Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed syllabus (DJS22)

M.Tech.

in

Mechanical Engineering

(Manufacturing Systems Engineering)

(Semester I, II, III and IV)

Revision: 1 (2022)

With effect from the Academic Year: 2022-2023

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Scheme for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Semester I

Sr	Course Code	Course	Teaching Scheme				Semester End Examination						Continuous Assessment									
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration (Hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Termwork			CA Total (B)	Aggregate (A+B)	Credits earned	
																Laboratory Work	Tutorial / Mini project / Presentation/ Journal	Term Work Total				
1	DJS22MPGC101	Computer Integrated Manufacturing Systems	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJS22MPGL101	Computer Integrated Manufacturing Systems Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	15	10	25	25	50	1	
2	DJS22MPGC102	Quality Engineering	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJS22MPGL102	Quality Engineering Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	15	10	25	25	50	1	
3	DJS22MPGL103	Advanced Manufacturing Lab	--	2	--	1	--	--	25	--	--	25	--	--	--	15	10	25	25	50	1	1
4@	DJS22MPGC111	New Product Design & Development	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22MPGC112	Smart Materials	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22MPGC113	World Class Manufacturing	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
5@	DJS22MPGC121	Manufacturing Planning and Control	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22MPGC122	Reliability Engineering	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22MPGC123	Micro and Nano Manufacturing	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
6#	DJS22OPGC131	Data Analytics	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC132	Journey from Intellectual Property to Patenting	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC133	Cyber Security and Laws	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC134	Agile Frameworks	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC135	Design of Experiments	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC136	Operations Research	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
		Total	**15**	**6**	**--**	**18**	**--**	**375**	**75**	**--**	**--**	**450**	**125**	**125**	**125**	**45**	**30**	**75**	**200**	**650**	**18**	

@ Any 1 Department Level Elective
# Any 1 Institue Level Elective

Shri Vile Parle Kelavani Mandal's
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Scheme for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Semester II

Sr	Course Code	Course	Teaching Scheme				Semester End Examination						Continuous Assessment							Aggregate (A+B)	Credits earned	
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration (Hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Termwork			CA Total (B)			
																Laboratory Work	Tutorial / Mini project / Presentation/ Journal	Term Work Total				
1	DJS22MPGC201	Industrial Automation	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJS22MPGL201	Industrial Automation Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	15	10	25	25	50	1	
2	DJS22MPGC202	Advanced Quantitative Techniques	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJS22MPGL202	Advanced Quantitative Techniques Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	15	10	25	25	50	1	
3	DJS22MPGL203	Manufacturing Simulation Lab	--	2	--	1	--	--	25	--	--	25	--	--	--	15	10	25	25	50	1	1
4@	DJS22MPGC211	Strategic Manufacturing for Sustainability	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22MPGC212	Additive Manufacturing and Rapid Prototyping	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22MPGC213	Manufacturing Systems Design	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
5@	DJS22MPGC221	Logistics & Supply Chain Management	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22MPGC222	Machine Health Monitoring Management	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22MPGC223	Smart Industries	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
6#	DJS22OPGC231	Machine Learning	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC232	Renewable Energy	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC233	Digital Marketing	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC234	Project Management	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC235	Research Methodology	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
	DJS22OPGC236	Product Life Cycle Management	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	3
		Total	**15**	**6**	**--**	**18**	**--**	**375**	**75**	**--**	**--**	**450**	**125**	**125**	**125**	**45**	**30**	**75**	**200**	**650**	**18**	

@ Any 1 Department Level Elective
# Any 1 Institue Level Elective

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Scheme for Second Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester IV (Autonomous)
(Academic Year 2023-2024)

Semester III

Sr	Course Code	Course	Teaching Scheme				Semester End Examination						Continuous Assessment								Aggregate (A+B)	Credits earned	
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration (Hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Termwork			CA Total (B)				
																Laboratory Work	Tutorial / Mini project/ Presentation	Term Work Total					
1@	DJS22MPGC301	NPTEL Online Course	03	--	--	3	--	--	--	--	--	75	25	25	25	--	--	--	25	100	3	**3**
2	DJS22MPGS302	Special Topic Seminar	--	04	--	2	--	--	50	--	--	50	--	--	--	--	50	50	50	100	2	**2**
3	DJS22MPGD303	Dissertation Phase I	--	20	--	10	--	--	--	--	--	--	--	--	--	--	100	100	100	100	10	**10**
		Total	**03**	**24**	**--**	**15**	**--**	**--**	**50**	**--**	**--**	**125**	**--**	**--**	**25**	**--**	**150**	**150**	**175**	**300**	**15**	

@ The NPTEL credit course is to be finalised by the student in consulation with the project guide/supervisor

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Scheme for Second Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester IV (Autonomous)
(Academic Year 2023-2024)

Semester IV

Sr	Course Code	Course	Teaching Scheme				Semester End Examination						Continuous Assessment								Aggregate (A+B)	Credits earned	
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration (Hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Termwork			CA Total (B)				
																Laboratory Work	Presentation/ Publication	Term Work Total					
1	DJS22MPGD401	Dissertation Phase II	--	30	--	15	--	--	100	--	--	100	--	--	--	50	50	100	100	200	15	**15**	
		Total	**--**	**30**	**--**	**15**	**--**	**--**	**100**	**--**	**--**	**100**	**--**	**--**	**--**	**50**	**50**	**100**	**100**	**200**	**15**		

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: Computer Integrated Manufacturing Systems</td><td colspan="3">Course Code: DJS22MPGC101</td></tr>
<tr><td colspan="8">Course: Computer Integrated Manufacturing Systems Laboratory</td><td colspan="3">Course Code: DJS22MPGL101</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme
(Hours / week)</td><td colspan="9">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="2">Lectures</td><td rowspan="2">Practical</td><td rowspan="2">Tutorial</td><td rowspan="2">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="3">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">2</td><td rowspan="3">--</td><td rowspan="3">4</td><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">50</td></tr>
<tr><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>25</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Manufacturing systems.
2. Various stages of Product life cycle.

Objectives:

1. To understand overall aspects of manufacturing systems and the manufacturing supporting systems.
2. To understand the CIM database and database management system of a manufacturing firm.
3. To understand the functioning of computer integrated manufacturing Enterprise.

Outcomes: On completion of the course, learner will be able to:

1. Understand the basic principles of CIM and its elements.
2. Distinguish different types of inspection methods.
3. Emphasis the importance of group technology and cellular manufacturing systems.
4. Design automated material handling and storage systems for a typical production system.
5. Understand the importance of data communications in CIM environment.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to CIM:** Introduction to CIM, Evolution, objectives, benefits, limitations, relationship between automation and CIM, CIM hardware and software, role and functioning of elements of CIM, CIM Wheel.	**07**
2	**Computer Process Monitoring and Control:** Computer Process Monitoring: Data logging Systems-Data acquisition systems- Multilevel scanning. Computer Control: Computer-Process Interfacing-Manufacturing Process Data- System Interpretation of Process Data-Interface Hardware Devices-Digital Input /Output Processing Interrupt system-Control programming-Computer Process Control-Structural Model of a Manufacturing Process- Process Control Strategies-Distributed Control versus Central Control- Supervisory Computer Control.	**08**
3	**Development and implementation of an FMS:** Planning phase, Integration, System configuration, FMS layouts, Simulation, FMS Project development steps. Project management, Equipment development, Host system development, planning, Hardware & Software development. **Automated Material Handling & Storage:** Functions, Types, Analysis of material handling equipment's, Design of Conveyor & AGV systems. Problems. Development for total material handling system (Case study: Automatic Identification and data capturing).	**06**
4	**Computer Aided Process Planning and Quality Control** **(CAPP):** Introduction and types. **(CAQC):** Introduction to inspection and testing. Automated inspection principles and methods- When and where to inspect, quantitative analysis of inspection, inspection technologies – contact and non-contact types. Computer aided testing.	**07**
5	**Cellular Manufacturing Systems:** Part Families, Parts Classification and Coding, Features of Parts Classification and Coding Systems, Opitz of Parts Classification and Coding Systems, Production Flow Analysis, Composite Part Concept, Machine Cell Design, Applications Of Group Technology, Quantitative analysis of Cellular Manufacturing, Grouping of parts and Machines by Rank Order Clustering, Arranging Machines in a GT Cell, introduction to just in time and Holonic manufacturing. Concurrent Engineering: Benefits and techniques of Concurrent Engineering, Framework for integration of Life-cycle phases in CE, and Collaborative Product Development.	**07**
6	**Role of Information Systems & Enterprise Wide Integration in CIM and CIM Models:** Introduction to Networking, Principles of Networking, Network Terminology, Types of Networks, Selection of Network Technology, networks for manufacturing, Communication medium, Network Topology, Medium access control Methods, Signaling methods; Network Architectures and Protocols: OSI Model, MAP & TOP, TCP/IP, Network Interconnection and Devices, Network Performance. Framework for Enterprise-wide Integration, CIM Models. CIM database and database management systems. Manufacturing Data: Types, sources, Database models, Architecture, Database Management System (DBMS), Product Data Management (PDM), Advantages of PDM.	**07**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

List of Experiments / Tutorials:

1. Case study presentation /Actual Visits/Presentation on below topic- Operation, Control and Programming of various computer controlled machines in the FMS such as CNC machine tools, Automated Storage/Retrieval (AS/RS) systems, Robots, automated assembly station, etc.
2. Simulation and performance analysis of the FMS, parts flow control on Assembly station.
3. Study experiments on Integration aspects in computer integrated manufacturing environment.
4. Importance of Artificial Intelligence.

Books Recommended:

Reference Books:

1. Groover, M.P: "Automation, Production System and CIM"- Prentice - Hall of India.
2. Vajpayee, "Principles of CIM" - Prentice-Hall of India.
3. Ranky, Paul G: "Computer Integrated Manufacturing"- Prentice-Hall of India.
4. Nanua Singh, "Systems Approach to Computer Integrated Design and manufacturing" - John Wiley.
5. Geoffrey Boothroyd , "Assembly Automation and Product Design", (Manufacturing Engineering and Materials Processing).
6. Radhakrishnan.P, Subramanyan. S, "CAD/CAM/CIM", New Age International Publishers.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practical performed during laboratory sessions.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of experiments/tutorials, Power Point Presentation and assignments.
The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments/Tutorials): 15 Marks
ii. Journal Documentation (Write-up, Power Point Presentation and Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: Quality Engineering</td><td colspan="3">Course Code: DJS22MPGC102</td></tr>
<tr><td colspan="8">Course: Quality Engineering Laboratory</td><td colspan="3">Course Code: DJS22MPGL102</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Basic statistics.
2. Knowledge of sample size, measurements and related terminology.

Objectives:

1. To study fundamentals of statistical techniques.
2. To acquaint with various quality management tools.
3. To overcome obstacles for achieving a successful quality management.
4. To enable and understand Total Quality Management (TQM).

Outcomes: On completion of the course, learner will be able to:

1. Demonstrate the understanding of modern quality concepts.
2. Demonstrate the understanding of statistical quality control charts.
3. Apply standard sampling plans.
4. Analyse modern management trends in quality improvement.
5. Apply concepts of TQM.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Quality Dimensions of Products and Services** Definition & Evolution of Quality, Quality Assurance, and Quality Characteristics (dimensions). Quality Control, Quality tasks & means to control them, Quality costs concept & its categories, Cost reduction program and economics of quality.	**07**
2	**Statistical Quality Control** Basic Concept of Statistical Quality Control (SQC), Statistical Tools in Quality Control. Concept & causes of variation, statistical aspect of control charting. Concept of rational sub-grouping and detecting patterns on the control charts, for variables and attributes: X and R, p, np, c and u charts; specification and tolerances, natural tolerance limits, specification limits, process capability ratio analysis and studies. Concept of Acceptance Sampling, Lot by lot sampling process, types.	**07**
3	**Total Quality Management** Basic concepts of TQM, historical review, leadership, concepts, role of senior management, quality statements, plans for process parameters, Implementation of TQM, ISO 9000 quality system, Jurans Triology, Deming's Approach to TQM, Zero defect Concept.	**07**
4	**Total Productive Maintenance** History and Impact of TPM, Overall Equipment Effectiveness (OEE). Developing the TPM implementation Plan, Preventive Maintenance, techniques- FMEA, POKAYOKE and Future of TPM.	**07**
5	**Six Sigma and Modern Quality Management Tools** Evolution of six-sigma quality approach, steps involved in the application of six sigma, six sigma and Indian Industries. Concept of process capability, Basic & Modern tools in quality improvement, Benchmarking, KAIZEN, JIT, 5-S, Taguchi quality loss function. Introduction to DOE and RSM.	**07**
6	**Case Studies** Few case studies to understand how companies in various industries successfully implemented QE into their systems and optimized it.	**07**

List of Experiments / Tutorials:

1. Using live data from separate case studies, complete analysis of minimum three topics. Every student is expected to do individual and different three case studies.
2. Use of modern software for complete analysis of data from experimentation or a Field/online survey questionnaire. One full report may be submitted mentioning all its objectives, methodologies, inferences etc.
3. Assignments based on each module

Books Recommended:

Reference Books:

1. Statistical Quality Control By M. Mahajan.
2. Grant, Eugene. L., "Statistical Quality Control", McGraw-Hill, 1996.
3. Ross, P. Taguchi, "Techniques for Quality Engineering", 2nd edition, McGrawHill,1966.
4. Douglas. C. Montgomery, "Introduction to Statistical quality control", John Wiley, 4th Edition 2001.
5. John.S. Oakland, "Statistical process control", Elsevier, 5th edition, 2005.
6. Besterfield D. H., "Quality Control", Prentice Hall, 1993.
7. Sharma S. C., "Inspection Quality Control and Reliability", Khanna Publishers, 1998.
8. Danny Samson, "Manufacturing & Operations Strategy", Prentice Hall, 1991.
9. J. Juran, "Quality Control Handbook", Mcgraw Hill USA.
10. A. V. Feigenbaum, "Total quality control", Mcgraw hill Int.edition USA.
11. W. E .Deming, "Out of crisis", Productivity & Quality publishing Pvt. Ltd., Chennai.
12. A. J. Dunkan, "Quality control & Industrial statistics", Richard D. Irwin INC USA.
13. A. Zaidi, "SPC,concepts,Methodology & tools", Prentice Hall India ltd., New Delhi.
14. Terry Wireman, "Total Productive Maintenance", Industrial Press, 2nd Edition, New York.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the topics discussed during laboratory/tutorial sessions.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of experiments/tutorials, Power Point Presentation and assignments.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments/Tutorials): 15 Marks
ii. Journal Documentation (Write-up, Power Point Presentation and Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

<table>
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<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="8">Course: Advanced Manufacturing Lab</td><td colspan="3">Course Code: DJS22MPGL103</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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<tr><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">50</td></tr>
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<tr><td>25</td><td>--</td><td>--</td><td>10</td><td>15</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Fundamental concepts of Manufacturing processes.

