



**MAULANA AZAD
NATIONAL INSTITUTE OF TECHNOLOGY, Bhopal - 462003**

**DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech (Full Time) in Industrial Design**

PROPOSED SCHEME M.Tech (w.e.f. July 2024)

First Semester:

Course No.	Subject	Schemes of studies periods per week			Total Credits
		L	T	P	
IEM24511	Work System Design and Ergonomics	3	-	-	3
ID24512	Accelerated Product Design & Development	3	-	-	3
ID24513	Design Thinking	3	-	-	3
	Department Elective – 1	3	-	-	3
	Department Elective – 2	3	-	-	3
ID24514	Advanced CAD Lab	-	-	2	1
SM 24515	Smart Manufacturing –I	-	-	2	1
ID24515	Seminar-I	-	-	2	1
ID24516	Minor Project-1 (Self Learning)	-	-	-	2
HUM 24511	Communication Skills (Audit Course)	2	-	-	-
Total Hours: 23 Total Credits: 20		Total Semester Credits			20

Second Semester:

Course No.	Subject	Schemes of studies periods per week			Total Credits
		L	T	P	
ID24521	Design and Development of product prototype	3	-	-	3
ID24522	Advanced Product Design	3	-	-	3
	Department Elective – 3	3	-	-	3
	Department Elective – 4	3	-	-	3
	Open Elective	3	-	-	3
ID24523	Product Development Lab	-	-	2	1
SM24523	Additive Manufacturing	-	-	2	1
ID24524	Seminar-II	-	-	2	1
ID24525	Minor Project-2 (Self Learning)				2
Total Hours: 21 Total Credits: 40		Total Semester Credits			20

Third Semester:

Course No.	Subject	Schemes of studies periods per week			Total Credits
		L	T	P	
ID24611	Dissertation Phase-I	-	-	40	20
Total Hours: 40 Total Credits: 60		Total Semester Credits			20

Fourth Semester:

Course No.	Subject	Schemes of studies periods per week			Total Credits
		L	T	P	
ID24621	Dissertation Phase-II	-	-	40	20
Total Hours: 40 Total Credits: 80		Total Semester Credits			20

List of Department Electives	
ID24551	Bearing Design & Selection
ID24552	Mechanism & Synthesis
ID24553	Detailed Design of Rotating Machines
ID24554	Design for Reliability
ID24555	Computer Aided Design and Manufacturing (CAD / CAM)
ID24556	Advanced Dynamics of Machine
ID24557	Material Selection in Mechanical Design
ID24558	Advanced Operations Research
ID24559	Concurrent Engineering
ID24560	Facility & Process Planning
ID24561	Additive Manufacturing
ID24562	Design of Experiments
ID24563	Supply Chain Management
ID24564	Robotics & Robot Applications
ID24565	Nature of Materials and Processes
ID24566	Computational Methods
ID24567	Product Planning & Design for Market
ID24568	Advanced Computer Graphics
ID24569	Universal Human Values and Professional Ethics
ME 24524	Research Methodology

List of Open Electives	
ARP24581	Introduction to Urban Planning
BSE24581	Bioprocess Engineering
BSE24582	Biophysics Tools and Techniques
CHE24581	Analytical Techniques
CHE24582	Green Technology & Processes
CE24581	Solid Waste Management
CE 24582	Basic Concept of GIS
CE24583	Road Safety
CSE24581	Machine Learning
CSE24582	Advanced Data Structures and Algorithms
PHY24581	Nanotechnology and Nanoscience
EE24581	Electric Machines & Applications
EE24582	Control and Instrumentation

ECE24581	Introduction to Fuzzy Logic
ECE24582	Neural Networks and its Applications
EC24581	Energy Resource Technologies
HUM24581	Intellectual Property Rights for Engineers
HUM24582	Applied Psychology: Human Centered Design and Engineering
MTH 24581	Advanced Operations Research
MTH24582	Computing Technologies
MME24581	Advanced Instrumentation Methods for Material Analysis
MME24582	Smart Materials and their Application
MBA24581	Engineering Startup Management

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I	Year - I
Name of Course		Work System Design and Ergonomics		
Course Code		IEM 24511		
Core / Elective / Other		CORE		
Prerequisite if any:				
1.	NONE			
Course Outcomes:				
1.	Productivity concept and ways to enhance productivity using best from human resource.			
2.	Understanding of Method study and work measurement as pre requisite to work system design / product design.			
3.	Understanding of Human Factor Engg. and related aspects with practice on few techniques of evaluation of human risk.			
Description of Contents in brief:				
Unit 1.	Definition of Industrial Engineering, Relevance of Productivity in Industrial Engineering, Work content, Definition, productivity and work content, environmental conditions and work content, techniques to increase work content, Work study, method study, purpose, and work measurement, purpose, wage incentives, criteria etc.			
Unit 2.	Method study steps, recording techniques, analysis methods, principles of motion economy, etc., work measurement techniques, work sampling, sample size calculations, estimation of time, time study, definition of qualified worker, rating, standard time calculations etc.,			
Unit 3.	Overview of ergonomics, Fundamentals of ergonomics, concept of Ergonomic Design, Scope of Ergonomics. Man- the prime system component; Man-machine-environment interaction system and user-friendly design practice			
Unit 4.	Human compatibility, comfort and adaptability; Physical (Anthropometrics, human body- structure and function, posture, movement and biomechanics)			
Unit 5.	Physiological (work physiology) and Psychological aspects(behavior, cognitive aspects and mental workload); Information processing, human error and risk perception			
Unit 6	Visual performance and visual displays; environmental factors influencing human performance; Occupational stress; safety and health issues; and Participatory ergonomics aspects; Supportive experiments.			
List of Text Books:				
1.	Introduction to Ergonomics, R.S. Bridger, 2 nd Ed., Taylor & Francis			
2.	An Introduction to Human Factors Engineering, C. D. Wicknes, S. E. Gordon, and Y. Liu, , Longman, New York			

3.	Human Factors in Engineering and Design, Sanders and McCormick, Mc-Graw-Hill, INC.	
List of Reference Books:		
1.	Indian Anthropometric Dimensions for ergonomic design practice, D. Chakrabarti, National Institute of Design, Ahmedabad, 1997	
2.	Handbook of Human Factors and ergonomics , G. Salvendy (ed.), John Wiley & Sons, Inc.	
3.	Ergonomics for beginners, a quick reference guide, J. Dul, and B Weerdmeester, Taylor & Francis,	
URLs:		
1.	https://nptel.ac.in/courses/107/103/107103004/	
2.	https://nptel.ac.in/courses/112/104/112104222/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction to Industrial Engineering /History and development of I.E.	
2.	Productivity Concepts and Different Measures of Productivity	
3.	Work Content / Measure of Work Content / Ways to improve Productivity	
4.	Work Study: Approach and Methods / Human Factor in Work Study	
5.	Method study: objectives, generic procedure in various charts	
6.	Operations Process Chart, Flow process Charts	
7.	Diagrams – String Diagram, Flow Diagram	
8.	Travel Chart and other charts	
9.	Principles of Motion Economy	
10.	Two Handed Chart	
11.	Therbligs	
12.	Use of photographic techniques etc	
13.	Summary of Method Study	
14.	MINI TEST	
15.	Work measurement, purpose, basic procedure, Work sampling	
16.	Various Techniques - PMTS, Time Study, Rating	
17.	Analytical Estimation,	
18.	Case studies	
19.	Overview of ergonomics - Scope of Ergonomics	
20.	Fundamentals of ergonomics	
21.	concept of Ergonomic Design	
22.	Man- the prime system component	
23.	Man-machine-environment interaction system and user-friendly design practice	
24.		
25.		
26.		
27.	Human compatibility, comfort and adaptability	

