

(Back to Index)

SEMESTER IV

Generic Elective (GE) Courses

Name of the Programme : M.E in Information Technology and Engineering (RC 2024-25)
Course Code : GEC-685
Title of the Course : Financial Management
Number of Credits : 04
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Finance, Economics	
Course Objectives:	The course aims to provide the student with an: 1. Understanding of Financial Systems and Its Management 2. Explanation of Financial Planning, Fund Flow and Cost Analysis 3. Analysis of Capital & Working Capital Management, Valuation, Long Term Financing 4. Description of product cost analysis, break even analysis and investment management.	
Content:		**No. of Hours**
Unit-1	**Financial Management: An Overview –** Types of Business organizations, Fundamental principle of finance. **The Financial System-** Functions, Financial Assets and Markets, **Financial Statements, Taxes, and Cash Flow**- Balance Sheet, Profit and loss Account, Profits Vs Cash Flow, Taxes; Financial decision making.	**15**
Unit-2	**Financial Statement Analysis**- Financial Ratios- Liquidity Ratios, Leverage & Profitability Ratios; **Fund Flow Analysis** - Fund Flow Statement; **Breakeven Analysis and Leverages**- Cost Volume Profit Analysis; **Financial Planning & Forecasting-** Financial Planning, Sales Forecast; **Cost Analysis-** Determination of product cost, overhead cost, volume and profits, planning and control on costs and decision making using costs.	**16**
Unit-3	**Fundamental Valuation Concepts -**The Time Value of Money, Risk and Return. **Capital Budgeting -**Techniques of Capital Budgeting – Capital Budgeting Process, project classification; cash flows, risk analysis, cost of capital; **Investment Criteria**- Net Present value, Benefit Cost Ratio, Internal Rate of return, Payback Period, Accounting rate of Return.	**15**

Unit-4	**Working Capital Management** -Working Capital Policy, Cash and Liquidity Management, Credit Management, Inventory Management, Working Capital Financing; **Corporate Valuation:** Debt analysis and management, Leasing, Hire Purchase, Valuation, Mergers, acquisitions and Restructuring; **Long Term Financing:** Sources of Long Term Finance, Raising Long Term Finance.	**14**
Pedagogy	Interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	1. Prasanna Chandra "Financial Management: Theory and Practice" 11th Edition, McGraw Hill Education Publishers, 2023, ISBN: 978-9355-322-203 2. Pandey I.M., Finance- A Management Guide for Managing Company Funds and Profits, Prentice Hall India Publications, 1995, ISBN:978-8120-309-180 3. Van Horne, J.C, "Fundamentals of Financial Management", 13th Edition, Pearson Publications, 2015, ISBN:978-933-255-8670. 4. Khan, M.Y. and Jain, P.K., "Financial Management", 8th Edition, McGraw-Hill Education Publishers, 2018, ISBN:978-9353-1622-184	
Course Outcomes:	After going through this course, student will be able to: CO 1. Understand the Financial Systems and Its Management CO 2. Explain Financial Planning, Fund Flow and Cost Analysis CO 3. Analyze Capital & Working Capital Management, Valuation, Long Term Financing CO 4. Describe product cost analysis, break even analysis and investment management.	

(Back to Index)

Name of the Programme : **M.E in Information Technology and Engineering (RC 2024-25)**
Course Code : **GEC-686**
Title of the Course : **Entrepreneurship**
Number of Credits : **04**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of Creative Thinking, Innovation, Finance, Economics	
Course Objectives:	The course aims to provide the student with an: 1. Understanding of entrepreneurial skill sets and different types of entrepreneurship. 2. Explanation of Differences between New Enterprise, Social Enterprise and Family Business 3. Describes the process of preparing business plan, operational plans to start an enterprise 4. Apply the knowledge of market analysis, product planning, customer requirements, costing and finance	
Content:		**No. of Hours**
Unit-1	**Entrepreneurial Characteristics:** Overview on Entrepreneurship, Broad classification of entrepreneurs; Leadership, Goal Setting, Time and resource Planning, Communication, Networking, Knowledge & Skill Upgradation; Awareness of Social and Industrial Eco-system; Awareness of Government Policies and Schemes; Digital marketing and business promotion; Local and global market; Basic understanding of Legal and regulatory system, Intellectual Property Rights; Financial Literary; Decision making and risk taking abilities	**18**
Unit-2	**Creation of New Enterprise:** Creativity, Innovation, technology, wealth creation, social impact, Team building, Business Plan, project formulation and feasibility analysis; business simulation; designing and configuring business models and customers, Enterprise management tools and techniques; Launching and managing enterprises; Sales & Marketing Strategies; Human Resources; Incubation, Costing and Financial Plans, Case Studies	**14**
Unit-3	**Social Entrepreneurship:** Overview**,** project formulation and feasibility analysis; understanding customer needs, positioning the firm for social change and strategic advantage; social business model; participatory development; stakeholders; social impact assessment; networking; regional economic models; banking and loans; Women Entrepreneurship; Case Studies	**14**

Unit-4	**Family Business Management :** Small and Medium Business Enterprises; Growth plan formulation; Vision, Values and Strategies, Turn around strategies, cost management, finance and liquidity, family to corporate culture; Case Studies;	**14**
Pedagogy	Interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	1. Nagasubba Rayudu, 'A Textbook on Entrepreneurship & Incubation', Mahi Publications, 2023, ISBN: 978811949282 2. Balasubramanya. M.H., 'Entrepreneurial Ecosystems for Tech Startup in India', Verlag Max Publications, 2021, 9783110679298. 3. Kenji Uchino, 'Entrepreneurship for Engineers', CRC Press, 2010, ISBN: 978143980063 4. Ryszard Praszkier, Andrzej Nowak, 'Social Entrepreneurship', Theory and Practice, Cambridge University Press, 2011, ISBN 9781139504331 5. Peter Leach, Tatwamasi Dixit, 'Indian Family Business Mantras', Rupa Publications, 2016, ISBN: 9788129136945 6. Bill Bolton, John Thompson, 'Entrepreneurs – Talent, Temperament, Opportunity', Elsevier Publications, 2004, ISBN:0750661283 7. John Bessant, Joe Tidd, 'Entrepreneurship', John Wiley Publications, 2015, ISBN: 9781118993095	
Course Outcomes:	After going through this course, student will be able to: CO 1. Understand entrepreneurial skill sets and different types of entrepreneurship. CO 2. Classify New Enterprise, Social Enterprise and Family Business CO 3. Explain process of preparing business plan, operational plans to start an enterprise CO 4. Apply the knowledge of market analysis, product planning, customer requirements, coting and finance	

(Back to Index)