Objectives:

1. To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes and writing part program for industrial machine parts.
2. To expose students to the newer technologies of 3D printing.

Outcomes: On completion of the course, learner will be able to:

1. Generate G & M codes and part programming for any given industrial machine components.
2. Prepare 3D models using various technologies of 3D printing.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
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List of Experiments:

A. Advanced Machining

1. Following experiments are to be conducted on the Computerized Turing Center:
    i. Step turning.
    ii. Taper turning.
    iii. Threading.
    iv. Grooving.
2. Following experiments are to be conducted on the Vertical Machining Center:
    i. Engraving.
    ii. Mirroring.
    iii. Rotation.
    iv. Circular pocketing.
    v. Rectangular pocketing.
3. Design and manufacture of a composite job, highlighting an industrial application.

B. 3D Printing Technology

1. Manufacturing an industrial application component, using Selective Laser Sintering (SLS) technique.
2. Manufacturing an industrial application component, using Stereolithography (SLA) technique.
3. Manufacturing an industrial application component, using Fused Deposition Modeling (FDM) technique.

Books Recommended:

Reference Books:

1. CNC Machines, B.S. Pabla and M. Adithan, New Age International Publishers, 2019.
2. Rapid Prototyping, Principles and Applications, Rafiq I. Noorani, Wiley & Sons, 2006.
3. Rapid Prototyping: Principles and Applications, Chua C.K, Leong K.F and Lim C.S, 2nd Edition, World Scientific, 2010.

Evaluation Scheme:

Semester End Examination (A):

Laboratory:

1. Oral examination will be based on the experiments performed.

Continuous Assessment (B):

Laboratory: (Term work)

Term work shall consist of experiments.

The distribution of marks for term work shall be as follows:

i. Laboratory work: 10 marks
ii. Mini project and Presentation: 15 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: New Product Design & Development</td><td colspan="3">Course Code: DJS22MPGC111</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Machine design fundamentals.
2. Elements of manufacturing engineering.
3. Exposure to computer aided design approach.

Objectives:

1. Acquire a deep understanding & assimilate key concepts pertaining to new product design & development process.
2. Get familiarised with product design & development approach & methodologies based on modern engineering practises, tools and processes.
3. To stimulate creative & inventive solutions to problems.
4. Enable the learner to cope up with the product design challenges posed by the ongoing global competitive scenario.

Outcomes: On completion of the course, learner will be able to:

1. Understand the generic product design & development process, tools and methodologies.
2. Get familiarised with product life cycle & product life cycle assessment.
3. Get familiarised with various software solutions and choose appropriate design approaches.
4. Understand product costing approach and economic feasibility of the product.
5. Get conversant with I.P rights & patenting procedure.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction:** Definition of product design, classification of products and product mix, product architecture. Various considerations for design. Generic steps involved in modern design and development process. Generation of concepts and embodiment of concept. Morphology of design, Design optimization.	**07**
2	**Development Process:** Product life cycle & its implications, identifying customer needs, Kano Model, Bench marking techniques & establishing engineering specifications, creativity techniques, simulation, Rapid Prototyping techniques, Axiomatic design, Pugh concept selection approach, Weighted design matrix.	**07**
3	**Design Process:** Design for manufacturing & assembly (DFMA) , Design for Reliability & Maintainability, Green Design, Sustainable design, Nano design, Sequential and Concurrent design, Reverse engineering techniques, Robust Design & Taguchi's DOE, Legal , Social & Ethical issues related to Design.	**07**
4	**Ergonomics & Aesthetics:** Concepts of human engineering, Psychological & Physiological Considerations, Anthropometry, Workplace, Man- Machine interaction, Comfort Criteria, Environmental Conditions including temperature, illusion, noise, vibrations, control panels and displays. Visual communication skills related to products & services, Concepts of size, shape & texture, Generation of product forms, analogies from nature, colours and colour wheel, psychological implications & interaction of colours.	**07**
5	**Product Costing:** Product costing elements and methodology of product costing. Economic analysis – qualitative and quantitative, Techno commercial viability, case studies on product costing. Value engineering/value analysis – methodology, value engineering job plan, value engineering check list, case studies on value engineering.	**07**
6	**Software solutions& IP Rights:** Drafting Modeling, CAD/CAE tools, CAM interface, CAPP, various softwares employed and their capabilities. Patents & IP Acts – overview & disclosure preparation.	**07**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. Karl T. Ulrich, Steven D. Eppinger, "Product Design & Development", Tata McGrawhill New Delhi, 2003.
2. David G. Ullman, "The Mechanical Design Process", McGrawhill Inc. Singapore, 1992.
3. N. J. M. Roozenberg, J. Ekels, N. F. M. Roozenberg, "Product Design Fundamentals and Methods", John Willey & Sons, 1995.
4. Byers, Mel, "The Design Encyclopedia", John Wiley & Sons, 1994.
5. Kevin Otto & Kristin Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", 1/e 2004, Pearson Education, New Delhi.
6. L. D. Miles, "Value Engineering".
7. Hollins B. & Pugh S., "Successful Product Design", Butterworths London.
8. Baldwin E. N. & Neibel B. W., "Designing for Production", Edwin Homewood Illinois.
9. Jones J. C., "Design Methods", John Willey New York.
10. Bralla J. G., "Handbook of Product Design for Manufacture", McGrawhill New York.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: Smart Materials</td><td colspan="3">Course Code: DJS22MPGC112</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Material Technology.

Objectives:

1. To study the working principles of various smart materials.
2. To identify applicability of various smart materials as actuator and sensor.
3. To study advances in smart materials.

Outcomes: On completion of the course, learner will be able to:

1. Understand working of smart materials and their application as actuator and sensor.
2. Select an appropriate smart material for a given application.
3. Identify applicability of smart materials for new prospective smart structures.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Smart Materials:** Overview of the different types of Smart Materials, Smart materials used in structures, smart material for sensors, actuators controls, memory and energy storage and their inter-relationships, concept of High Bandwidth- Low Strain generating materials (HBLS), and Low Bandwidth High Strain Generating Materials (LBHS).	**07**
2	Overview of the following materials with focus on synthesis, constitutive/governing relationships, strengths and weaknesses, and applications (both sensing and actuation, etc.): a. Peizoelectric Materials. b. Magnetostrictive Materials. c. Shape Memory Alloys. d. Electroactive Polymers.	**07**
3	Overview of the following materials with focus on synthesis, strengths and weaknesses, and applications: a. Ferrofluids and Magneto rheological Fluids and applications in dampers. b. Soft Matter and its applications as smart skins, smart textiles, etc. c. Carbon Nanotubes and Carbon nano-structures and its applications. d. Thermoelectric Materials and Peltier devices.	**07**
4	**Smart Materials for Energy Applications:** Materials used for energy storage, Hydrogen storage materials, Energy harvesting and Energy scavenging from vibrations.	**07**
5	**Composite Materials:** Introduction to Composite Materials, Nano Composite Materials, Soft conducting and magnetic solids, active fiber composites and Smart polymer matrix composites.	**07**
6	**Simulation of Smart Materials:** Case studies on simulation of smart materials.	**07**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. Shape Memory Alloys, D.C. Lagoudas, Springer Science, 2008.
2. Self-healing Materials: Fundamentals, Design Strategies and Applications, S.K. Ghosh, Wiley-VCH Verlag GmbH and Co., 2009.
3. Energy Harvesting Technologies, S Priya and D J Inman, Springer-Verlag, 2008.
4. Optical Materials and Applications, Moriaki Wakaki, CRC Press, 2012.
5. Polymer Nano-composites and their Applications, S.S. Ray, M Bousmina, American Scientific Publishers, 2018.
6. Smart Materials and Structures, M.V. Gandhi and B.S. Thompson, Chapman & Hall, London, New York, 1992.
7. Encyclopedia of Smart Materials Vol. I and II, Mel Scwartz, John Wiley & Sons, 2002.
8. Smart Structures: Analysis and Design, A.V. Srinivasan, Cambridge University Press, Cambridge, New York, 2001.
9. Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, G. Gautschi, Springer, Berlin, New York, 2002.
10. Piezoelectric Actuators and Ultrasonic Motors, K. Uchino, Kluwer Academic Publishers, Boston, 1997.
11. Handbook of Giant Magnetostrictive Materials, G. Engdahl, Academic Press, San Diego, Calif., London, 2000.
12. Shape Memory Materials, K. Otsuka and C.M. Wayman, Cambridge University Press, Cambridge, New York, 1998.
13. Fiber Optic Sensors: An Introduction for Engineers and Scientists, Eric Udd, John Wiley & Sons, New York, 1991.
14. Electroactive Polymers for Robotic Applications: Artificial Muscles and Sensors, Kwang J KIm and Satoshi Tadokore, Springer-Verlag, London, 2007.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: World Class Manufacturing</td><td colspan="3">Course Code: DJS22MPGC113</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
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<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Pre-requisite: Knowledge of

1. Production Management.
2. Industrial Engineering.
3. Quality Assurance.

Objectives:

1. Help the learner understand and assimilate deeper insights into the opportunities & challenges faced by manufacturing as a domain today.
2. Prepare the learner to face the demands and complexities of a global market place.

Outcomes: On completion of the course, learner will be able to:

1. Understand the relevance and basics of World Class Manufacturing.
2. Design and develop a roadmap for world class manufacturing.
3. Meet the challenges that the Indian manufacturer's faces, as it evolves from a domestic to a world class global manufacturer status.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Historical Perspective:** World class manufacturing organizations, Models for manufacturing excellence: Schonberger, Halls, Gunn and Maskell models, Business Excellence. Globalization and International Business; Global Competitiveness and Manufacturing Excellence, Manufacturing and Information age competition; Manufacturing challenges and Problems in Manufacturing Industries.	**06**
2	**System and Tools for World Class Manufacturing:** Improving Product & Process Design – Lean Production – SQC, FMS, Rapid Prototyping, Poka Yoke, 5-S, 3 M, JIT, Product Mix, Optimization, Procurement & stores practices. Total Productive maintenance, Visual Control.	**07**
3	**Benchmark, Bottlenecks and Best Practices:** Concepts of benchmarking, Bottleneck and best practices, Best performers Gaining competitive edge through world class manufacturing Value added manufacturing, Value Stream mapping, Eliminating waste, Toyota Production System, Example.	**07**
4	**HR Dimensions in WCM – WCM Strategy Formulation:** Adding value to the organization, Organizational learning – techniques of removing Root cause of problems – People as problem solvers, New organizational structures. Associates, Facilitators – Teamsmanship, Motivation and reward in the age of continuous improvement.	**07**
5	**Typical Characteristics of WCM Companies:** Performance indicators like POP, TOPP and AMBITE systems– what is world class Performance –Six Sigma philosophy.	**07**
6	**Competitive Indian Manufacturing:** Manufacturing Performance and competitiveness of Indian Firms, Manufacturing objectives and Strategy, Usage of Management Tools and Technologies. Manufacturing Management Practices, IT Infrastructure and Practices, Strategic Intent Framework, Breadth and Integration of IT Infrastructure, The Future WCM. Manufacturing strategy: Futile search for an Elusive Link, Manufacturing Strategic Intent classification translating into action. **WCM - the Indian Scenario:** Case studies on leading Indian companies moving towards world class manufacturing – Task Ahead. Green Manufacturing, Clean manufacturing, Agile manufacturing.	**08**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
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Books Recommended:

Text books:

1. Sahay B. S., Saxena KBC and Ashish Kumar, "World Class Manufacturing - Strategic Perspective Mac Milan Publications", New Delhi.
2. Korgaonkar M. G., "Just In Time Manufacturing", MacMilan Publications.
3. Narayanan V. K., "Managing Technology and Innovation for Competitive Advantage", Prentice Hall, 2000.

Reference Books:

1. Adam and Ebert, "Production and Operational Management", 5th Edition, Prentice Hall learning Pvt. Ltd., New Delhi.
2. Ron Moore, "Making Common Sense Common Practice – Models for manufacturing Excellence", Butter worth Heinmann.
3. Jeffrey K. Liker "The Toyota Way – 14 Management Principles", Mc-Graw Hill, 2003.
4. Chase Richard B., Jacob Robert., Operations Management for Competitive Advantage", 11th Edition, McGraw Hill Publications, 2005.
5. Moore Ron, "Making Common Sense Common Practice", Butterworth-Heinemann, 2002.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

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<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: Manufacturing Planning and Control</td><td colspan="3">Course Code: DJS22MPGC121</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Mathematical statistics.
2. Basic production process.