28.	Human compatibility, comfort and adaptability	
29.		
30.	Physical (Anthropometrics, human body- structure and function, posture, movement and biomechanics)	
31.		
32.		
33.		
34.		
35.	Physiological (work physiology) and Psychological aspects (behavior, cognitive aspects and mental workload)	
35.		
36.		
37.		
38.		
38.	Information processing	
39.	Information processing	
40.	Human error and risk perception, Techniques to evaluate risk	
41.	Human error and risk perception, Techniques to evaluate risk	
42.	Visual performance and visual displays	
43.	Visual performance and visual displays	
44.	Environmental factors influencing human performance	
45.	Environmental factors influencing human performance	
46.	Occupational stress; safety and health issues	
47.	Occupational stress; safety and health issues	
48.	Participatory ergonomics aspects; Supportive experiments.	
49.	Summary of the course	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I	Year I
Name of Course	Accelerated Product Design and Development		
Course Code	ID 24512		
Core / Elective / Other	Core		
Prerequisite if any:			
1.	Not any		
Course Outcomes:			
1.	To enable students to learn and apply various product development techniques to speed up the product development process		
2.	To enable students to apply various techniques and develop innovative concepts in product design and development		
3.	To design methods to solve technical contradictions in design and introduce innovation.		
Description of Contents in brief:			
Unit 1.	Trends affecting product development; Concurrent engineering and product development process; market analysis; methods, customer needs analysis, technology capability forecasting, benchmarking.		
Unit 2.	Quality function deployment, Case studies, idea generation techniques, brainstorming, theory of inventive problem solving (TRIZ), morphological analysis etc., Case studies		
Unit 3.	Product design stage, identification of alternatives, trade off analysis, process design, prototypes and rapid prototyping and types of prototypes, modeling and simulation, variability and uncertainty analysis, environmental stress analysis, Case studies.		
Unit 4.	Design for test, verification and validation. Robust design concepts, DFMA, design simplification methods, process development methods, CAM, CAPP, MRP and ERP, GT, etc.,		
Unit 5.	Sales and Distribution, design for supply chain and environmental considerations, design for customer service, design for disassembly, packing design, design for environment, design for serviceability, design for reparability and maintainability, design for safety, design for people, etc.		
List of Text Books:			
1.	“Product Design and Manufacturing” by A.K.Chitale and R.C.Gupta, PHI Learning Pvt. Limited 2013.		
2.	“Product Development and Design for Manufacturing” by John W Priest, CRC Publications, 2001		
3.	“Rapid Prototyping” by Ramesh S, ANE Books Publications, 2013		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

List of Reference Books:		
1.	“Simplified TRIZ New Problem-Solving Applications for Technical and Business Professionals”, by Kalevi Rantanen, David W. Conley, and Ellen R. Domb, CRC press, 2016.	
2.	“Product Design for Manufacture and Assembly”, by Geoffrey Boothroyd, Marcel Dekker Inc, 2002	
3.	“Rapid Prototyping” by M.Adhithan, Atlantic Publishers and Distributors Pvt Ltd, 2018.	
URLs:		
1.	https://nptel.ac.in/courses/112/107/112107217/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Trends affecting product development	
2.	Concurrent engineering and product development process	
3	Concurrent engineering and product development process	
4	market analysis; methods	
5	customer needs analysis	
6	Tutorial on questionnaire preparation	
7	technology capability forecasting	
8	Tutorial on above	
9	Benchmarking technique	
10	Case study on above	
11	Quality function deployment technique	
12	Quality function deployment technique	Mini test
13	Case study on above	
14	idea generation techniques, brainstorming	
15	idea generation techniques, morphological analysis	
16	idea generation techniques, TRIZ	
17	idea generation techniques, TRIZ	
18	idea generation techniques, TRIZ	
19	Case study 1 on TRIZ	Assignment 1
20	Case study 2 on TRIZ	
21	Product design stage, identification of alternatives, trade off analysis	
22	process design, prototypes and rapid prototyping	
23	RP processes	
24	types of prototypes, RP tools	
25	modeling and simulation in PD process	
26	variability and uncertainty analysis	
27	environmental stress analysis	
28	Case studies	
29	Design for test, verification and validation	
30	Robust design concepts	
31	Robust design concepts	Assignment

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

		2
32	Tutorial on above	
33	DFMA	
34	Case study on above	
35	design simplification methods	
36	process development methods, CAM, CAPP	
37	process development methods, MRP, ERP, GT	
38	Case studies	
39	Sales and Distribution	
40	design for supply chain and environmental considerations	
41	design for customer service	
42	Tutorial on above	
43	design for disassembly	
44	packing design, design for environment	
45	design for serviceability	
46	design for reparability and maintainability	
47	design for safety, design for people	
48	Case study on above	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment/Case studies if any	10	Two assignments
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if ay		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M. Tech. in Mechanical Engineering with Specialization in Industrial Design	Semester: I	Year: I
Name of Course		Design Thinking		
Course Code		ID 24513		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	N/A			
2.	N/A			
Course Outcomes:				
1.	Develop a strong understanding of the design process and apply it in a variety of business settings			
2.	Analyze self, culture, teamwork to work in a multidisciplinary environment and exhibit empathetic behavior			
3.	Formulate specific problem statements of real time issues and generate innovative ideas using design tools			
4.	Apply critical thinking skills in order to arrive at the root cause from a set of likely Causes			
5	Demonstrate an enhanced ability to apply design thinking skills for evaluation of claims and arguments.			
Description of Contents in brief:				
Unit 1.	Introduction to design thinking, traditional problem solving versus design thinking, history of design thinking, wicked problems. Innovation and creativity, the role of innovation and creativity in organizations, creativity in teams and their environments, design mindset. Introduction to elements and principles of design, 13 Musical Notes for Design Mindset, Examples of Great Design, Design Approaches across the world			
Unit 2.	Understanding humans as a combination of I (self) and body, basic physical needs up to actualization, prosperity, the gap between desires and actualization. Understanding culture in family society, institution, startup, socialization process. Ethical behavior: effects on self, society, understanding core values and feelings, negative sentiments and how to overcome them, definite human conduct: universal human goal, developing human consciousness in values, policy, and character. Understand stakeholders, techniques to empathize, identify key user problems. Empathy tools Interviews, empathy maps, emotional mapping, immersion and observations, customer journey maps, and brainstorming, Classifying insights after Observations, Classifying Stakeholders, Do's & Don'ts for Brainstorming, Individual activity- 'Moccasin walk'			
Unit 3.	Defining the problem statement, creating personas, Point of View (POV) statements. Research- identifying drivers, information gathering, target groups, samples, and feedbacks. Idea Generation-basic design directions, Themes of Thinking, Lateral Thinking, inspirations and references, brainstorming, inclusion, sketching and presenting ideas, idea evaluation, double diamond approach, analyze – four W's, 5 why's, “How Might We”, Defining the problem using Ice-Cream Sticks, Metaphor & Random Association Technique, Mind-Map, ideation activity games - six thinking hats, million-dollar idea, introduction to visual collaboration and brainstorming tools - Mural, Jam Board			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Unit 4.	Fundamental concepts of critical thinking, the difference between critical and ordinary thinking, characteristics of critical thinkers, critical thinking skills linking ideas, structuring arguments, recognizing incongruences, five pillars of critical thinking, argumentation versus rhetoric, cognitive bias, tribalism, and politics. Case study on applying critical thinking on different scenarios.
Unit 5.	The argument, claim, and statement, identifying premises and conclusion, truth and logic conditions, valid/invalid arguments, strong/weak arguments, deductive argument, argument diagrams, logical reasoning, scientific reasoning, logical fallacies, propositional logic, probability, and judgment, obstacles to critical thinking. Group activity/role plays on evaluating arguments.

List of Text Books:

1.	Vijay Kumar, 101 Design Methods: A Structured Approach for Driving Innovation in Your Organization, 2013, John Wiley and Sons Inc, New Jersey
2.	BP Banerjee, Foundations of Ethics and Management, 2005, Excel Books
3.	Gavin Ambrose and Paul Harris, Basics Design 08: Design Thinking, 2010, AVA Publishing SA
4.	Roger L. Martin, Design of Business: Why Design Thinking is the Next Competitive Advantage, 2009, Harvard Business Press, Boston MA

List of Reference Books:

1.	PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
2.	E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3.	A.N. Tripathy, 2003, Human Values, New Age International Publishers.
4.	B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
5.	Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
6.	Edward De Bono, 1986, Six Thinking Hats, Viking England
7.	C.K. Prahalad, M.S. Krishnan, the new age of innovation, Tata McGraw Hill
8.	Don Norman, 2013, The Design of Everyday Things, Basic Books, Philadelphia
9.	GE Dieter, Engineering Design. McGraw Hill
10.	David G Ullman, The Mechanical Design Process, McGraw Hill

URLs:

1.	www.nptel.ac.in
2.	https://swayam.gov.in/nc_details/NPTEL

Lecture Plan (about 40-50 Lectures):

*Lecture No.	Topic	Remarks
1.	Introduction to design thinking, traditional problem solving versus design thinking	
2.	History of design thinking, wicked problems	
3.	Innovation and creativity, the role of innovation and creativity in Organizations	
4.	Creativity in teams and their environments, Design mindset	
5.	Introduction to elements and principles of design	
6.	13 Musical Notes for Design Mindset	
7.	Examples of Great Design	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

8.	Design Approaches across the world	
9.	Understanding humans as a combination of I (self) and body	
10.	Basic physical needs up to actualization, prosperity, the gap between desires and actualization.	
11.	Understanding culture in family society, institution, startup, socialization Process	
12.	Ethical behavior: effects on self, society, understanding core values and feelings, negative sentiments and how to overcome them	
13.	definite human conduct: universal human goal, developing human consciousness in values, policy, and character	
14.	Understand stakeholders, techniques to empathize, identify key user Problems	
15.	Empathy tools Interviews, empathy maps, emotional mapping, immersion and observations, customer journey maps, and brainstorming	
16.	Classifying Stakeholders, Do's & Don'ts for Brainstorming, Individual activity- 'Moccasin walk'	
17.	Defining the problem statement, creating personas, Point of View (POV) Statements	
18.	Research- identifying drivers, information gathering, target groups, samples, and feedback	
19.	Idea Generation-basic design directions, Themes of Thinking, inspirations and references, brainstorming, inclusion, sketching and presenting ideas	
20.	Idea evaluation, double diamond approach, analyze – four W's, 5 why's, "How Might We"	
21.	Defining the problem using Ice-Cream Sticks, Metaphor & Random Association Technique, Mind-Map	
22.	Ideation activity games - six thinking hats, million-dollar idea	
23.	introduction to visual collaboration and brainstorming tools - Mural,	
24.	Visual collaboration and brainstorming tools - Jam Board	
25.	Fundamental concepts of critical thinking	
26.	Difference between critical and ordinary thinking	
27.	Characteristics of critical thinkers	
28.	Critical thinking skill slinking ideas	
29.	Structuring arguments, recognizing incongruence	
30.	Five pillars of critical thinking	
31.	Argumentation versus rhetoric, cognitive bias, tribalism, and politics	
32.	Case study on applying critical thinking on different scenarios	
33.	The argument, claim, and statement	
34.	Identifying premises and conclusion,	
35.	Truth and logic conditions	
36.	Valid/invalid arguments, strong/weak arguments, deductive argument, argument diagrams	
37.	Logical reasoning, scientific reasoning, logical fallacies	
38.	Propositional logic, probability, and judgment	
39.	Obstacles to critical thinking	
40.	Group activity/role plays on evaluating arguments.	

Evaluation Criteria:

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any	Nil	
5	Quiz if any	10	
6	Seminar, Viva voce if any	Nil	
7	End Semester Examination	50	
8	Experiments if any (for practical courses)	Nil	
9	Any other	Nil	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M. Tech. in Mechanical Engineering with Specialization in Industrial Design	Semester: I	Year: I
Name of Course		Advanced CAD Laboratory.		
Course Code		ID 24514		
Core / Elective / Other		Laboratory		
Prerequisite if any:				
1.	Engineering Drawing			
2.	Mechanical Drawing			
Course Outcomes:				
1.	An ability to develop part drawing of simple machine components through CAD software.			
2.	An ability to develop assembly drawing using part drawing through CAD software.			
3.	An ability to understand the interface of CAD software's.			
4.	An ability to develop detail drawing of part and assembly.			
5.	An ability to transfer the CAD data to other CAD oriented software for further analysis.			
Description of Contents in brief:				
Exp. -1	Introduction of computer aided software and application			
Exp. -2	Basic commands of 2D modeling			
Exp. -3	Basic commands of 3D modeling			
Exp. -4	Modeling of simple 3D components			
Exp. -5	Introduction of Basic Assembly tools.			
Exp. -6	Assembly of 3D components knuckle joint, coupling, tool head of shaping machine.			
Exp. -7	Drawing of assembly using CAD software knuckle joint, coupling, and tool head of shaping machine.			
List of Text Books:				
1.	Pro / Engineer PTC Creo Parametric 3.0		Sham Tickoo, WILEY	
2.	Creo Parametric 3.0 Advanced Tutorial		Roger Toogood	
3.	PTC Creo™ Parametric 3.0 (Activate Learning with these NEW titles from Engineering!		Louis Gary Lamit	
URLs:				
1.	https://support.ptc.com/help/creo/creo_pma/usascii/index.html#page/tutorials_pma/online_help/aux_files/pma_tutorials.html			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks
1.	Introduction and Evolution of CAD.			
2.	Familiar with software interface.			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

3.	Extrude Tool- Add or Remove.	
4.	Revolve.	
5.	Engineering tool- Shell, Chamfer, Draft etc.	
6.	Engineering tool- Rib, Hole, round etc.	
7.	Datum plane creation user defined.	
8.	Editing tools- Mirror, Copy, Merge and trim etc.	
9.	Variable section sweep- Constant and Variable.	
10.	Helical sweep- Constant and Variable pitch.	
11.	Assembly.	
12.	Curve generation.	
13.	Surface modelling.	
15.	Detail drawing.	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test		
2	Mid Semester Test		
3	Assignment if any		
4	Tutorial if any	20	
5	Quiz if any	20	
6	Seminar, Viva voce if ay		
7	End Semester Examination		
8	Experiments if any (for practical courses)	60	
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M. Tech. in Mechanical Engineering with Specialization in Industrial Design	Semester: I	Year: I
Name of Course	Smart Manufacturing Lab I		
Course Code	SM 24515		
Core / Elective / Other	Core		
Prerequisite if any: NIL			
Course Outcomes: At the end of the course, the student will be able to:			
CO1	Understanding and Preparation of Programs in MATLAB etc.		
CO2	Understand the measurement of 2D and 3D cavity.		
CO3	Apply the programming on real time robotic movement.		
CO4	Create the interlinking between the machine and the robot.		
List of Experiments			
1. Introduction to programming in Python, C, C++, MATLAB, etc 2. Creation of arrays 3. Mathematical operations with arrays 4. Creation of 2D plots 5. Creation of 3D plots 6. Curve fitting with polynomials 7. Programming applications in numerical analysis 8. Robot Programming and path planning 9. Controlling of robotic manipulator using arduino/robot programming 10. Do it yourself (DIY) experiments (Students should take the real-world issue and they have to think, decide and do things independently)			