Objectives:

1. To provide insight into fundamental principles and methodologies related to planning, design, operation, and control of manufacturing systems.
2. To impart analytical abilities to formulate and solve problems faced by modern Manufacturing systems and implement the cost-effective solutions.

Outcomes: On completion of the course, learner will be able to:

1. Analyse various aspects of good manufacturing planning and control framework.
2. Design demand management scheme using demand forecasting methods and prepare aggregate plan.
3. Develop the plan for scheduling and sequencing of manufacturing operations.
4. Create a logical approach to Line balancing in various production systems.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Basic Concepts of Manufacturing Planning and Control (MPC)**: Overview of manufacturing systems and changing manufacturing environment. MPC system, its framework. **Demand Management**: Demand Management in MPC environment. Need for Forecasting the demand in MPC, forecasting methods of qualitative type, quantitative type. Time series analysis: least square method, moving average method, exponential smoothing method. Causal method: regression Analysis. Forecasting Errors and Forecasting Bias.	**06**
2	**Aggregate Planning:** Concept of aggregate planning, decision rules, strategies and methods. **Capacity Planning:** Measures of capacity, Factors influencing effective capacity planning, short range, medium range and long-range capacity planning, Rough cut capacity planning. **Master Production Scheduling:** MPS activity, Techniques.	**08**
3	**Inventory Control:** Basic concepts of inventory, Types of inventory – Q system and p system, Economic Order Quantity, Inventory Models – Deterministic and Probabilistic. Other inventory control techniques – ABC Analysis, HML VED etc. techniques. **Operational Planning: MRP, MRP II, JIT:** Material Requirement planning (MRP) and Manufacturing Resource Planning (MRP-II) - general concepts, types of demands, Inputs to MRP, MRP objectives, outputs of MRP, Estimation of planned order releases. Benefits and Limitations of MRP II, Concept of JIT.	**07**
4	**Production Scheduling and Sequencing:** Inputs for scheduling, factors affecting scheduling, use of Gantt Charts. Sequencing of m jobs on one, two, three and m machines. Two jobs on m machines. Resource Scheduling: Resource smoothing, Resource levelling.	**07**
5	**Process Planning:** Need, pre-requisites and steps in process planning. **Line balancing:** Objectives and constraints in assembly line, heuristic methods for line balancing. **Enterprise Resource Planning (ERP):** Evolution, features, purpose of modeling an enterprise, information mapping, generic model of ERP, Modules in ERP, Methodology of implementation, critical success factors of ERP, Case studies of success and failure of ERP implementations, ERP packages.	**06**
6	**Quantitative Techniques in MPC:** Linear Programming Problems, Assignment, Transportation and Transshipment Models.	**08**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Text books:

1. Thomas E. Vollmann, William L. Berry, D. Clay Whybark (2004), Manufacturing Planning and Control Systems for Supply Chain Management, Mcgraw-hill Companies.
2. Stephen N. Chapman (2005), Fundamentals of Production Planning and Control, Prentice hall, 2006.

Reference Books:

1. Sipper D. and Bulfin R. L., Production Planning, Control and Integration, McGraw Hill, 1997.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
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<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: Reliability Engineering</td><td colspan="3">Course Code: DJS22MPGC122</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Probability theory and distribution curves.

Objectives:

1. To familiarize learners with theory and laws of probability.
2. To acquaint learners with reliability and its concepts.
3. To acquaint learners with various methods to evaluate the system reliability of simple and complex systems.
4. To familiarise learners with the various aspects of Maintainability, Availability and FMEA.

Outcomes: On completion of the course, learner will be able to:

1. Understand and apply the theory and laws of Probability to solve engineering problems.
2. Apply various reliability concepts to calculate different reliability parameters.
3. Estimate the system reliability of simple and complex systems and improve the reliability of system with various techniques.
4. Apply the Reliability concepts in Maintenance of device/equipment.
5. Apply a Failure Mode Effect and Criticality method to carry out Reliability analysis.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Reliability Mathematics:** **Probability Concepts**: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions**: Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of central tendency and Dispersion**: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	**05**
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis**: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models**: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	**07**
3	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems. **Reliability Improvement**: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set and Tie-set method, Success Path method, Decomposition method.	**07**
4	**Failure Mode, Effects and Criticality Analysis**: Failure mode effects analysis (FMEA), severity/criticality analysis, FMECA examples, Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis (FTA) and Event tree Analysis (ETA).	**07**
5	**Reliability Testing:** Types of testing: Life testing, Accelerated testing, Sequential testing, Success failure testing. **Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair vs. Replacement, Availability – qualitative aspects.	**09**
6	**Case studies based on following topics:** Nuclear Power plants, Marine power plant, Computer system and General complex system.	**07**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Text books:

1. L. S. Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. E. Balagurusamy, Reliability Engineering, Tata McGraw-Hill.

Reference Books:

1. B. S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
2. Gupta A. K, "Reliability Engineering & Technology", Macmillan India Ltd., 1996.
3. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
4. P. D. T. Conor, "Practical Reliability Engineering", John Wiley & Sons, 1985.
5. K. C. Kapur, L. R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: Micro and Nano Manufacturing</td><td colspan="3">Course Code: DJS22MPGC123</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Conventional machining processes.
2. Non-conventional machining processes.

Objectives:

1. To give awareness of different techniques used in micro and nano manufacturing.
2. To give in-depth idea of the conventional techniques used in micro manufacturing.
3. To introduce Non-conventional micro-nano manufacturing and finishing approaches.
4. To introduce Micro and Nanofabrication Techniques and other processing routes in Micro and nano manufacturing.
5. To know different techniques used in Micro Joining and the metrology tools in micro and nano manufacturing.

Outcomes: On completion of the course, learner will be able to:

1. Get an awareness of different techniques used in micro and nano manufacturing.
2. Get in-depth idea of the conventional techniques used in micro manufacturing.
3. Become aware about non-conventional micro-nano manufacturing and finishing approaches.
4. Get awareness on micro and nano finishing processes.
5. Understand micro and nanofabrication techniques and other processing routes in micro and nano manufacturing.
6. Know about different techniques used in micro joining and the metrology tools in micro and nano manufacturing.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Precision engineering:** Macro milling and micro drilling, Micro-electromechanical systems – merits and applications, Micro phenomenon in Electro-photography – applications. Introduction to Precision engineering, macro milling and micro drilling, Micro-electromechanical systems – merits and applications, Micro phenomenon in Electro-photography – applications, Introduction to Bulk micromachining, Surface micromachining- steps, Micro instrumentation – applications, Micro Mechatronics, Nanofinishing – finishing operations. Laser technology in micro manufacturing- Practical Lasers, application of technology fundamentals. Introduction to Micro-energy and chemical system (MECS), Space Micro-propulsion, e-Beam Nanolithography – important techniques, Introduction to Nanotechnology, Carbon Nano-tubes – properties and structures, Molecular Logic Gates and Nano level Biosensors – applications.	**06**
2	**Introduction to mechanical micromachining:** Micro drilling – process, tools and applications. Micro turning- process, tools and applications, Diamond Micro turning – process, tools and applications. Micro milling and Micro grinding – process, tools and applications. Micro extrusion- process and applications. micro bending with Laser. Nano- Plastic forming and Roller Imprinting.	**06**
3	**Introduction to Non-conventional micro-nano manufacturing:** Process, principle and applications – Abrasive Jet Micro Machining, WAJMM. Micro EDM, Micro WEDM, Micro EBM – Process principle, description and applications. Micro ECM, Micro LBM - Process principle, description and applications. Focused ion beams - Principle and applications.	**07**
4	**Introduction to Micro and Nano Finishing Processes:** Magnetorheological Finishing (MRF) processes, Magnetorheological abrasive flow finishing processes (MRAFF) – process principle and applications. Force analysis of MRAFF process, Magnetorheological Jet finishing processes. Working principle and polishing performance of MR Jet Machine.Elastic Emission Machining (EEM) – machine description, applications. Ion Beam Machining (IBM) – principle, mechanism of material removal, applications. Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications.	**08**
5	**Introduction to Micro Fabrication:** Basics, flowchart, basic chip making processes. **Introduction to Nanofabrication:** Nanofabrication using soft lithography – principle, applications – Examples (Field Effect Transistor, Elastic Stamp) Manipulative techniques – process principle, applications. Introduction to Carbon nano materials – CN Tubes CN Tubes – properties and applications CN Tube Transistors – Description only Diamond - Properties and applications, CVD Diamond Technology LIGA Process.	**08**
6	**Laser Micro welding:** Laser Micro welding – description and applications, Defects Electron Beam Micro-welding – description and applications Introduction to micro and nano measurement, defining the scale, Uncertainty Scanning Electron Microscopy – description, principle Scanning White-light Interferometry – Principle and application Optical Microscopy – description, application Scanning Probe Microscopy, scanning tunneling microscopy description, application Confocal Microscopy - description, application Introduction to On-Machine Metrology.	**07**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
2. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006.
3. Nitaigour Premchand Mahalik, Micro-manufacturing and Nanotechnology, 2006.
4. V. K. Jain, Micro-manufacturing Processes, CRC Press, 2012.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: Data Analytics</td><td colspan="3">Course Code: DJS22OPGC131</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Fundamentals of probability.
2. Applied Mathematics.

Objectives:

1. To build the strong foundation in statistics which can be applied to analyze data and make predictions.

Outcomes: On completion of the course, learner will be able to:

1. Interpret data using descriptive statistics.
2. Demonstrate sampling distributions and estimate statistical parameters.
3. Develop hypothesis based on data and perform testing using various statistical techniques.
4. Perform analysis of variance on data.
5. Examine relations between data.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Statistics:** Types of statistics, population vs sample Measures of Central Tendency: arithmetic mean, properties, weighted mean, properties, median, mode, grouped and ungrouped data, empirical relation between the mean, median and mode, geometric mean, harmonic mean, relation between arithmetic, geometric and harmonic mean, outlier. Measures of dispersion: range, quartile deviation, mean deviation, standard deviation, properties, variance, root mean square deviation, empirical relations between measures of dispersion, absolute and relative dispersion, coefficient of variation, moments, Pearson's β and γ coefficients, skewness, kurtosis, population parameters and sample statistics, histogram, frequency polygon Measures of position: quartiles, interquartile range, semi interquartile range, percentiles, percentile rank, 10–90 percentile range, box and whisker plot.	**07**
2	**Sampling distribution and Estimation:** Sampling distribution: Central limit theorem, population distribution, chi-square distribution, Z - distribution, student's t-distribution, F-Distribution. Statistical Estimation: Characteristics of estimators, consistency, unbiasedness, unbiased estimates, efficient estimates, sufficient estimators, point estimates, interval estimates, determination of sample size for estimating mean and proportions, estimates of population parameters, probable error.	**07**
3	**Hypothesis Testing for data driven decision making:** Hypothesis testing: Test of significance, null and alternative hypothesis, type I and type II error, factors affecting Type II error, probability of Type II error, power of test, p-Value, critical region, level of significance. Confidence interval: Population mean, difference between two population means, population proportion, difference between two population proportions, variance, ratio of variances of two populations Goodness of fit test using Kolmogorov Smirnov test and Anderson Darling test. Tests using z-statistics: difference between sample proportion and population proportion, difference between two sample proportion, difference between sample mean and population mean with known σ and unknown σ, difference between two sample means, one tailed and two tailed tests Test using t-statistics: difference between sample mean and population mean, difference between two independent sample means, difference between means from the same group; Test using F-statistics: equality of population variance Test using chi-square statistics: test of independence, goodness of fit.	**12**
4	**Analysis of Variance (ANOVA) for data analysis:** Sample size calculation, one way ANOVA, POST-HOC Analysis (Tukey's Test), randomized block design, two-way ANOVA.	**08**
5	**Examining Relationship:** Correlation: Scatter plot, covariance, Karl Pearson's coefficient of correlation, hypothesis test for correlation, correlation vs causation, extreme data values, limits of correlation coefficient, Rank correlation, Spearman's rank correlation coefficient, Repeated ranks, partial and multi correlation. Regression: linear regression analysis, lines of regression, regression coefficients, scatter plot with regression lines, hypothesis test for regression, multiple regression, coefficient of determination, residuals, collinearity, influential observations.	**08**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Text Books:

1. Ken Black, Business Statistics for Contemporary Decision Making, John Wiley & Sons, Inc. Sixth Edition.
2. Anderson Sweeney Williams, Statistics for Business and Economics, Cengage Learning, 2011.

Reference Books:

1. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Cengage Learning, 2011.
2. Douglas C. Montgomery, George C. Runger, Applied Statistics & Probability for Engineering, John Wiley & Sons, Inc, 2002.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

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<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="2">Semester: I</td></tr>
<tr><td colspan="8">Course: Journey from Intellectual Property to Patenting</td><td colspan="2">Course Code: DJS22OPGC132</td></tr>
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</table>

Objectives:

1. To understand, define and differentiate different types of intellectual properties (IPs).
2. Assessing different IP management (IPM) approaches.
3. Exposure to the Legal management of IP and understanding of real-life practice of IPM.

Outcomes: On completion of the course, learner will be able to:

1. Recognize the crucial role of IP for the purposes of product and technology development.
2. Understand how and when to file a patent.
3. Apply the knowledge to understand the entire ecosystem.
4. Derive value from IP and leverage its value in new product and service development.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Intellectual Property Law:** Introduction and the need for intellectual property right (IPR), Intellectual Property laws, IPR in India: Genesis and development, Major International Instruments concerning Intellectual Property Rights: Paris Convention, the Berne Convention, the Universal Copyright Convention, the WIPO Convention, the Patent Cooperation Treaty, the TRIPS Agreement, Types of IPR.	**05**
2	**Patents and Trademarks:** Elements of Patentability: Novelty, Non-Obviousness, Industrial Application, Non-Patentable Subject Matter, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties, Patent office and Appellate Board, Case study of existing patents related to software, healthcare, devices. Concept of Trademarks, Different kinds (brand names, logos, signatures, symbols, well known marks, certification marks and service marks), Non-Registrable Trademarks, Registration of Trademarks, Rights of holder and assignment and licensing of marks, Infringement, Remedies & Penalties, Trademarks registry and appellate board.	**09**
3	**Copyrights and Design:** Copyrights: Nature, Subject matter: original literary, dramatic, musical, artistic works, cinematograph films and sound recordings, Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright, Infringement, Remedies & Penalties, Related Rights, distinction between related rights and copyrights. Design: meaning and concept of novel and original, procedure for registration, effect of registration and term of protection.	**09**
4	**Patenting:** Introduction to the Indian Patent System, Patent Law as Concepts, IPR as a group of rights, Patent Rights, Fundamental of Patents, Patent Law in India, Understanding the Patents Act and the Rules.	**08**
5	**Patent Drafting and Searching:** • Anatomy of a patent application • Adequate disclosure • The art of drafting patent claims • Patent searching: • Purposes and techniques • Available On-line tools	**06**
6	**Actions for patent infringement:** • Interpretation of claims • Doctrine of equivalents • Product testing as a possibly infringing use • Doctrine of exhaustion • Legal and equitable remedies for infringement	**05**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Text books:

1. Feroz Ali, The Law of Patents -With A Special Focus On Pharmaceuticals In India, LexisNexis, 2011.
2. Ronald D. Slusky, Invention Analysis and Claiming – A Patent Lawyer's Guide, Second Edition, American Bar Association, 2012.
3. Feroz Ali, The Touchstone Effect – The Impact of Pre-grant Opposition on Patents, LexisNexis, 2009.

Reference Books:

1. Drucker. F. Peter, Innovation and Entrepreneurship, Harper business, 2006.
2. Deborah. E. Bouchoux, Intellectual Property Rights, Cengage Learning, 2013.
3. Prabuddha Ganguli, Intellectual Property Rights– Unleashing The Knowledge Economy, Tate Mc Graw Hill Publishing Company Ltd., 2001.
4. Martin Roger, The Design of Business, Harvard Business Publishing, 2009.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: Cyber Security and Laws</td><td colspan="3">Course Code: DJS22OPGC133</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Computer Network.
2. Information Security.

Objectives:

1. To understand and identify distinct types of cybercrime and cyber offences.
2. To recognized Indian IT Act 2008 and its latest amendments.
3. To learn several types of security standards compliances.

Outcomes: On completion of the course, learner will be able to:

1. Understand the distinct types of cybercrime and security issues E Business.
2. Analyses distinct types of cyber threats and techniques for security management.
3. Explore the legal requirements and standards for cyber security in various countries to regulate cyberspace.
4. Impart the knowledge of Information Technology Act and legal framework of right to privacy, data security and data protection.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Cybercrime:** Cyber Crime, Cyber Law, Cyber Security, History of Cyber Crime, Hacking, Data Theft, Cyber Terrorism ,Virus & Worm's ,Email Bombing ,Pornography, online gambling ,Forgery ,Web Defacements, Web Jacking, Illegal online Selling, Cyber Defamation, Software Piracy, Electronics/ Digital Signature, Phishing ,Password Cracking, Key loggers and Spywares, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Over Flow ,Attacks on Wireless Networks ,Phishing Identity Theft (ID Theft). **Cyber offenses:** How criminal plan the attacks, Social Engg, Cyber stalking, Cybercafe and Cybercrimes, Botnets, Attack vector.	**12**
2	**Cyber Threats Analysis:** Knowledge of Dynamic and Deliberate Targeting, Knowledge of Indications and Warning. Knowledge of Internal Tactics to Anticipate and/or,Emulate Threat Capabilities and Actions. Knowledge of Key Cyber Threat Actors and their Equitie, Knowledge of Specific Target. Identifiers and Their Usage. **Cyber Security Management:** Knowledge of Emerging Security Issues, Risks, and Vulnerabilities.	**08**
3	**Electronic Business and legal issues:** Evolution and development in Ecommerce, Policy Frameworks for Secure Electronic Business, paper vs paper less contracts, E-Commerce models- B2B, B2C, E security. E-Payment Mechanism; Payment through card system, E-Cheque, E-Cash, E-Payment Threats & Protections, Security for E-Commerce.	**06**
4	**Indian IT Act:** Cyber Crime and Criminal Justice, Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments. **Security aspect in cyber-Law:** The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law.	**08**
5	**Security Industries Standard Compliances:** IT Security v/s IT Compliance, Cyber Security Standards, critical security controls for cyber security, GRC (Governance, Risk Management, and Compliance). SOX, GLBA, HIPAA, ISO/IEC 27001, NIST Cyber Security Framework (CSF), PCI-DSS. OWASP Top Ten Project., GDPR (General Data Protection Regulation), NIST (National Institute of Standards and Technology), CIS Controls (Center for Internet Security Controls).	**08**

Books Recommended:

Reference Books:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi.
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi.
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. E-Commerce Security and Privacy", Anup K. Ghosh, Springer Science and Business Media, 2012.
5. Izzat Alsmadi , The NICE Cyber Security Framework Cyber Security Intelligence and Analytics, Springer.
6. Cyber Law & Cyber Crimes by Advocate Prashant Mali; Snow White Publications, Mumbai.
7. Nina Godbole, Information Systems Security, Wiley India, New Delhi.
8. Kennetch J. Knapp, Cyber Security &Global Information Assurance Information Science Publishing.
9. William Stallings, Cryptography and Network Security, Pearson Publication.
10. Websites for more information is available on: The Information Technology ACT, 2008- TIFR: https://www.tifrh.res.in.
11. Website for more information, A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: I</td></tr>
<tr><td colspan="8">Course: Agile Frameworks</td><td colspan="3">Course Code: DJS22OPGC134</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="4">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="4">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">--</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">--</td><td rowspan="2">--</td><td rowspan="2">3</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Pre-requisite: Knowledge of

1. Software Engineering.

Objectives:

1. To focus on the phases of agile project management.
2. To equip the student on the scaling techniques for agile projects.
3. To analyze the performance of agile projects.
4. To develop the skills of the students on product development.
5. To equip the students on agile delivery and risk mitigation.

Outcomes: On completion of the course, learner will be able to:

1. Summarize the concepts of agile practices and business objectives.
2. Gain knowledge on the phases of agile development framework.
3. Have an exposure on the scaling factors and models to be developed for agile projects.
4. Acquire knowledge on the agile performance measurement.
5. Develop the product based on agile factors with risk mitigation.
6. Describe the role of agile in enterprise management and incremental delivery.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Agile Frameworks:** Agile definitions and historical context, Agile Values and Principles found in the Agile Manifesto, Misconceptions about Agile. Selecting an Approach that Fits: Choosing between an Agile or Traditional Approach, Selecting the Right Agile Approach.	**05**
2	**Agile Methodologies:** The Agile Methodologies: Common Themes, Methodology Descriptions, Extreme Programming, Scrum, Feature Driven Development, The Crystal Methodologies, Adaptive, Software Development, Dynamic Systems Development Method, Lean Software Development, Starting Monday: Investigate Further.	**07**
3	**Extreme Programming (XP):** Understanding XP (Extreme Programming) - XP life cycle, XP team, XP Concepts, Adopting XP-Knowing whether XP is suitable, Implementing XP, assessing Agility, Practicing XP - Thinking-Pair Programming, Energized work, Informative Workspace, Root cause Analysis, Retrospectives.	**07**
4	**Planning Agile Projects:** Planning for Agile Teams, Scrum Teams, XP Teams, General Agile Teams, Collaboration Rooms, Team Distribution. Agile Project Lifecycles, Typical Agile Project Lifecycles, Activities within each Phase, Create product vision, Producing a Minimum Marketable Feature. Release Planning, Creating the Product Backlog, User Stories, Prioritizing and Estimating, Creating the Release Plan. Monitoring and Adapting, Task Boards and Information Radiators, Control Limits, Variance and Trend Analysis, Managing Risks and Issues, Retrospectives.	**10**
5	**Agile Estimations and Leading Agile Teams:** Introduction to Agile Estimations, Needs, Stakeholders, Estimation Stages, Estimation Styles and Process. Velocity, Sprint Velocity. Skills needed by Agile Leaders, Emotional Intelligence, Listening Skills, Command and Control vs. Servant Leadership, Adaptive Leadership, Collaboration, Facilitation, Problem Solving and Participatory Decision-Making Skills, Coaching and Mentoring Teams, Conflict Resolution.	**07**
6	**Advanced Emerging Techniques and Case Studies:** Learn, value streams and Kanban models, Lean, Crystal, DevOps and continuous deployment strategies, Scaling agile processes, Case study.	**06**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Text Books:

1. The art of Agile Development, James Shore and Shane Warden, 11th Indian Reprint, O'Reilly, 2018.

Reference Books:

1. Learning Agile, Andrew Stellman and Jennifer Greene, O'Reilly, 4th Indian Reprint, 2018.
2. Practices of an Agile Developer, Venkat Subramaniam and Andy Hunt, SPD, 5th Indian Reprint, 2015.
3. Agile Project Management - Jim Highsmith, Pearson Low price Edition 2004.

Web Resources (For Reference):

1. https://www.xpand-it.com/blog/top-5-agile-methodologies.
2. https://apc01.safelinks.protection.outlook.com/GetUrlReputation.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="4">Semester: I</td></tr>
<tr><td colspan="8">Course: Design of Experiments</td><td colspan="4">Course Code: DJS22OPGC135</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="4">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="4">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
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<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Pre-requisite: Knowledge of

1. Applied Statistics.
2. Regression and Analysis of Variance.

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE).
2. To list the guidelines for designing experiments.
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization.

Outcomes: On completion of the course, learner will be able to:

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action.
2. Apply the methods taught to real life situations.
3. Plan, analyze, and interpret the results of experiments.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	**07**
2	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models. Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	**07**
3	**Two-Level Factorial Designs and Analysis:** The 2^2 Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split Plot Designs.	**07**
4	**Two-Level Fractional Factorial Designs and Analysis:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	**07**
5	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	**07**
6	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	**07**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001.
2. D. C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001.
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley.
4. W. J. Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2.
5. Design and Analysis of Experiments (Springer text in Statistics), Springer, A. M. Dean, and D. T. Voss.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="4">Semester: I</td></tr>
<tr><td colspan="8">Course: Operations Research</td><td colspan="4">Course Code: DJS22OPGC136</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="4">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="3">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">--</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">--</td><td rowspan="2">--</td><td rowspan="2">3</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Pre-requisite: Knowledge of

1. Fundamental concepts of Mathematical statistics.

Objectives:

1. To formulate a real-world problem as a mathematical programming model.
2. To understand the mathematical tools that are needed to solve optimization problems.
3. To use mathematical software to solve the proposed models.

Outcomes: On completion of the course, learner will be able to:

1. Convert a real-world problem in to a Linear Programming Problem and Interpret the solution obtained using Simplex method or other algorithms.
2. Understand reasons of formation of queues, Classify various queuing systems and Apply performance parameters defined for various queuing systems for decision making in real life situations.
3. Describe concept of simulation and Apply Monte Carlo Simulation technique to systems such as inventory, queuing and Develop solutions for them.
4. Solve the Game and explore the optimal strategies.
5. Identify the decision situations which vary with time and Analyze them using principle of dynamic programming to real life situations.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Linear Programming Problem:** Introduction to Operations Research (OR), Decision situations, Decision making process, Concept of Optimization, Mathematical Models. Linear Programming: Linear Programming Problem - Mathematical Formulation, Finding Optimal solution using Graphical method, Simplex method, Big-M method, Two Phase method, Special cases, Principle of Duality.	**09**
2	**Special Cases of LPP:** Transportation problem: Formulation - Finding Optimal solution, Degeneracy. Assignment problem: Formulation - Finding Optimal solution. Travelling Salesman Problem.	**07**
3	**Dynamic Programming:** Introduction - Bellman's Principle of optimality - Applications of dynamic programming to capital budgeting, inventory, employment smoothening, cargo loading and shortest path problem.	**08**
4	**Game Theory:** Introduction - Minimax (Maximin) Criterion and optimal strategy - Solution of games with saddle points – 2 x 2 games - dominance principle - m x 2 & 2 x n games, Iterative Method.	**06**
5	**Queuing Model:** Introduction - Poisson arrivals - Exponential service time. Single Channel – Single server - Infinite population and finite population models, Multichannel - Single server - Infinite population models. Constant Service rate - Single Channel – Single server - Infinite population.	**06**
6	**Simulation:** Definition - Methodology of simulation – Monte Carlo Simulation Technique - applications to Inventory and Queuing problems – Advantages and Limitations of Simulation. Simulation Languages.	**06**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester I (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="4">Semester: II</td></tr>
<tr><td colspan="8">Course: Industrial Automation</td><td colspan="4">Course Code: DJS22MPGC201</td></tr>
<tr><td colspan="8">Course: Industrial Automation Laboratory</td><td colspan="4">Course Code: DJS22MPGL201</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="4">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td colspan="3">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">50</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">2</td><td rowspan="2">--</td><td rowspan="2">4</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>25</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Manufacturing systems.
2. Mechanical measurements and control.
3. Industrial electronics.

Objectives:

1. To acquaint with basic concepts of industrial automation involving pneumatic and hydraulic controls.
2. To familiarize with the elements of electro-pneumatic interface with control systems.
3. To learn about programmable logic controller.
4. To know the role of robotics in Automation.