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Lab record	20	
2	Lab experiments	30	
3	Assignment if any		
4	Tutorial if any		
5	Quiz if any		
6	Viva voce if ay	30	
7	End Semester experimentation	20	
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester II	Year I
Name of Course	Design and development of product prototype		
Course Code	ID 24521		
Core / Elective / Other	Core		
Prerequisite if any:			
1.			
2.			
Course Outcomes:			
1.	Student will able to learn how to design and prototype user interfaces to address the users and tasks identified in user research.		
2.	Student will able to learn and apply principles from graphic design, including design patterns.		
3.	Student will able to learn how to design for specific populations and situations, including principles and practices of accessible design.		
Description of Contents in brief:			
Unit 1.	Introduction : Prototyping, Traditional Prototyping v/s Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP methods.		
Unit 2.	CAD Modelling and Data Processing for RP : CAD model preparation, Data Requirements, Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), STL file repair, Data interfacing, Part orientation and support generatio Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation, Introduction of MAGIC & MIMICS software.		
Unit 3.	Photo polymerization process : Stereo lithography (SL), SL resin curing process, SL scan patterns, Micro stereo lithography, Applications of Photo polymerization Processes. Powder Bed Fusion process : Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes. Extrusion based process : Fused Deposition Modelling (FDM), Principles, Plotting and path control, Applications of Extrusion-Based Processes. 3D Printing process : 3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modelling, Applications of Printing Processes. Sheet Lamination process : Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. Beam deposition process : Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks, Introduction of Bio printing and Medical Applications of RP.		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Unit 4.	Errors in RP Processes : Processing, Pre processing, Post processing errors, Part building errors in SLA, SLS. Rapid manufacturing process optimization: Design & Engineering analysis, Planning applications, Factors influencing accuracy, Data preparation error, Part building error, Error in finishing, Influence of build orientation. Allied Process: Vacuum casting, surface digitizing, Surface generation from point cloud, Surface modification- Data transfer to solid models.	
Unit 5.	Reverse Engineering : Basic concept, Digitization techniques, Model Reconstruction, Data Processing for Rapid Prototyping, Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.	
List of Text Books:		
1.	Prototyping for Designers Developing the Best Digital and Physical Products By Kathryn McElroy	
2.	DesignAgility Toolbox Media Prototyping: Developing Media Products with Design Thinking Using Agile Methods By OkkeSchlüter, Stefanie Quade	
List of Reference Books:		
1.	Prototyping Architecture The Solar Roofpod: An Educational Design-Build Research Project By Christian Volkmann	
2.	Prototyping and Modelmaking for Product Design By BjarkiHallgrímsson	
URLs:		
1.	https://nptel.ac.in/courses/112/104/112104230/	
2.	https://nptel.ac.in/courses/112/107/112107217/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
Unit - I Introduction		
1.	Prototyping	
2.	Traditional Prototyping v/s Rapid Prototyping (RP)	
3.	Need for time compression in product development	
4.	Usage of RP parts, Generic RP process	
5.	Distinction between RP and CNC	
6.	other related technologies	
7.	Classification of RP methods.	
Unit – II CAD Modelling and Data Processing for RP		
8.	CAD model preparation	
9.	Data Requirements	
10.	Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), STL file repair	
11.	Data interfacing, Part orientation and support generation	
12.	Support structure design	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

13.	Model Slicing and contour data organization	
14.	direct and adaptive slicing	
15.	Tool path generation	
16.	Introduction of MAGIC & MIMICS software.	
Unit – III Photo polymerization process		
17.	Stereo lithography (SL), SL resin curing process,	
18.	SL scan patterns, Micro stereo lithography	
19.	Applications of Photo polymerization Processes.	
20.	Powder Bed Fusion process: Selective laser Sintering (SLS)	
21.	Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes.	
22.	Extrusion based process: Fused Deposition Modelling (FDM),	
23.	Principles, Plotting and path control, Applications of Extrusion-Based Processes. 3D Printing process: 3D printing (3DP), Research achievements in printing deposition,	
24.	Technical challenges in printing, Printing process modelling, Applications of Printing Processes. Sheet Lamination process: Laminated Object Manufacturing (LOM),	
25.	Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. Beam deposition process: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD)	
26.	Processing-structure-properties, relationships	
27.	Benefits and drawbacks,	
28.	Introduction of Bio printing and Medical Applications of RP	
Unit – IV; Errors in RP Processes		
29.	Processing	
30.	Preprocessing, Post processing errors, Part building errors in SLA	
31.	SLS. Rapid manufacturing process optimization	
32.	Design & Engineering analysis	
33.	Planning applications, Factors influencing accuracy,	
34.	Planning applications, Factors influencing accuracy,	
35.	Influence of build orientation. Allied Process:	
36.	Vacuum casting, surface digitizing, Surface generation from point cloud	
37.	Surface modification- Data transfer to solid models	
Unit – V Reverse Engineering		
38.	Basic concept	
39.	Digitization techniques	
40.	Model Reconstruction,	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

41.	Data Processing for Rapid Prototyping,	
42.	Reverse Engineering (RE) Methodologies and Techniques	
43.	Selection of RE systems	
44.	RE software, RE hardware	
45.	RE in product development.	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	5	
4	Tutorial if any		
5	Quiz if any		
6	Seminar, Viva voce if ay		
7	End Semester Examination	60	
8	Experiments if any (for practical courses)		
8	Any other	5	Project

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester II	Year - I
Name of Course		ADVANCED PRODUCT DESIGN		
Course Code		ID 24522		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Basic knowledge of engineering fundamentals. Ability to create sketches with proper conventions and abbreviations			
Course Outcomes:				
1.	Able to learn how to think, design and develop new parts/products.			
2.	Able to understand the existing designs, synthesize and analyze the information for modification or addition in the existing components			
3.	Able to improve quality of processes / products by applying the specified procedures of product development			
Description of Contents in brief:				
Unit 1	Engineering design process stages and activities, materials life cycle and types, categories of product design, need analysis and information gathering methods, customer requirements			
Unit 2	Opportunity analysis, principles of cross functional teamwork, simultaneous engineering methods			
Unit 3	Concept generation and development, selection, and evaluation methods, creative thinking methods, decision making models, product design specifications			
Unit 4	Embodiment design, axiomatic design, product architecture, modular and integral designs, product configuration and design for function, parametric design techniques including DFM, DFA, FMEA			
Unit 5	Industrial design, detail design, design for environment and manufacturing, quality by design, robust design, cost evaluation, legal and ethical issues			
Unit 6	Materials selection, design with materials, material performance indices, material selection with decision matrices, design for recycling and reusability			
List of Text Books:				
1.	Engineering Design, George E. Dieter and Linda C. Schmidt, Mc Graw hill.			
2.	Product Design and Development, Karl T. Ulrich and Steven D. Eppinger, Mc Graw Hill.			
3.	Product Design for Engineers, Devdas Shetty, Cengage Learning.			
List of Reference Books:				
1.	Engineering Design Methods, Nigel Cross, Wiley.			
2.	Materials Selection in Mechanical Design, Michael F. Ashby			
3.	Product Design, Techniques in Reverse Engineering and New Product			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

	Development, Kevin Otto, Kristin wood, Pearson Education	
URLs:		
1.	https://www.digimat.in/nptel/courses/video/112104230/L01.html	
2.	https://nptel.ac.in/courses/110/105/110105087/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction	
2.	Product, process, and materials cycle	
3.	Categories of designs	
4.	Opportunity analysis	
5.	Cross functional teams	
6.	Problem definition and need identification	
7.	Concept generation and development techniques	
8.	Concept map or mind map	
9.	Benchmarking techniques	
10.	Product dissection or reverse engineering	
11.	Kano’s model for quality attributes	
12.	House of quality configurations	
13.	Product functional decomposition and structure	
14.	Morphological methods for design	
15.	Axiomatic design domains	
16.	Using axiomatic design for concept generation	
17.	TRIZ inventive principles	
18.	Decision making models (certainty and uncertainty)	
19.	Decision making models (risk and conflict)	
20.	Concept evaluation based on absolute criteria	
21.	Pugh concept selection method	
22.	Measurement scales and weighted decision matrix	
23.	Analytical hierarchy process (AHP)	
24.	Product design specifications	
25.	Embodiment design phase	
26.	Product architecture, modular and integral	
27.	Configuration design analysis	
28.	Configuration design guidelines	
29.	Systematic steps in parametric design	
30.	Design for manufacture	
31.	Design for assembly	
32.	Failure modes and effect analysis (FMEA)	
33.	Quality by design	
34.	Industrial design	
35.	Human factors design	
36.	Assessing the quality of industrial design	
37.	Detail design activities	
38.	Final design review	
39.	Materials selection to design	
40.	Performance characteristics of materials	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