Outcomes: On completion of the course, learner will be able to:

1. Students shall be able to understand the working of automation systems and shall acquire the insight to build the automation systems.
2. Illustrates the use of PLC in Automation.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Automation:** Need of Automation, Automation Principles and Strategies, Elements of Automated system, Levels of Automation, Automation in manufacturing system, Advanced automation function, Arguments for and against automation (with case studies).	**03**
2	**Hardware components for Automation:** Sensors- Displacement, position and Proximity Sensors, Velocity and Motion Sensors, Force and Fluid Pressure Sensors, Liquid level and Flow sensors, Temperature and light Sensors, Actuators- Hydraulic, Pneumatic and electric, ADC and DAC and systems concepts, time domain analysis, frequency domain analysis, time-frequency analysis.	**06**
3	**Industrial Circuits:** Pneumatic Control - Different types of valves and Actuators in Pneumatics, their applications and use of their ISO symbols, Design of Pneumatic circuits using Cascade method and Shift Register Method. (Up to 3 cylinders), Design of Electro- Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping Hydraulic Control - Different types of valves and Actuators in Hydraulics, their applications and use of their ISO symbols, Meter in, meter out and Bleed off circuits. Sequencing circuits, Accumulators and their types. Applications of Accumulator circuits, Problems based on sizing and selection of Hydraulic components, Actuation technology in Hydraulic valves: Proportional and Servo Hydraulics and Digital Hydraulics. Design of Electro- Hydraulic, circuits.	**12**
4	**Programmable and Logic Controller:** PLC configuration and selection, PLC Basic components and their symbols Control transformers and fuses - Switches and Indicator lamps, Relays and time delay relays PLC Programming - Fundamentals of Ladder Programming, Ladder programming for logic gates and latching, Sequencing, counters, timers, shift register and Master & Jump control, Data acquisition system, Data logger, Microprocessor, Microcontroller, digital communication, digital controller, SCADA.	**08**
5	**Control Engineering:** Design of PD, PI and PID Controllers. Frequency Response Analysis - Frequency domain specifications for second order system, Nyquist plot State Space Analysis - State space representation of systems, Controllability and Observability, Transfer function from state space matrices Mathematical modelling of Servo systems - Armature controlled D. C. motor, Field controlled D.C. motor.	**07**
6	**Robotics:** Automation and Robotics, Robot types, anatomy and related attributes, accuracy, repeatability Trajectory planning, Robot control system and end effector, Sensors in robotics, Industrial application and future applications, Introduction to Artificial Intelligence.	**06**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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List of Experiments / Tutorials:

1. Using live data from separate case studies, complete analysis of minimum three topics. Every student is expected to do individual and different three case studies.
2. Use of modern software for complete analysis of data from experimentation or a Field / online survey questionnaire. One full report may be submitted mentioning all its objectives, methodologies, inferences etc.
3. Assignment based on each module.

Books Recommended:

Reference Books:

1. Mikell P. Grover, Automation Production Systems, and Computer Integrated Manufacturing, PHI, 2011, Third Edition.
2. W. Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering, Pearson Education, 2003.
3. K. Ogata, Modern Controls Engineering, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
4. Antony Esposito, Fluid Power Systems and control, Prentice-Hall, 1988.
5. Joji P., Pneumatic Controls, Wiley India, 2011.
6. I. J. Nagrath and Gopal, Control System Engineering, New age international (P) Ltd., 2005.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of experiments/tutorials, Power Point Presentation and assignments.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments/Tutorials): 15 Marks
ii. Journal Documentation (Write-up, Power Point Presentation and Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: II</td></tr>
<tr><td colspan="8">Course: Advanced Quantitative Techniques</td><td colspan="3">Course Code: DJS22MPGC202</td></tr>
<tr><td colspan="8">Course: Advanced Quantitative Techniques Laboratory</td><td colspan="3">Course Code: DJS22MPGL202</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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<tr><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">50</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">2</td><td rowspan="2">--</td><td rowspan="2">4</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>25</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Basic Knowledge of Algebra, Probability and Statistics.

Objectives:

1. To equip the students with the expert knowledge and skills needed to apply the various quantitative techniques for decision making.

Outcomes: On completion of the course, learner will be able to:

1. Explain significance of sensitivity analysis of LPP and Perform sensitivity analysis on various parameters involved in LP model.
2. Recognize the limitations of simplex method in deriving integer solution to LPP and Employ suitable algorithm to obtain integer solution.
3. Analyse various decision-making situations, Outline decision alternatives and Select the best alternative.
4. Describe a real-world problem as a Non-Linear Programming Problem and Distinguish local, global extreme points and point of inflection.
5. Explain significance of Markov Analysis to predict the state of a system.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Decision model and Quantitative techniques:** Concept of decision making and decision problem, Mathematical Model of decision problem, Concept of Optimization, Quantitative techniques for finding optimal solutions to decision problems. **Linear Programming Problem:** Mathematical Formulation. Overview of Simplex Method. Sensitivity Analysis. **Linear Goal programming:** Formulation as Goal programming model, Optimal solution by graphical method and simplex method.	**08**
2	**Integer Programming Problem:** Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique.	**06**
3	**Nonlinear programming problems (NLPP):** Convex programming. Unconstrained NLPP –Search Algorithm and Gradient method. Constrained NLPP – Kuhn-Tucker Conditions, Geometric Programming. Quadratic programming.	**08**
4	**Network Optimization Models:** Shortest Path, Minimum Spanning Tree, and Maximum Flow Problems.	**06**
5	**Decision Theory:** Decision Making under risk, under uncertainty, Decision Trees & Utility Theory, Bayesian approach in decision making. Decision Making under certainty, Introduction to concepts of AHP (Analytic Hierarchy Process) & ANP (Analytic Network Process).	**08**
6	**Markov Analysis:** Stochastic Process, Markov Process, Transition Probability Matrix, Markov Chain.	**06**

List of Experiments / Tutorials:

1. Exercises on LPP Software, AHP Software's & others.
2. Exposure to other OR & Simulation software.
3. Live case studies / Assignments based on each module.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. Taha H.A., Operations Research - An Introduction, Prentice Hall.
2. Ravindran A., Phillips, D. T and Solberg, J. J., Operations Research: Principles and Practice, John Willey and Sons.
3. Hiller F. S. and Liebermann G. J., Introduction to Operations Research, Tata McGraw Hill.
4. Pradeep Prabhakar Pai, Operations Research Principles and Practice, Oxford University Press.
5. S. D. Sharma and Kedar Nath Ram Nath, Operations Research, Meerut.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the topics discussed during laboratory/tutorial sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Laboratory work shall consist of at least one assignment from each unit and each assignment shall involve solving at least four examples/ case studies. Students are expected to use software available online to solve some of the problems.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments/Tutorials): 15 Marks
ii. Journal Documentation (Write-up, Power Point Presentation and Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: II</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="8">Course: Manufacturing Simulation Lab</td><td colspan="3">Course Code: DJS22MPGL203</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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</table>

Pre-requisite:

1. Basic knowledge of Engineering Mechanics.
2. Basic knowledge of types of loads, free body diagram.
3. Basic knowledge of Forging, Forming and Additive manufacturing.

Objectives:

1. To gain knowledge of different types of stresses, strain and deformation induced in the mechanical components due to external loads and other processes.
2. To gain knowledge of cost reduction in any considered process.

Outcomes: On completion of the course, learner will be able to:

1. Identify Understand, simulate and optimize the processes under consideration.
2. Simulate and work for cost reduction in any given process.

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List of Experiments: *(Any Eight selecting at least 1 from each field)*

1. **Simulation in the Fields of Forming considering any of the following:**
   Cold Forming / Hot Forging / Ring Rolling / Sheet Metal Forming / Rolling.
2. **Simulation in the Fields of Joining considering any of the following:**
   Arc Welding / Mechanical Joining.
3. **Simulation in the Fields of Additive Manufacturing considering any of the following Fields of application:**
   Power bed Fusion / Deposition method / metal Binder Jetting.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.
The experiments can be performed on SIMUFACT,ANSYS or Any other relevant software.

Evaluation Scheme:

Semester End Examination (A):

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Laboratory: (Term work)

Term work shall consist of minimum 8 experiments, and minimum 6 assignments.
The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal Documentation (Write-up, and Assignments: 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="4">Semester: II</td></tr>
<tr><td colspan="8">Course: Strategic Manufacturing for Sustainability</td><td colspan="4">Course Code: DJS22MPGC211</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="4">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
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</table>

Pre-requisite:

1. Exposure to environmental science and engineering.
2. Knowledge on engineering materials and new age materials.
3. Knowledge of product design and product life cycle management.

Objectives:

1. To get acquainted with concepts, various dimensions and significance of sustainability.
2. Acquire knowledge on emerging approaches in waste management.
3. Understand the ongoing trends and innovations in energy management.
4. Get exposure to the role of environmental management in modern business world.

Outcomes: On completion of the course, learner will be able to:

1. Identify and deal with economic, social and technological concerns in sustainable manufacturing front.
2. Pursue eco-friendly approaches in managing various forms of waste including hazardous waste.
3. Apply environment friendly options in design and manufacturing operations to bring down carbon foot prints.
4. Get adequate exposure to energy efficient initiatives and energy management.
5. Get exposure to environmental standards/legislations and develop capability in assessing environment impact.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction:** Concepts related to sustainability and sustainable development, Green expectations and global sustainability agenda. Confronting climate change and global warming, Environmental preservations, wake up conferences, voice of society and green movement.	**07**
2	**Waste Management:** Types & sources of waste, segregation &waste processing, Green processing and engineering approaches, energy recovery, life cycle approach – cost benefits, R3&R6 cycles, methods to infuse sustainability in early phase of product design approach, cradle to cradle approach.	**07**
3	**Materials for Sustainability**: Energy efficient and environment friendly materials. New age materials, Materials and process selection, Material disposal, Material for recycling, biodegradable materials, control on non-renewable material usage, integrating sustainability concepts, Toxicity and health impact.	**07**
4	**Design for Sustainability:** Conversion technologies, concept of Eco-innovation, sustainable loading on ecosystems, energy conservation and energy audit, environmental analysis from raw material to disposal, product life cycle assessment, sustainable design approach and matrices for sustainable designs, case studies on sustainable design.	**07**
5	**Environment Management:** Influence of cultural, political and economic changes in transforming role of environmental management in business world, Environmental standards & legislation, carbon foot print assessment and carbon trading, Anti-Pollution boards, Kyoto protocol, Initiatives at national and global level, Alternative product & process change and manufacturing practices, Environment and human health effect hazards, mitigation management. Role of IT & communication networking.	**07**
6	**Sustainability Assessment:** Multi-Objective decision making, concept models and approaches, evolving sustainability issues in operating strategy. Product and process sustainability and risk /benefit assessment. Sustainability impact assessment, corporate social responsibilities and initiatives, sustainability rating schemes, eco -labelling and energy labelling programmes, Continuous sustainability awareness initiatives, Industrial case students.	**07**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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Books Recommended:

Reference Books:

1. Sustainable Development by M. K. Ghosh Roy - Ane Books Pvt. Ltd.
2. Green Management by M. Karpagam, Geetha Jaikumar - Ane Books Pvt. Ltd.
3. Essential Environmental Studies by S. P. Misra, S.N. Pandey - Sheth Publishers.
4. Design for Environment: A Guide to Sustainable Product Development by Joseph Fiksel - McGraw-Hill Companies.
5. E books Sustainable Manufacturing by J. Paulo Davim – Wiley Publishers.
6. E book - Sustainable Manufacturing- Shaping global value creation by Gunther Seliger – Springer.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="4">Semester: II</td></tr>
<tr><td colspan="8">Course: Additive Manufacturing and Rapid Prototyping</td><td colspan="4">Course Code: DJS22MPGC212</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="4">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Computer-aided design & computer-aided manufacturing.

Objectives:

1. To familiarize with importance of Rapid Prototyping in Product Development.
2. To make students aware about latest additive manufacturing technology used in industry.
3. To make students aware about various additive manufacturing processes and material availability.
4. To enable students to understand, describe and evaluate the different post processing techniques currently used on Additive Manufacturing parts.
5. To make students aware about latest research in the area of additive manufacturing.

Outcomes: On completion of the course, learner will be able to:

1. Understand importance of Rapid Prototyping in product development.
2. Apply basic knowledge of additive manufacturing to decide type of additive manufacturing process and material according components design requirement.
3. To calculate and justify the cost of a typical additive manufacturing operation including labour costs, overhead costs, and consumable costs.
4. Evaluate the different post processing techniques used on AM parts, including those required for removal of support structures, improvement of surface characteristics and structural integrity.
5. Conduct research work and research writing in the field of additive manufacturing.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction:** Product Development Cycle and the product Life Cycle, Problems in Product Development, Relationship between Product Development Cost and the Selling Price, Rapid prototyping need, Classification of RP systems, advantages and limitations of RP, Applications and scope of RP, Introduction to additive manufacturing.	**08**
2	**Design for Additive Manufacturing:** Multiple Materials, Hybrids, Functionally Graded Materials, Composite Materials, current and future directions; Process Modelling of AM process- Design optimization through finite-element modelling of AM- Simulation of phase transformations- heating, melting, forming, solidification and finishing and rheological studies of various AM materials.	**06**
3	**Classification of Additive Manufacturing Processes:** Seven Classes of Additive Manufacturing, Binder jetting, Directed Energy Deposition, Powder Bed Fusion, Sheet Lamination, Material Extrusion, Material Jetting, Vat Photo Polymerization Detailed discussion on latest technique available on each type of additive manufacturing processes. Specification, working principal, material compatibility and Post processing.	**08**
4	**Additive Manufacturing System Design:** Process selection, Material selection, labour cost involved, overhead cost calculation, consumables cost, machine maintenance, Project Planning, Sensors used Jigs and fixtures, Thermal management, Manufacturing Quality management.	**08**
5	**Applications of Additive Manufacturing:** Aerospace Applications, Medical applications, Art and Design applications, Energy applications, architecture applications.	**06**
6	**Intellectual Property Rights, IPR in Additive Manufacturing:** Case studies on Latest patents in the field of additive manufacturing, Case studies based on latest article Published in Scopus, SCI, and ESCI indexed journal.	**06**

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Books Recommended:

Text Books:

1. Additive Manufacturing Technologies – Ian Gibson, David W Rosen, Brent Stucker., Mahyar Khorasani – Springer.
2. Additive Manufacturing – Juan Pou, Antonio Riveiro and J. Paulo Davim – Elsevier.