41.	Material performance indices	
42.	Material selection with decision matrices	
43.	Design for recycling and reusability	
44.	Cost evaluation methods	
45.	Design to cost	
46.	Product liability	
47.	Legal and ethical domains	
48.	Case study I	
49.	Case study II	
50	Summary	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any	05	
5	Quiz if any	05	
6	Seminar, Viva voce if ay		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester: II	Year: I
Name of Course		Product Development Laboratory		
Course Code		ID 24523		
Core / Elective / Other		Core		
Prerequisite if any:				
1.	Understanding of conceptual design phase, problem solving methodology			
2.	Knowledge of working on CAD platforms			
Course Outcomes:				
CO 1	Enable to conceptualize and envision the novelty in the existing products			
CO 2	Enable to develop the new part/ product or variants with complete design specifications.			
CO 3	Apply Industrial design knowledge and skills for investigating and development of promising product using CAD applications			
Description of Contents in brief:				
Unit 1.	Study of Product Aesthetics and development of alternatives, design thinking –Case of a Selected Product			
Unit 2.	Find the variants available, enlist the parts, components, and sub-assemblies with pictures			
Unit 3.	Explain the function and identify the material for every part, component, and sub-assembly.			
Unit 4.	Analyze and design the product using the application of various computer aided design software packages			
Unit 5.	Study about the product ergonomics, reverse engineering, and conceptually provide the feasible solution			
List of Text Books:				
1.	Engineering Design, George E. Dieter and Linda C. Schmidt, Mc Graw hill.			
2.	Product Design and Development, Karl T. Ulrich and Steven D. Eppinger, Mc Graw Hill.			
3.	Product Design for Engineers, Devdas Shetty, Cengage Learning.			
List of Reference Books:				
1.	Engineering Design Methods, Nigel Cross, Wiley.			
2.	Materials Selection in Mechanical Design, Michael F. Ashby			
3.	Product Design, Techniques in Reverse Engineering and New Product Development, Kevin Otto, Kristin wood, Pearson Education			
URLs:				
1.	https://www.digimat.in/nptel/courses/video/112104230/L01.html			
2.	https://nptel.ac.in/courses/110/105/110105087/			
Lecture Plan:				
*Lecture No.	Topic			Remarks
1.	Introduction – Brainstorming on identification of part/product for design and development (Feasibility, social, environmental, and economical considerations)			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

2.	Describe the product using CAD applications. Explain the working principle and process	
3.	Find the variants available. Discussions on their pros and cons.	
4.	Enlist the parts, components, and sub-assemblies with pictures	
5.	Identify the materials for parts, components, and sub-assemblies	
6.	Explain the function of every part, component, and sub-assembly	
7.	Steps for disassembly and reassembly of the product (finding obstructed access, time required etc.) – Reverse Engineering	
8.	Discuss ergonomics (including no. of operators required, comfort, vibrations, holding requirements etc.)	
9.	Identify the general problems with this product	
10.	Suggest the solutions for those problems and conceptually provide the proposed alteration/modification for the existing product	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test		
2	Mid Semester Test		
3	Assignment if any		
4	Tutorial if any		
5	Quiz if any	20	
6	Seminar, Viva voce if any		
7	End Semester Examination	60	
8	Experiments if any (for practical courses)	20	
9	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester: II	Year: I
Name of Course		Additive Manufacturing Lab		
Course Code		SM 24523		
Core / Elective / Other		Core		
Prerequisite if any: NIL				
Course Outcomes: At the end of the course, the student will be able to:				
CO1	Understand the basic processes of additive manufacturing.			
CO2	Understand the softwares used in additive manufacturing			
CO3	Prepare components using AM by applying optimum process parameters			
CO4	Fabricate components for industrial and medical applications.			
List of Experiments				
1. Study on liquid, solid and powder based additive manufacturing processes 2. Creation of geometrical models in Creo, CATIA, SolidWorks, etc., 3. Introduction to AM software like Cura/Slic3r, Magics/ mimics, etc., 4. Error removal in STL file 5. Study of process parameters of AM 6. Slicing procedure in AM 7. Post processing of parts manufactured by AM processes 8. Generation of CAD models using reverse engineering technique 9. Study of industrial and medical applications of AM (case studies) 10. DIY experiments to be performed by students using AM process				
List of Text Books:				

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Lab record	20	
2	Lab experiments	30	
3	Assignment if any		
4	Viva voce if any	30	
5	End Semester experimentation	20	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I/II	Year I
Name of Course		Bearing Design & Selection		
Course Code		ID 24551		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.				
Course Outcomes:				
1.	Enables to understand the engineering principles underlying the phenomena of lubrication, including the selection of lubricant in several engineering application.			
2.	Enables to analyze different lubrication theories in terms of bearing.			
3.	Enables to design and select of lubrication bearing for machines using charts and tables.			
4.	Enables to design and select of ball and rolling bearing in different machinery.			
Description of Contents in brief:				
Unit 1.	Introduction- Lubrication, hydrostatic bearings			
Unit 2.	Hydrodynamics lubrication full journal bearing			
Unit 3.	Friction, pressure distribution, load carrying capacity thermal equilibrium			
Unit 4.	Partial journal bearings influence of end leakage on behaviour of bearings, maximum oil pressure with end leakage			
Unit 5.	Practical considerations in bearing design. Bearing – design, selection of ball & roller bearings			
List of Text Books:				
1.	Shigley (2014). Mechanical Engineering Design:10/e, McGraw-Hill Education, ISBN:10: 9780073398204 New Delhi.			
2.	Manwell, J. F. (2009) Wind Energy Explained : theory, design, and application / James Manwell, Jon McGowan, Anthony Rogers. – 2nd ed, John Wiley & Sons Ltd. ISBN 978-0-470-01500-1 (cloth)			
3.	Maurice, L. Adams (2018) Bearings: Basic Concepts and Design Applications. CRC Press, 2018. ISBN 1351689991			
List of Reference Books:				
1.	Siraj Ahmed (2014): Mechanical Engineering Design: Principles and concepts, PHI Learning Pvt. Ltd, ISBN-978-81-203-4931-5, New Delhi			
2.	Avraham Harnoy (2002) Bearing Design in Machinery: Engineering Tribology and Lubrication. CRC Press, 2002. ISBN: 0824744004, 9780824744007			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks
1.	Introduction, Bearing types, Classification			
2.	Hydrodynamics and lubrication			
3.	Pressure distribution			
4.	Mounting and enclosure			
5.	Bearing life, Reliability versus life, Combined Radial and			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

	Thrust loading	
6.	Design problems on ball bearings	
7.	Design problems on ball bearings	
8.	Design problems on ball bearings	
9.	Design problems on roller bearings	
10.	Design problems on roller bearings	
11.	Design problems on roller bearings	
12.	Tutorial	
13.	Tutorial	
14.	Tutorial	
15.	Tutorial	
16.	Introduction to lubrication and Journal bearings	
17.	Types of lubrication, Viscosity	
18.	Petroff's equation, Stable lubrication	
19.	Thick film lubrication	
20.	Stable lubrication	
21.	Design considerations	
22.	The relationship of the variables	
23.	Self contained bearings	
24.	Pressure fed bearings	
25.	Loads and materials	
26.	Thrust bearings	
27.	Boundary lubricated bearings	
28.	Bearing types	
29.	Bearings failures	
30.	Comparison between sliding and rolling contact bearings	
31.	Design problems on sliding contact bearings using charts and tables	
32.	Design problems on sliding contact bearings using charts and tables	
33.	Tutorial	
34.	Tutorial	
35.	Tutorial	
36.	Tutorial	
37.	Tutorial	
38.	Tutorial	
39.	Tutorial	
40.	Tutorial	
41.	Tutorial	
42.	Tutorial	
43.	Tutorial	
44.	Tutorial	
45.	Tutorial	
46.	Tutorial	
47.	Tutorial	
48.	Tutorial	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if ay		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I/II	Year I
Name of Course	Mechanism & Synthesis		
Course Code	ID 24552		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Theory of Machine		
Course Outcomes:			
1.	Enables to practice of engineering terms being used in kinematics of mechanism parts, practical approach in analysis and synthesis of links.		
2.	Enables to draw function generation by pole and relative pole method.		
3.	Enables to draw couple curve for different engineering application.		
4.	Enables to gain basic knowledge about cognate linkages, Euler savory equation, Freudenstein equation and Least square technique in different synthesis of mechanism.		
Description of Contents in brief:			
Unit 1.	Mechanism and Machines:- Mechanism, link, linkage and mechanism planar and spatial mechanisms, Grubler's criteria for degree of freedom, equivalent mechanisms, inversions of four link chain, slider crank chain and double slider crank chain		
Unit 2.	Velocity analysis: Relative velocity method, instantaneous' center methods of velocity		
Unit 3.	Acceleration analysis: Acceleration analysis including Coriolis component of acceleration. Application to slider crank chain four bar chain, stone crusher mechanism sewing machine mechanism, Quick return mechanisms wrapping m/c mechanism etc.Klein's construction		
Unit 4.	Graphical and Computer aided synthesis of mechanism: Pole, relative pole, inversion overlay Freudenstein and block methods, least square technique. Application to four link mechanism and slider crank mechanism function generation, modification of timing of cam mechanism. Limit & dead center positions transmission angle, Cognate linkages, Coupler curves, Euler savory equation		
List of Text Books:			
1.	Joseph E. Shigley (2015): Theory of Machines and Mechanisms, Oxford University Press, ISBN: 978-0-19-945416-7.		
2.	A G Ambeker (2007): Mechanism & Machine Theory, PHI Pvt. Ltd., ISBN 978-81-203-3134-1, New Delhi.		
List of Reference Books:			
1.	Rao and Dukkippatti (2006): Mechanism and Machine Theory: New age International Pvt. Ltd., ISBN 81-224-0426-X, New Delhi.		
2.	Sharma and Purohit (2006): Theory of Mechanism and Machines, PHI Pvt. Ltd, ISBN 81-203-2901-5, New Delhi.		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction to mechanism and linkages	
2.	Planar and spatial mechanisms	
3.	Spatial mechanisms	
4.	Grubler's criteria for degree of freedom	
5.	Equivalent mechanisms	
6.	Inversions of four link chain	
7.	Slider crank chain and double slider crank chain	
8.	Tutorial	
9.	Tutorial	
10.	Tutorial	
11.	Steps to draw velocity diagram	
12.	Relative velocity method	
13.	Tutorial	
14.	Tutorial	
15.	Tutorial	
16.	Instantaneous' center methods of velocity	
17.	Tutorial	
18.	Tutorial	
19.	Tutorial	
20.	Tutorial	
21.	Construction of acceleration diagram using velocity Diagram	
22.	Coriolis component of acceleration	
23.	Tutorial	
24.	Tutorial	
25.	Tutorial	
26.	Stone crusher mechanism, Sewing machine mechanism	
27.	Quick return mechanisms wrapping m/c mechanism etc Klein's construction	
28.	Quick return mechanisms wrapping m/c mechanism etc Klein's construction	
29.	Tutorial	
30.	Tutorial	
31.	Concept of pole and relative pole	
32.	Freudenstein equation	
33.	Block methods least square technique	
34.	Application to four link mechanism and slider crank mechanism function generation	
35.	Modification of timing of cam mechanism	
36.	Limit & dead center positions transmission angle	
37.	Cognate linkages	
38.	Coupler curves	
39.	Euler savory equation	
40.	Tutorial	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if ay		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I/II	Year II
Name of Course	Detailed Design of Rotary Machines		
Course Code	ID 24553		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.			
Course Outcomes:			
1.	Enables to understand the basic application of computer for component design and its assembly		
2.	Enables to understand the wind/fluid characteristics parameters such as speed, direction, turbulence, lift, drag, moment et cetera.		
3.	Enables to apply the blade momentum theory and design aerodynamically the wind turbine rotor.		
4.	Enables to design blades subjected to static and dynamic loadings.		
Description of Contents in brief:			
Unit 1.	Introduction: Historical developments, latest developments, state of art of wind energy technology, turbine rating, cost of energy, wind power plant economics, installation and operation costs, decommissioning, Indian scenario and worldwide developments, present status and future trends, Nature of atmospheric winds; wind resource characteristics and assessment; advanced techniques of wind measurement, profile, extrapolation and prediction.		
Unit 2.	Aerodynamics of Blade and Rotor: Aerodynamics of aerofoil; lift; drag; stall; effect of Reynold's number; actuator disc; momentum theory and Betz coefficient.		
Unit 3.	design of wind turbine blade; effect of stall and blade pitch on coefficient of power vs tip speed ratio and coefficient of torque vs tip speed ratio characteristics, wind tunnel studies of aerofoil, optimal choice of cut-in, rated and cut-out wind speeds, blade materials, composites and nano materials.		
Unit 4.	Wind Turbine Design: Vertical and horizontal axis turbines, design considerations, multiple stream tube theory, vortex wake structure; tip losses; rotational sampling, wind turbine design procedure, aerodynamic loads, tower shadow, wind shear, blade coning, gyroscopic, transient and extreme loads. Aerodynamic damping and stability, teetering motion, stiff and soft towers. Power train dynamics and mechanisms. Pitch control, yaw control, Electrical and Mechanical aerodynamic braking, teeter mechanism and wind turbine dynamics		
Unit 5.	Specific examples to be taken such as centrifugal pump, wind turbines rotor in detail, machine tools etc. calculation of loads, stresses and strengthening of blades.		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

List of Text Books:		
1.	Ahmad Hemami (2012) Wind Turbine Technology. Cengage Learning. ISBN: 1435486463, 9781435486461	
2.	Trevor M. Letcher (2017). Wind Energy Engineering: A Handbook for Onshore and Offshore Wind Turbines. Academic Press. ISBN: 012809429X, 9780128094297	
3.	Eggleston, D.M. and Stoddard, F.S. (1987) ‘Wind Turbine Engineering Design’, Van Nostrand Rheinhold, New York.	
List of Reference Books/ Links:		
1.	Ahmed Siraj (2016). WIND ENERGY: Theory and Practice, 3/e PHI, Eastern Economy Edition ISBN 978-81-203-5163-9 New Delhi.	
2.	Hau, E. (2006) ‘Wind Turbines: Fundamentals, Technologies, Application, Economics, 2nd edition’, Springer, Heidelberg.	
3.	Wind Turbine Blade Analysis using the BladeElement Momentum Method.Version 1.1 Grant IngramOctober 18, 2011. http://creativecommons.org/licenses/by-sa/3.0/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Application to computer in mechanical component design and assembly	
2.	Introduction to modern wind energy and its origins	
3.	General Characteristics of the Wind Resource	
4.	Wind Data Analysis and Resource Estimation	
5.	Wind Turbine Energy Production Estimates Using Statistical Techniques	
6.	Regional Wind Resource Assessment	
7.	Wind Prediction and Forecasting	
8.	Wind Measurement and Instrumentation	
9.	Advanced Topics	
10.	One-dimensional Momentum Theory and the Betz Limit	
11.	One-dimensional Momentum Theory and the Betz Limit	
12.	Ideal Horizontal Axis Wind Turbine with Wake Rotation	
13.	Airfoils and General Concepts of Aerodynamics	
14.	Blade Design for Modern Wind Turbines	
15.	Blade Design for Modern Wind Turbines	
16.	Momentum Theory and Blade Element Theory	
17.	Generalized Rotor Design Procedure	
18.	Generalized Rotor Design Procedure	
19.	Simplified HAWT Rotor Performance Calculation Procedure	
20.	Computational and Aerodynamic Issues in Aerodynamic Design	
21.	Tutorial Problems	
22.	Tutorial Problems	
23.	Tutorial Problems	
24.	Tutorial Problems	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