Reference Books:

1. Multi-dimensional Additive Manufacturing – Soshu Kiriharal, Kazuhiro Nakata – Springer.
2. Additive Manufacturing Processes – SanjayKumar – Springer.
3. Polymer Based Additive Manufacturing – Declan M. Devine – Springer.
4. Materials for Additive Manufacturing – Yusheng Shi, Chunze Yan, Yan Zhou, Jiamin Wu, Yan Wang, Shengfu Yu,Ying Chen – Academic Press, Elsevier.
5. Additive Manufacturing (A Tool for Industrial Revolution 4.0) – M. Manjaiah, K. Raghavendra, N. Balashanmugam, J. Paulo Davim – Woodhead Publishing.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

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<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: II</td></tr>
<tr><td colspan="8">Course: Manufacturing Systems Design</td><td colspan="3">Course Code: DJS22MPGC213</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Different manufacturing processes.
2. Production planning and Control.
3. Important software tools for design and manufacturing.

Objectives:

1. To acquaint the students with concepts of manufacturing systems engineering and design.
2. To familiarise the students with various manufacturing systems and approaches for various areas of applications.
3. To impart knowledge in design and adoption of manufacturing systems to achieve improved productivity and cost benefits.

Outcomes: On completion of the course, learner will be able to:

1. Understand and appreciate the capabilities and limitations of various manufacturing systems.
2. Identify and select appropriate manufacturing systems for specific applications.
3. Design and implement appropriate model of manufacturing systems in specific contexts.
4. Cope up with the ongoing demands of the industry, specifically on the manufacturing front.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Manufacturing system fundamentals:** Basic concepts and definition of system, system design, structural and transformational aspects of manufacturing systems, integrated manufacturing and management systems.	**04**
2	**Process systems for manufacturing:** Logistics planning and design, Product planning and design, Process planning and design, Layout planning and design.	**06**
3	**Group technology and cellular manufacturing systems:** Concepts of cellular manufacturing, comparison between cellular and traditional manufacturing, Cell characteristics, Techniques of cellular manufacturing, Advantages and Limitations. Cell design and cell formation techniques, processing of exceptional components in cellular manufacturing. Evaluation of cellular manufacturing solutions, cell characteristics, Production control activities in cellular manufacturing and implementation issues.	**10**
4	**Management systems for manufacturing:** Managerial information flow, Aggregate production planning and scheduling, Inventory management, Production control and Quality control.	**08**
5	**Automation systems for manufacturing:** CAD, CAM, CIM, FMS, Computer integrated automation systems- concept of ghost factory and Overview of industry 4.0.	**07**
6	**Information system for manufacturing:** MIS (Management information systems), SIS (Strategic information systems), Parts oriented production information systems, Online production control systems and Computer based production management systems.	**07**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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Books Recommended:

Reference Books:

1. Marco Garetti, Design and Management of Production Systems: Tutorials and Case Studies.
2. Wallace J. Hopp and Mark L. Spearman, Factory Physics, Waveland Press Inc. USA.
3. B.S. Nagendra Parashar, Cellular Manufacturing Systems: An Integrated Approach, PHI Learning Pvt. Ltd.
4. Manufacturing Systems Engineering, Katsundo Hitomi, Viva Books Pvt. Ltd.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

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<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: II</td></tr>
<tr><td colspan="8">Course: Logistics and Supply Chain Management</td><td colspan="3">Course Code: DJS22MPGC221</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Engineering Physics.
2. Materials Technology.
3. Strength of Materials.

Objectives:

1. To understand the primary differences between logistics and supply chain management.
2. To understand the individual processes of supply chain management and their interrelationships within individual companies and across the supply chain.
3. To understand the management components of supply chain management.
4. Familiarize the students with the tools and techniques used in implementing supply chain management.
5. To understand how supply chain strategy can provide competitive advantage for organization.

Outcomes: On completion of the course, learner will be able to:

1. Demonstrate the functional strategy map of supply chain management.
2. Analyze the determinants of Supply Chain and Transportation networks design.
3. Demonstrate the need of coordination and sourcing decisions in supply chain.
4. Understand pricing, revenue management and role of IT in supply chain.
5. Understand various sustainability aspects of a supply chain.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to LSCM:** Objective, Importance, Decision Phases, Process Views. Competitive and Supply Chain Strategies, Achieving Strategic Fit, Expanding Strategic Scope, Challenges to Achieving and Maintaining Strategic Fit. **Supply Chain Drivers and Metrics:** Financial Measures of Performance, Drivers of Supply Chain Performance, Framework for Structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing. **Creating the Responsive Supply Chain:** Product push versus demand pull, The Japanese philosophy, The foundations of agility, A route-map to responsiveness. **Information Systems in Supply Chain:** IT enabled SC, Best practices & benchmarking for SC, towards Green SC, towards World class SCM. Role of IT in Logistics management, the role of information in the virtual supply chain.	**09**
2	**Network Design in the Supply Chain:** The Role of Network Design in the Supply Chain, Factors Influencing Network Design Decisions, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation.	**07**
3	**Designing Global Supply Chain Networks:** The Impact of Globalization on Supply Chain Networks, The Offshoring Decision: Total Cost, Risk Management in Global Supply Chains, Discounted Cash Flows, Evaluating Network Design Decisions Using Decision Trees.	**07**
4	**Coordination and Sourcing Decisions in a Supply Chain:** Lack of Supply Chain Coordination and the Bullwhip Effect, The Effect on Performance of Lack of Coordination, Obstacles to Coordination in a Supply Chain, Managerial Levers to Achieve Coordination, Continuous Replenishment and Vendor-Managed Inventories, Collaborative Planning, Forecasting, and Replenishment. The Role of Sourcing in a Supply Chain, In-House or Outsource, Third- and Fourth-Party Logistics Providers, Using Total Cost to Score and Assess Suppliers, Supplier Selection—Auctions and Negotiations, Contracts, Risk Sharing and Supply Chain Performance, Design Collaboration, The Procurement Process.	**07**
5	**Pricing and Revenue Management in a Supply Chain:** The Role of Pricing and Revenue Management in a Supply Chain, Pricing and Revenue Management for Multiple Customer Segments, Pricing and Revenue Management for Perishable Assets, Pricing and Revenue Management for Seasonal Demand, Pricing and Revenue Management for Bulk and Spot Contracts.	**06**
6	**Sustainable Supply Chain:** The Role of Triple Bottom Line, Key Metrics for Sustainability, Greenhouse gases and the supply chain, Reducing the transport-intensity of supply chains, Beyond the carbon footprint, Reduce, reuse, recycle, Sustainability and Supply Chain Drivers.	**06**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. Sunil Chopra, P. Meindl, Supply Chain Management, Pearson Education Asia.
2. R. P. Mohanty, S. G. Deshmukh, Essentials of Supply Chain management, Phoenix publishing House Pvt. Ltd.
3. Martin Christopher, Logistics and Supply Chain Management, Pitman Publishing.
4. Bowon Kim, Mastering Business in Asia: Supply Chain Management, John Wiley and Sons.
5. Michael Hugos, Essentials of Supply Chain Management, John Wiley and Sons.
6. S.K. Bhattacharya, Logistics Management, Pearson Publication.
7. R.P. Mohanty, S.G. Deshmukh, Supply Chain management- Theories and Practices, Biztantra.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="4">Semester: II</td></tr>
<tr><td colspan="8">Course: Machine Health Monitoring Management</td><td colspan="4">Course Code: DJS22MPGC222</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="4">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Mechanical Vibrations.

Objectives:

1. To introduce parameters involved in machine health monitoring management.
2. To make students aware about Instrumentation and Signal Processing in machine health monitoring management.
3. To introduce importance of pattern recognition in machine health monitoring management.
4. To impart knowledge about the application of artificial intelligence techniques in Condition monitoring.
5. To impart knowledge about the application of Machine learning techniques in Condition monitoring.

Outcomes: On completion of the course, learner will be able to:

1. Understand basics of machine health monitoring management.
2. Apply basic Instrumentation and signal processing technique in machine health monitoring management.
3. Recognize pattern in problems involved in machine health monitoring.
4. Gain knowledge about the application of artificial intelligence techniques in Condition monitoring.
5. Gain knowledge about the application of Machine learning techniques in Condition monitoring.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Asset Management:** Digital Asset Management, Fixed Asset Management, IT Asset Management, Enterprise Asset Management, Financial Asset Management, Infrastructure Asset Management. **Introduction to Maintenance Strategies:** Proactive Maintenance, Predictive Maintenance, Planned Maintenance, Condition-Based Maintenance, Responsive Maintenance, Emergency Maintenance.	**08**
2	**Introduction to Machine Health Monitoring Management:** Machine failures, Maintenance strategies, machine condition monitoring, Vibration signatures of faults in rotating and reciprocating machines, detection and diagnosis of faults. **Fracture mechanics:** LEFM, EPFM, Stress intensity factor, crack identification, crack propagation, residual life, residual life determination, Airy's stress function, Westguard's solution.	**08**
3	**Instrumentation and Signal Processing:** Types of sensors used in machine health monitoring: vibration, acoustics and noise, acoustic emission, temperature, ultrasonic and infrared sensors - Signal processing: basic signal and systems concepts, time domain analysis, frequency domain analysis, time-frequency analysis.	**06**
4	**Pattern Recognition:** Feature extraction and feature selection methods, feature reduction using PCA - discriminant functions and decision boundaries, decision trees, maximum likelihood and nearest neighbour. Application and case studies of machine health monitoring: Bearings, gear boxes, engines, structural health monitoring, machine tool condition monitoring etc.	**08**
5	**Introduction to Condition Monitoring Using Artificial Intelligence:** Approaches to Condition Monitoring, Components of Condition Monitoring, Measurement System and Pre-processing, Feature Extraction, Statistical Features, Vibration-based Condition Monitoring, Dissolved Gas Analysis, Artificial Intelligence Approaches, Single AI Approaches, Hybrid AI Approaches.	**06**
6	**Introduction to Machine Learning in Conditioning monitoring:** Machine Learning Tools, Artificial Neural Network, Support Vector Machine, Extension Neural Network, Fuzzy ARTMAP. Introduction to Incremental Learning and its Application to Condition Monitoring.	**06**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. Telli Van der Lei, Paulien Herder and Ype Wijnia, Asset Management, Springer.
2. Dan B. Marghitu and Mihai Dupac ButterworthHeinemann, Machine Component Analysis with MATLAB, Elsevier.
3. Juan Carlos A. Jauregui Correa and Alejandro A. Lozano Guzman, Mechanical Vibrations and Condition Monitoring, Academic Press, Elsevier.
4. Hasmat Malik, Nuzhat Fatema and Atif Iqbal, Intelligent Data-Analytics for Condition Monitoring, Academic Press, Elsevier.
5. Ray S. Beebe, Predictive Maintenance of Pumps Using Condition Monitoring, Elsevier Science.
6. William Bolton Newnes, Instrumentation and Control Systems, Elsevier.
7. Leonidas Deligiannidis and Hamid R. Arabnia Morgan Kaufmann, Emerging Trends in Image Processing, Computer Vision and Pattern Recognition, Elsevier.
8. Sergios Theodoridis, Aggelos Pikrakis, Konstantinos Koutroumbas and Dionisis Cavouras, Introduction to Pattern Recognition, Academic Press, Elsevier.
9. Lin C. and Lee G., Neural Fuzzy Systems, Prentice Hall International Inc.
10. Cornelius Leondes, Fuzzy Logic and Expert Systems Applications, Academic Press, Elsevier.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="4">Semester: II</td></tr>
<tr><td colspan="8">Course: Smart Industries</td><td colspan="4">Course Code: DJS22MPGC223</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Basic courses in Mechanical Engineering.

Objectives:

1. To provide students with a comprehensive understanding of the smart industry concept, Industry Revolution and Industry 4.0, key drivers and technologies for Smart Industries and Implications of Smart Industry.