25.	Wind Turbine Loads	
26.	General Principles of Mechanics	
27.	General Principles of Mechanics	
28.	Wind Turbine Rotor Dynamics	
29.	Material Fatigue	
30.	Wind Turbine Materials	
31.	Machine Elements	
32.	Principal Wind Turbine Components	
33.	Design Procedure	
34.	Wind Turbine Rotor Design	
35.	Wind Turbine Standards, Technical Specifications, and Certification	
36.	Wind Turbine Design Loads	
37.	Power Curve Prediction	
38.	Design Evaluation	
39.	Wind Turbine and Component Testing Procedure	
40.	Wind Turbine and Component Testing Procedure	
41.	Tutorial Problems	
42.	Tutorial Problems	
43.	Tutorial Problems	
44.	Tutorial Problems	
45.	Tutorial Problems	
46.	Tutorial Problems	
47.	Tutorial Problems	
48.	Tutorial Problems	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if ay		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M.Tech. in Mechanical Engineering with specialization in Industrial Design	Semester I/II	Year I
Name of Course	Design for Reliability		
Course Code	ID-24554		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Basic knowledge of design process		
2.	Basic knowledge of probability theory		
Course Outcomes:			
1.	Understand the reliability theory and maintenance function and their objectives, importance and applications in engineering.		
2.	Gain the necessary knowledge about the system concept and types of failures and failure modes and also types of maintenance systems.		
3.	Understand the concept of maintainability and Availability and to apply its theory for better reliability.		
4.	Understand the concept of quality and maintenance along with availability so as to design and maintain systems and product for better performance.		
Description of Contents in brief:			
Unit 1.	Introduction and basic concepts of Reliability and Reliability Engineering		
Unit 2.	Reliability of Products and Systems		
Unit 3.	Failures and failure mode analysis		
Unit 4.	Introduction and basic concepts of Maintainability and Availability		
Unit 5.	Quality, Value Analysis and Value Engineering		
Unit 6			
List of Text Books:			
1.	Introduction to Reliability Engineering by E.E. Lewis, Wiley Publications.		
2.	Reliability Engineering By L.S. Srinath, East-West Publishers.		
3.	Reliability Engineering By Balaguruswamy Roy, McGraw Hills.		
List of Reference Books:			
1.	Practical Reliability Engineering by Patrick D.T.O, Connor, Apos, Wiley Publications		
2.	Reliability and Maintainability Engineering by C.E. Ebeling, McGraw Hills.		
3.	Reliability Engineering and Life Testing by V.N.A.Naik, Printice Hall India.		
URLs:			
1.	https://www.sciencedirect.com/topics/engineering/reliability-engineering		
2.	https://study.com/academy/lesson/reliability-engineering-definition-purpose.html		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction to Reliability and Reliability Engineering	
2.	Definitions and Importance of Reliability in design process.	
3.	Definitions and Importance of Reliability in design process cont.	
4.	Applications of Reliability Engineering	
5.	Applications of Reliability Engineering cont.	
6.	Bath-Tub diagram of failures	
7.	Product Life Cycle diagram and burn in period.	
8.	Total Productive cost vs reliability cost curve.	
9.	Product reliability and failure rate	
10.	Product reliability and failure rate cont.	
11.	Design for Reliability introduction and theory	
12.	Design for reliability procedure	
13.	Design for reliability procedure cont.	
14.	Ways of improving reliability by design	
15.	System concept and system interfaces	
16.	Introduction to System reliability	
17.	Functional analysis	
18.	Reliability of the systems in series	
19.	Reliability of the systems in parallel	
20.	Introduction to failures and failure modes	
21.	Failures and their classification	
22.	Causes of failures and their effects	
23.	Failure modes and their classification	
24.	Failure modes and their classification cont.	
25.	Failure Modes, Effects and Criticality Analysis (FMECA)	
26.	Failure Modes, Effects and Criticality Analysis cont.	
27.	Fault Tree Analysis (FTA)_	
28.	Fault Tree Analysis cont.	
29.	Cause and Effect diagrams (CED)	
30.	Cause and Effect diagrams cont.	
31.	Baysian Belief Networks (BBN)	
32.	Baysian Belief Networks (BBN)	
33.	Event Tree Analysis and its types (ETA)_	
34.	Event Tree Analysis and its types cont.	
35.	Reliability Block Diagrams (RBD)	
36.	Introduction to Maintainability	
37.	Types of maintenance schedules	
38.	Availability: Basic concepts	
39.	Availability function and limiting availability	
40.	Instant availability, steady system availability,	
41.	Inherent, achieved and operational availability	
42.	Introduction to quality, definitions and types	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

43.	Dimensions of quality	
44.	Principles of quality	
45.	Introduction to value analysis and value engineering	
46.	Value analysis terms and basic concepts	
47.	Value analysis principles	
48.	Value analysis principles cont.	
49.	Value analysis methodology	
50.	Value analysis methodology cont.	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any	--	
5	Quiz if any	10	
6	Seminar, Viva voce if any	--	
7	End Semester Examination	50	
8	Experiments if any (for practical courses)	--	
8	Any other	--	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I/II	Year I
Name of Course		Computer Aided Design and Manufacturing (CAD/CAM)		
Course Code		ID24555		
Core / Elective / Other		Elective		
Prerequisite if any: NIL				
Course Outcomes:				
1.	Understand the basic concepts of CAD/CAM and apply geometric transformations in CAD			
2.	Develop mathematical models to represent curves and surfaces			
3.	Model typical components using solid modelling techniques for design			
4.	Develop part programs for typical components			
5.	Understand the elements of the CAM environment			
Description of Contents in brief:				
Unit 1.	The design process,Product life cycle, Overview of computer aided design and manufacturing(CAD/CAM), Hardware and software requirements in CAD/CAM, Introduction to geometric representation- Implicit, explicit and parametric equations, Transformations in 2D and 3D			
Unit 2.	Wire Frame entities, Representation of curves: Non parametric and parametric. Synthetic curves: Hermitecubic spline, Bezier curves and B-Spline curves, Surface modeling: Plane surface, Ruled surface, Surface of revolution, Tabulated cylinder,Hermite Bi-cubic surface, Bezier surface, B-spline surface			
Unit 3.	Representation of solids: Topology of surfaces, Euler and modified form of equations, Representations: Quadtree, Octree, Halfspace, Boundary representation (B-Rep), Constructive solid geometry (CSG), Boolean operations in 2D- set membership classification, Union, Difference and Intersection			
Unit 4.	An Overview,classification and components of CNC Machines, Part programming fundamentals, Process planning, Axes selection, Tool selection, Steps involved in development of part program, Job and tool set up planning, Machining path planning, Manual part programming methods, Preparatory functions: G- Codes, Miscellaneous Functions: M Codes, Tool length and cutter radius compensations, Writing part programs for typical components: Milling, Turning, etc., Canned cycles,Automatically programmed tool(APT), Geometry statements, Motion statements, Post processor statements, Auxiliary statements, Writing complete part programs for typical components with APT			
Unit 5.	Introduction to group technology, Part classification & coding systems: OPITZ coding, Production flow analysis. Computer aided process planning (CAPP): Introduction to CAPP, Variant &generative methods of CAPP, Flexible manufacturing system (FMS): Components of FMS, FMS equipment & control, FMS case studies, Terminology in quality control (QC), the computer			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