Outcomes: On completion of the course, learner will be able to:

1. Understand the basic principles behind smart industry.
2. Identify smart industry key levers and drivers.
3. Understand the supporting technologies for Smart factories.
4. Learn from leading industries and develop smart factory roadmaps.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Smart Industry:** Traditional Manufacturing Practices and Limitations, Industry Revolution, Introduction to Fourth Industrial Revolution and Concept of Smart Industry, Journey of Smart Industry, Key Drivers of smart industry/Industry 4.0, Changing Society, Product and Processes, Need for renovating and standardizing production and manufacturing Industries to compete with global challenges, Smart Industry Roadmap, Opportunities and Challenges.	**06**
2	**Supporting Tools and Technologies for Smart Industries – Part I:** Introduction to and Use of following Technologies in Smart Industries: Industrial IOT, Sensing and actuation, Autonomous Robots, Additive Manufacturing, Horizontal and Vertical System Integration.	**06**
3	**Supporting Tools and Technologies for Smart Industries – Part II:** Introduction to and Use of following Technologies in Smart Industries: AI, Cloud Computing, Big Data and advanced analytics, ICT, Block chain technology, smart grids, Cyber Physical Systems, Augmented Reality and Virtual Reality in Smart Factories.	**10**
4	**Dimensions of Smart Manufacturing and Logistics:** **Smart manufacturing:** Smart and connected products, Smart Machines, Smart materials, smart manufacturing processes, Smart material handling, Sustainable manufacturing and renewable energy. **Smart Logistics:** Marketing and sales, post sales service and customer relationship management, Smart Money: Digital payment strategy in India.	**10**
5	**Real time tracking and Machine monitoring:** Real time tracking of parts, WIP, tools, personnel and associated tools and challenges. Purpose of machine monitoring, tools and functions involved in predictive maintenance of machines.	**05**
6	**Smart Industry applications with case studies:** Discussion on case studies and success stories across industries who had developed and implemented several smart factory solutions.	**05**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Text Books:

1. Handbook of Industry 4.0 and SMART Systems, Diego Galar Pascual, Pasquale Daponte and Uday Kumar, CRC Press.

Reference Books:

1. Implementing Industry 4.0: The Model Factory as the Key Enabler for the Future of Manufacturing, Carlos Toro, Wei Wang, and Humza Akhtar, Springer Publications.
2. Smart Digital Manufacturing: A guide of digital transformation with real case studies across industries, Rene Wolf and Raffaello Lepratti, Wiley-VCH publications.
3. Intelligent Transportation Systems: Smart and Green Infrastructure Design, Frank Kreith, Mechanical Engineering Series, Taylor and Francis Group.
4. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj and Anupama C. Raman, CRC Press.
5. Internet of Things, Jeeva Jose, Khanna Publishing House, Delhi.
6. Block Chain Basics, Daniel Drescher, Apress.
7. Sensors and Actuators, C.W. De Silava, CRC Press.
8. Introduction to sensors, J. Vetelino and A. Reghu, CRC Press.
9. Smart Plant Factory: The Next Generation Indoor Vertical Farms, Toyoki Kozai, Springer Nature Publications.
10. Introduction to Industry 4.0 and Industrial Internet of Things, Prof. Sudip Misra, NPTEL Course, IIT Kharagpur.
11. Smart Industry & Smart Education, Michael E. Auer and Reinhard Langmann – Springer Publications.
12. Cyber physical systems in the context of Industry 4.0, IEEE International Conference on Automation, Quality and Testing, Robotics, 2014.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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</table>

Pre-requisite: Knowledge of

1. Statistical Signal Processing.

Objectives:

1. To To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with regression methods, classification methods and clustering methods.
3. To introduce students to the basics of Genetic Algorithms.

Outcomes: On completion of the course, learner will be able to:

1. Analyze the applications, which can use Machine Learning Techniques.
2. Understand and Apply regression, classification and clustering methods to the database.
3. Interpret the difference between supervised and unsupervised learning methods.
4. Understand the working of Reinforcement learning.
5. Understand basic concepts of Genetic Algorithms.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Machine Learning:** Machine Learning Terminologies, Types of ML, Goals and Applications of ML, Choosing the right Algorithm. Designing a Learning System: The concept learning task, concept learning as search General to specific ordering of hypothesis, Find-S, Candidate elimination Algorithm.	**07**
2	**Regression and Tree based Learning:** Linear Regression, Logistics Regression. Introduction, Decision tree representation, appropriate problems for decision tree learning, basic decision tree algorithm, hyperspace, search in decision tree learning, issues in decision tree learning.	**07**
3	**Probability and Instance based Learning:** Probability theory and Bayes rule, Naive Bayes learning algorithm. Introduction, K-nearest neighbour learning, case-based learning, radial basis functions.	**07**
4	**Clustering and Unsupervised Learning:** Learning from unclassified data, K-means Clustering, Expectation maximization Algorithm, Semi supervised learning with EM using labelled and unlabelled data. Supervised Learning after clustering, Choosing number of clusters.	**07**
5	**Supervised and Reinforcement Learning:** Techniques of Supervised Learning: Supervised Learning Overview, Linear Model (Numerical Functions), Perceptron Learning Algorithm (PLA) – Classification, From Linear to Nonlinear, Adaptive Perceptron Learning Algorithm (PLA), Classification, Support Vector Machine (SVM), Extension to Multi-class Problems. Reinforcement Learning: Overview, Example and Uses.	**08**
6	**Genetic Algorithms:** Genetic Algorithms: Introduction, genetic operators, genetic programming, models of evolution & learning, parallelizing genetic algorithm.	**06**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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Books Recommended:

Text books:

1. Peter Harrington, Machine Learning in Action, DreamTech Press, 2012.
2. Ethem Alpaydın, Introduction to Machine Learning, MIT Press, 2014.
3. Tom M.Mitchell, Machine Learning, McGraw Hill Science, 1997.
4. Stephen Marsland, Machine Learning an Algorithmic Perspective CRC Press 2014.
5. Christopher Bishop, Pattern recognition and machine learning, Springer, 2006.
6. Stuart J. Russell and Peter Norvig, Artificial Intelligence A Modern Approach, 2nd Edn, Pearson Education.
7. George F Luger, Artificial Intelligence, Low Price Edn, 4th Edn, Pearson Education.

Reference Books:

1. William W.Hsieh, Machine Learning Methods in the Environmental Sciences: Neural Networks and Kernels, Cambridge, 2009.
2. Han Kamber, Data Mining Concepts and Techniques, 3rd Edn, Morgann Kaufmann Publishers.
3. Margaret H. Dunham, Data Mining Introductory and Advanced Topics, Pearson Education, 2006.
4. Elaine Rich and Kevin Knight, Artificial Intelligence, 3rd Edn, Pearson Education.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

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<tr><td colspan="8">Course: Renewable Energy</td><td colspan="4">Course Code: DJS22OPGC232</td></tr>
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</table>

Objectives:

1. Understand the renewable energy resources availability, potential and suitability as a substitute for conventional energy resources in future energy demand.

Outcomes: On completion of the course, learner will be able to:

1. Identify sustainable energy solutions for sustainable development.
2. Analyze renewable energy resources availability and utilization.
3. Demonstrate competency in renewable systems analysis independently.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction:** Renewable and non-renewable energy sources, global and Indian scenario. **Energy alternatives:** The solar option, nuclear option, tar sands and oil shale, tidal energy, geothermal energy.	**05**
2	**Solar energy:** Solar radiation, availability, measurement and estimation, solar thermal conversion devices such as flat plate collector, tubular collector, solar air collector, solar concentrator and storage. **Applications:** Crop drying, distillation, water heating, electric power generation. **Solar photovoltaic:** Photovoltaic cell technologies, generations of solar cell, electrical characteristics, photovoltaic module and array, photovoltaic module system components and design.	**09**
3	**Biomass energy conversion:** Biomass characteristics and their availability, biofuel production processes, bio-methane, bio-hydrogen, alcoholic fermentation, biodiesel, microbial fuel cell, biomass-based steam power plant, combined cycle power plant, cogeneration plant, Energy from Waste.	**09**
4	**Wind energy:** Wind turbines, aerodynamics, types of turbines wind energy conversion system, wind turbine generator types, advantages and disadvantages. **Hydro power:** Water turbines, hydroelectric system theory, measurement and components, advantages and disadvantages of hydroelectric system.	**08**
5	**Geothermal energy:** Structure of earth, geothermal resources, exploration of geothermal energy. **OTEC:** Principle, applications. **Tidal:** Principle, power calculation, tidal modes of operation. **Wave:** Wave motion, energy conversion and devices applications.	**06**
6	**Economic analysis:** Initial and annual costs, present worth calculation, annual savings, payback period.	**05**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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Books Recommended:

Text books:

1. Vaughn C. Nelson, Kenneth L. Starcher, Introduction to Renewable Energy (Energy and the Environment, CRC Press, UK, 2016.
2. B. K Khan, Non-Conventional Energy Resources, TMH New Delhi, 2013.
3. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley, New York, 2013.

Reference Books:

1. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2015.
2. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, Tata McGraw-Hill, New Delhi, 2008.
3. J. Twidell and T. Weir, *Renewable Energy Resources*, E & F N Spon Ltd, London, 1986.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
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</table>

Pre-requisite: Knowledge of

1. Marketing.

Objectives:

1. To learn the fundamentals of Digital marketing.
2. To understand the use of content strategy and social media marketing and email marketing.
3. To understand the role of Search Engine Optimization.
4. To apply techniques in display advertising.

Outcomes: On completion of the course, learner will be able to:

1. Apply B2B and B2C contexts to plan content marketing.
2. Develop and measure impact of content that works well for your target audience.
3. Manage social media presence, and create effective content for each platform.
4. Optimize search engine presence through on-site and off-site activities, develop target keyword list, optimize website UX and design, and execute a link building campaign.
5. Create, execute, and optimize an effective Ad campaign. Display and set up advertising works.
6. Create an email marketing strategy, create and execute email campaigns, and measure the results.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Marketing Fundamentals:** Welcome to Digital Marketing, The Digital Marketing Framework, What: Your Business Welcome to Digital Marketing, The Digital Marketing Framework, What: Your Business Who& When: Your Customer, Where: Marketing Channels, why: Marketing Objectives & KPIs.	**08**
2	**Content Strategy:** Plan Your Content Strategy, Create Content, Distribute & Promote Content, Optimize Website UX & Landing Pages, Measure Impact.	**08**
3	**Social Media Marketing:** Social Media Marketing (Organic), Social Media Landscape, Social Media Channels, Social Media Content, Implement & Monitor Campaigns, Measure Impact, Social Media Advertising (Paid), Intro to Social Media Advertising, Platforms for Social Ads, Facebook – Getting Started, Facebook - Create Ad Sets, Facebook - Create and Manage Ads.	**08**
4	**Search Engine Optimization (SEO):** Search Engine Marketing with AdWords (SEM), How Search Works Keywords, On-Site SEO: Optimize UX & Design, Off-Site SEO:Link-building, SEO Audit & Future of SEO, Adwords & Keyword Selection, Create Text Ads, CPC Bidding, Navigate AdWords, SEM Metrics & Optimization.	**06**
5	**Display Advertising:** How Do Display Ads Work? Display Ads &Targeting, Sales Models, Display Ads in AdWords, Video Advertising.	**06**
6	**Email Marketing:** Email List Generation, Create an Effective Email Campaigns, and Create an Email Plan, Measure Results.	**06**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Text Books:

1. B2B Digital Marketing: Using the Web to Market Directly to Businesses – Miller.
2. Digital Marketing: An Integrated Marketing approach –Star Business series, 2019.
3. Social Media Marketing All-In-One for Dummies by Jan Zimmerman and Deborah Ng, 2017.
4. Google Adwords for Beginners: A Do-It-Yourself Guide to PPC Advertising.
5. Digital Marketing, 1st edition, Vandana Ahuja, Oxford University Press.

Reference Books:

1. Digital Marketing for Dummies by Ryan Deiss and Russ Hennesberry, 2017.
2. Digital Marketing Handbook: A Guide to Search Engine Optimization – Shivani Karwal.
3. Introduction to Programmatic Advertising by Dominik Kosorin, 2016.
4. The Webinar Way: The Single Most Effective Way to Promote Your Services, Drive Leads & Sell a Ton of Product by Sherri Rose, 2012.
5. Social Media Marketing: Strategies for Engaging in Facebook, Twitter & Other Social Media by Liana Evans, Que Publishing, 2010.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="4">Semester: II</td></tr>
<tr><td colspan="8">Course: Project Management</td><td colspan="4">Course Code: DJS22OPGC234</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="4">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
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</table>

Objectives:

1. Identify key areas of concern over Project Life Cycle (PLC) and use of project management principles across all the phases of PLC.
2. Make them understand the importance and necessity of project plan.
3. Make them understand the importance of team and how to work as a team member, share best project management practices.

Outcomes: On completion of the course, learner will be able to:

1. Assess a project by establishing a business case and accordingly prepare a project proposal.
2. Develop a project plan.
3. Identify task inter-dependencies, construct and analyze a network diagram.
4. Monitor and control the performance of the project.
5. Demonstrate Team work and team spirit and resolve conflicts.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**An overview of Project Management:** What is project? Characteristics of project, Project Vs Operations, Project Goals, Project Life Cycle (typical & atypical), Evolution of Project Management, Need of Project Management, Different forms of Project Management, Project Environment, PMBOK. Remote (Virtual) Project Management: Introduction, benefits, challenges, tools for remote project management.	**05**
2	**Project Initiation and Planning:** Project Feasibility, Request for Proposal (RFP), Business Case, Project selection and approval process, Project Proposal, Project Contracting. Planning steps, Project Management Process, Project Charter, Project Planning Framework, Work Breakdown Structure (WBS), Linear Responsibility Chart, Gantt Chart.	**05**
3	**Project Time Management:** Network Diagrams (AOA&AON), Critical Path, PDM network, PERT, CPM, Resource Loading, Resource Leveling, Goldratt's Critical Chain.	**07**
4	**Project Cost Management:** Cost estimating, Cost escalation, Cost estimating and system development cycle, Cost estimating process, Elements of budgets and estimates, Top down and bottom-up budgeting, Project cost accounting and MIS, Budgeting using cost accounts, Cost schedules and forecasts.	**04**
5	**Project Human Resource Management:** Formal & Informal organization, project team, multidisciplinary teams, project leadership, ethics in projects, multicultural projects, Role of project manager. The nature of change, the change management plan, dealing with resistance and conflicts. Remote collaboration and its current state, future prospect of remote collaboration, managing remote teams effectively.	**06**
6	**Project Communication Management:** Monitoring and controlling the project, the project communications plan, project metric – Earned Value Management, data collection and reporting, reporting performance and progress, information distribution.	**05**
7	**Project Risk Management, Project Quality Management:** Basic concepts, Identification, Assessment, and Response plan. Quality Planning, Quality Assurance, Quality Control.	**05**
8	**Project Procurement Management and Project Closure:** Introduction, project procurement management, outsourcing. Project implementation, administrative closure, project evaluation.	**05**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Text Books:

1. John M. Nicholas, Project Management for Business and Technology, 4th edition, Pearson Education.
2. Jack T. Marchewka, Information Technology Project Management, 4th edition, Wiley India, 2009.

Reference Books:

1. E-Book –A Guide to Project Management Body of Knowledge (PMBOK ® Guide), 5th edition, Project Management Institute PA, USA.
2. Claudia M. Baca, Patti M. Jansen, PMP: Project Management Professional Workbook, Sybex Publication.
3. S. J. Mantel, J. R. Meredith and etal., Project Management 7thedition, Wiley India, 2009.
4. Joel Henry, Software Project Management, A real-world guide to success, Pearson Education, 2008.
5. Gido and Clements, Successful Project Management, 2ndedition, Thomson Learning.
6. Hughes and Cornell, Software Project Management, 3rdedition, Tata McGraw Hill.
7. Joseph Phillips, IT Project Management, end edition, Tata McGraw Hill.
8. Robert K. Wyzocki, Effective Project Management, 5th edition, Wiley.
9. Brown, K. A. Project Management, McGraw Hill, 2002.
10. Dinsmore, P. C. (Ed.), The AMA Handbook of Project Management. AMACOM, 1993.
11. https://www.pmi.org.
12. https://www.projectmanager.com.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: II</td></tr>
<tr><td colspan="8">Course: Research Methodology</td><td colspan="3">Course Code: DJS22OPGC235</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Research concepts.

Objectives:

1. To understand Research and Research Process.
2. To acquaint students with identifying problems for research and develop research strategies.
3. To familiarize students with the techniques of data collection, analysis of data and interpretation.

Outcomes: On completion of the course, learner will be able to:

1. Understand research concepts, types, significance and importance of research profile.
2. Prepare a preliminary research design for projects in their subject matter areas.
3. Accurately collect, analyze and report data.
4. Review and analyze research findings.
5. Prepare the research report.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction and Basic Research Concepts:** Meaning of Research, Objectives of Research, Types of Research, Significance of Research, Research Methods versus Methodology, Criteria of Good Research, Problems Encountered by Researchers in India. **Creating Research Profile:** Google Scholar, ResearchGate, ORCID and Publons.	**07**
2	**Defining the Research Problem**: Identifying and Selecting the Research Problem, Necessity of Defining the Research Problem, Technique Involved in Defining a Problem, Importance of literature review in defining a Research Problem, Literature review from primary and secondary sources, research databases, institution repository, searching the web, critical literature review, identifying research gap areas from the literature, developing theoretical background and research framework. **Research Design:** Meaning, Types and Significance. **Research Questions and Hypothesis:** Variables and their linkages, characteristics of a good Hypothesis, Research question and formulation of Research hypotheses, Basis for hypotheses.	**09**
3	**Sample Design:** Sample Design – Meaning and Significance, Essentials of a good sampling. Stages in Sample Design, Sampling methods/techniques, Sampling Errors. **Measurement and Scaling:** Classifications of Measurement Scales, Sources of Error in Measurement, Scaling, Scale Classification Bases, Scaling techniques, Deciding the Scale.	**07**
4	**Data Collection and Analysis:** Sources of Data, Types of Data, Methods of Collecting Data, data processing and analysis with statistical packages, hypothesis testing, generalization and interpretation.	**06**
5	**Research Writing:** Synopsis, Article/Research Paper, Research Proposal for funding agencies, Thesis, Dissertation, Book-Chapter. Layout, structure and format of a Research Report, Criteria of Good Research Writing, Precautions for Writing Research Reports, Patent possibilities. Software for paper formatting, like LaTeX/MS Office. **Indexation & Citation Style:** Concept of Indexing, Indexed by Scopus, PubMed, EBSCO, Web of Science, ISI Indexing, etc. MLA, APA, IEEE, ISO, Chicago, etc. style of citation in Bibliography, Reference Management Software like, Zotero, Mendeley, etc. **Publications from Research:** Identifying the relevant journal and its publisher, predatory journals, Journal Rankings, Research presentation in Conferences, Conferences proceedings.	**07**
6	**Research Ethics:** Research Ethics, Importance of Research Ethics, Scientific Misconduct, Similarity check (Turnitin, Quetext, Plagiarism Detector, Ouriginal software) and Their Prevention, Acknowledgement. **IPR:** Intellectual Property Rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS).	**06**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. Dawson, Catherine, Practical Research Methods, New Delhi, UBS Publishers Distributors, 2002.
2. C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, New Age International 4th Edition, 2018.
3. Ranjit Kumar, Research Methodology a step-by-step guide for beginners, SAGE Publications Ltd 3rd Edition, 2011.
4. Donald R. Cooper, Pamela S. Schindler, J.K. Sharma, Business Research Methods, 12/e (SIE), McGraw-Hill Education, 2018.
5. Wadehra, B.L., Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing, 2000.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

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<tr><td colspan="8">Program: First Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: II</td></tr>
<tr><td colspan="8">Course: Product Life Cycle Management</td><td colspan="3">Course Code: DJS22OPGC236</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Product development process.
2. Environmental science.

Objectives:

1. To familiarize the students with the need, benefits and components of PLM.
2. To acquaint students with Product Data Management & PLM strategies.
3. To give insights into new product development program and guidelines for designing and developing a product.
4. To familiarize the students with Virtual Product Development.

Outcomes: On completion of the course, learner will be able to:

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Understand the need for Product Life Cycle Assessment (LCA) and Life Cycle Cost Analysis.
4. Demonstrate the various PLM Applications, Modules, and virtual product development tools for components, machining and manufacturing plant.
5. Appreciate the significant effect of effective marketing strategies and integration of PLM with other business modules.

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Fundamentals of Product Life Cycle Management (PLM):** Overview of product and product life cycle (PLC), background and concept of product life cycle management (PLM), Need for PLM, Elements/components of PLM, PLM paradigm and environment, Internal and external factors affective PLM, phases involved in PLM, PLM life cycle model and implementation (case study) PLM strategies and principles, organization's visions in line with PLM, strategy identification and selection, change management for PLM etc**.**	**10**
2	**Product Design and Development:** Product, Product structure, product design process and product analysis, New Product design and it's need, organization and decomposition in product design, Design for X and Robust design, Strategies for recovery at end of life, recycling, human factors in product design and concurrent engineering etc. What is product development? New product development – strategies and process, and successful product development.	**08**
3	**Product Life Cycle Assessment (LCA) and Life Cycle Cost Analysis:** Detailed methodology, ISO framework and phases of LCA, Application, benefits and limitations of LCA, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.	**07**
4	**PLM applications and software solutions:** Industry/Product specific Applications of PLM. Product Data Management (PDM) – concept and implementation, Product portfolio management, computer aided design and manufacturing, Digital manufacturing, Product modelling and simulations. (Industry case studies and examples to explain the benefits of PLM and related software tools)	**06**
5	**Integrating PLM Systems with other Aspects of Business and Environment:** Integration of PLM systems with Supply Chain Management, Enterprise resource planning, industry 4.0, Sustainable product development and Design for environment etc.	**07**
6	**Effective Marketing Strategies to Improve Life Cycle of Product:** Understanding marketing, Role of marketing in PLC and organization performance, Identifying business opportunities through market analysis, Consumer/Buyer behavior pattern etc. Developing effective marketing strategies – Differentiating and Positioning product, developing new product, product lines and width, pricing strategies, Market segmentation and Identifying target market, Advertising, branding, customer relations and managing market channels.	**04**

Syllabus for First Year M. Tech. Program in Mechanical Engineering (Manufacturing Systems Engineering): Semester II (Autonomous)
(Academic Year 2022-2023)

Books Recommended:

Reference Books:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105.
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229.
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314.
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for Second Year M. Tech. Mechanical Engineering (Manufacturing Systems Engineering) Semester III and IV (Autonomous) - Academic Year 2023-2024

<table>
<tr><td colspan="8">Program: Second Year M. Tech. Mechanical Engineering</td><td colspan="4">Semester: III</td></tr>
<tr><td colspan="8">Course: NPTEL Credit Course</td><td colspan="4">Course Code: DJS22MPGC301</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="4">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
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</table>

Guidelines for NPTEL Credit Course:

1. The NPTEL online credit course should be finalised by the student in consultation with the project guide/supervisor.
2. The course shall be of advanced or recent topics and should be relevant to the area of the project selected.
3. The selected NPTEL course should have a duration of 8 weeks or 12 weeks.
4. The NPTEL course will be considered equivalent to 3 credits irrespective of its duration.
5. NPTEL courses of 4 weeks will not be considered for credit transfer.
6. Students should register and complete the course and examination in semester III itself.

Syllabus for Second Year M. Tech. Mechanical Engineering (Manufacturing Systems Engineering) Semester III and IV (Autonomous) - Academic Year 2023-2024

<table>
<tr><td colspan="8">Program: Second Year M. Tech. Mechanical Engineering</td><td colspan="5">Semester: III</td></tr>
<tr><td colspan="8">Course: Special Topic Seminar</td><td colspan="5">Course Code: DJS22MPGS302</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="5">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme (Hours / week)</td><td colspan="9">Evaluation Scheme</td></tr>
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</table>

Guidelines for Special Topic Seminar:

1. Special Topic Seminar should be based on thrust areas in Mechanical Engineering.
2. Students should do literature survey, identify the topic of seminar and finalize it with consultation of Guide/Supervisor.
3. Students should use multiple literatures (at least 10 papers from Refereed Journals/conferences) and understand the topic and research gap.
4. Students should compile the report in standard format and present it in front of a Panel of Examiners (Pair of Internal and External examiners).

Guidelines for Assessment of Special Topic Seminar:

1. Special Topic Seminar should be assessed jointly by a pair of Internal and External Examiners.
2. Special Topic Seminar should be assessed based on the following points:
    - Quality of Literature survey and Novelty in the topic
    - Relevance to the specialization
    - Understanding of the topic
    - Quality of Written and Oral Presentation

Syllabus for Second Year M. Tech. Mechanical Engineering (Manufacturing Systems Engineering) Semester III and IV (Autonomous) - Academic Year 2023-2024

<table>
<tr><td colspan="8">Program: Second Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: III</td></tr>
<tr><td colspan="8">Course: Dissertation Phase I</td><td colspan="3">Course Code: DJS22MPGD303</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="2">Lectures</td><td rowspan="2">Practical</td><td rowspan="2">Tutorial</td><td rowspan="2">Total Credits</td><td colspan="5">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="5">--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td rowspan="3">--</td><td rowspan="3">20</td><td rowspan="3">--</td><td rowspan="3">10</td><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Term Work Total</td><td rowspan="3">100</td></tr>
<tr><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project/ Presentation</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>100</td><td>100</td></tr>
</table>

Guidelines for Dissertation Phase I

Students should do literature survey and identify the problem for Dissertation and finalize it in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The report should be compiled strictly as per the standard report writing guidelines.

Guidelines for Assessment of Dissertation Phase I

1. Dissertation Phase I will be assessed by a panel of internal examiners. The assessment will consist of a mid-semester review/progress evaluation for 50 marks and an end semester progress evaluation for 50 marks.

2. Dissertation Phase I should be assessed based on the following points:
   - Quality of Literature survey and Novelty in the problem
   - Clarity of Problem definition and Feasibility of problem solution
   - Relevance to the specialization
   - Clarity of objective and scope

Syllabus for Second Year M. Tech. Mechanical Engineering (Manufacturing Systems Engineering) Semester III and IV (Autonomous) - Academic Year 2023-2024

<table>
<tr><td colspan="8">Program: Second Year M. Tech. Mechanical Engineering</td><td colspan="3">Semester: IV</td></tr>
<tr><td colspan="8">Course: Dissertation Phase II</td><td colspan="3">Course Code: DJS22MPGD401</td></tr>
<tr><td colspan="8">Course: --</td><td colspan="3">Course Code: --</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="2">Lectures</td><td rowspan="2">Practical</td><td rowspan="2">Tutorial</td><td rowspan="2">Total Credits</td><td colspan="4">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="4">--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td rowspan="3">--</td><td rowspan="3">30</td><td rowspan="3">--</td><td rowspan="3">15</td><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Term Work Total</td><td rowspan="3">200</td></tr>
<tr><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Presentation/ Publication</td></tr>
<tr><td>100</td><td>--</td><td>--</td><td>50</td><td>50</td><td>100</td></tr>
</table>

Guidelines for Dissertation Phase II

Students should attempt solution to the identified problem by analytical/simulation/experimental methods. The solution is to be validated with proper justification and the thesis should be compiled strictly as per the standard report writing guidelines.

Guidelines for Assessment of Dissertation Phase II

Dissertation phase II will be assessed by a panel of internal examiner/guide and external examiner, appointed by the Research Approval Committee (RAC). The assessment will be based on the final thesis and the presentation. Prior to evaluation of the final thesis, assessment at the institute level will be carried out by the Research Approval Committee.

The final presentation and the thesis should highlight the following points of the project:

- Literature survey
- Problem definition
- Research and Design
- Execution
- Experimental and Simulation results
- Conclusion and future work
- Published material (Publications in reputed conference / journals is mandatory)