	in QC, Contact inspection methods, Non-contact inspection methods, computer aided (CA) testing, Integration of CAQC with CAD/CAM	
List of Text Books:		
1.	D. F. Rogers and J. A. Adams, Mathematical Elements for Computer Graphics, McGraw Hill, 2002.	
2.	Grover M. P. and Zimmers E.W. “CAD/CAM: Computer Aided Design and Manufacturing”, Prentice Hall of India, 2010.	
3.	I. Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill, 2006	
List of Reference Books:		
1.	T.C. Chang, R.A. Wysk, H.P. Wang “Computer Aided Manufacturing”, 3rd Edition, Pearson Prentice Hall, 2006.	
2.	M. E. Mortenson, Geometric Modeling, John Wiley & Sons, 1985.	
3.	P.N. Rao, “CAD/CAM Principles and Applications”, 3rd Edition, Tata McGraw Hill, New Delhi, 2010.	
URLs:		
1.	https://nptel.ac.in/courses/112/102/112102101/	
2.	https://nptel.ac.in/courses/112/102/112102103/	
3.	https://nptel.ac.in/courses/112/104/112104031/	
Lecture Plan (about 40-50 Lectures):		
Lecture No.	Topic	Remarks
1.	The Design Process	
2.	Product Life Cycle	
3.	Overview of CAD/CAM, Hardware and software requirements in CAD/CAM	
4.	Introduction to geometric representation- Implicit, explicit	
5.	Introduction to geometric representation- Parametric equations	
6.	Transformations in 2D	
7.	Transformations in 3D	
8.	Wire Frame entities, Representation of Curves: Non parametric and parametric	
9.	Synthetic Curves: Hermite Cubic spline	
10.	Bezier Curves	
11.	B-Spline Curves	
12.	Surface Modeling: Plane Surface, Ruled Surface	
13.	Surface of Revolution, Tabulated Cylinder	
14.	Hermite Bi-cubic Surface	
15.	Bezier Surface	
16.	B– Spline Surface	
17.	Representation of solids: Topology of surfaces, Euler and modified form of equations	
18.	Representations: Quadtree, Octree, Halfspace	
19.	Boundary Representation (B-Rep), Constructive Solid Geometry (CSG)	
20.	Boolean operations in 2D- set membership classification,	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

	Union, Difference and Intersection	
21.	An Overview, classification and components of CNC machines	
22.	CNC Programming: Part programming fundamentals	
23.	Process planning, Axes selection, Tool selection	
24.	Steps involved in Development of Part Program	
25.	Job and Tool Set up Planning, Machining path planning	
26.	Manual Part Programming: Manual part programming Methods	
27.	Preparatory functions: G- Codes, Miscellaneous Functions: M Codes	
28.	Tool length and Cutter radius compensation	
29.	Writing Part programs for typical components: Milling,	
30.	Writing Part programs for typical components: Turning, etc.	
31.	Canned cycles	
32.	Automatically Programmed Tool (APT)	
33.	Geometry statements	
34.	Motion statements	
35.	Post processor statements, Auxiliary statements	
36.	Writing complete Part programs for typical components with APT	
37.	Group Technology: Introduction to Group technology	
38.	Part classification & coding systems	
39.	OPITZ coding	
40.	Production flow analysis	
41.	Computer Aided Process Planning (CAPP): Introduction to CAPP	
42.	Variant & Generative methods of CAPP	
43.	Flexible Manufacturing System (FMS): Components of FMS	
44.	FMS equipment & control	
45.	FMS case studies	
46.	Terminology in quality control (QC)	
47.	contact inspection methods	
48.	Non-contact inspection methods	
49.	computer aided (CA) testing	
50.	integration of CAQC with CAD/CAM	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if ay		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester – I / II	Year-I
Name of Course	ADVANCED DYNAMICS OF MACHINE		
Course Code	ID24556		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.			
2.			
Course Outcomes:			
1.	Able to formulate mechanical engineering problems and to find solution using principles engineering sciences, mathematics and literature.		
2.	Ability to synthesis and analysis of the information, interpretation of data to find valid conclusion of the problem		
3.	Able to understand the actual mechanism involved in the machinery along with different dynamic forces acting on various parts of the machinery.		
Description of Contents in brief:			
Unit 1.	Design and force analysis of Gears like Spur Gear, Helical Gear, Bevel Gear, Worm Gear .		
Unit 2.	Concept of Vibrations: Longitudinal, Transverse and Torsional Vibration, Natural frequency calculation with different Methods, Undamped, Damped and Forced Damped Vibration, Vibration Isolation and Transmissibility, Concept of Whirling of Shaft,		
Unit 3.	Rotary Balancing: Balancing of Rotating Masses in same and different planes, Dynamic Balancing Machine.		
Unit 4.	Reciprocating Balancing: Concept of Primary and Secondary Unbalanced Forces in Reciprocating Machines, Balancing of Locomotive Engines, Inline Engines, Radial Engines, V Engines, Hybrid Engines.		
Unit 5.	Cam And followers: Basics, Terminology, Motion of the Followers, Motion of the Follower with specified Contours, Analysis of Elastic Cam System, Spring Surges, Unbalance and Wind Up.		
Unit 6	Gyroscope: Gyroscopic Couple in a Plane Disc, Effect of Gyroscopic couple in a Aero-plane, Effect of Gyroscopic couple in a Navel Ships, Effectof Gyroscopic couple in aTwo Wheelers, Effectof Gyroscopic couple in aFour Wheeler.		
List of Text Books:			
1.	Theory of Machines by SS Rattan (5 th edition)		
2.	Design of Machine Elements by V.B. Bhandari, McGraw Hill publication		
3.	Mechanical vibration by Singiresu S.Rao, pearson publication		
List of Reference Books:			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

1.	Theory of machines by Thomas Bevan	
2.	Theory Of Machines and Mechanisms by J E Singley etc	
3.	Engineering mechanics by KL kumar, Veenu kumar, McGraw Hill publication	
URLs:		
1.	https://wifigyan.com/ss-rattan-tom-theory-of-machines-book/	
2.	https://books.google.co.in/books/about/Design_of_Machine_Elements.html?id=M1y4_cfXyoAC&printsec=frontcover&source=kp_read_button&redir_esc=y#v=onepage&q&f=false	
3.	https://www.academia.edu/35666026/THEORY_OF_MACHINES_AND_MECHANISMS_Third_Edition	
Lecture Plan (about 40-50 Lectures):		
Lecture No.	Topic	Remarks
1.	Gear Drives	
2.	Classification of Gear Drives	
3	Gear Terminology, Interference and undercutting	
4	Gear Materials and Design considerations	
5	Defects in the gears during fabrication and working under dynamic loadings.	
6	Design and force analysis of Gears	
7	Lewis Equation, Buckingham equation, dynamic load factor	
8	Design of Spur Gears using Lewis equation	
9	Design of Spur Gears by AGMA consideration	
10	Problems	
11	Problems	
12	Basics of Helical Gears	
13	Design of Helical Gears using Lewis equation	
14	Design of Helical Gears by AGMA consideration	
15	Problems	
16	Basics of Bevel Gears	
17	Design of Bevel Gears using Lewis equation	
18	Design of Bevel Gears by AGMA consideration	
19	Design of Worm Gear	
20	Concept of Vibrations: Longitudinal, Transverse and Torsional Vibration	
21	Natural frequency calculation with different Methods	
22	Un-damped Vibration, Damped Vibrations	
23	Forced Damped Vibrations	
24	Vibration Isolation and Transmissibility	
25	Concept of Whirling of Shaft	
26	Problems	
27	Problems	
28	Rotary Balancing: Balancing of Rotating Masses in same and different planes	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

29	Balancing of Rotating Masses in a different planes	
30	Problems	
31	Problems	
32	Dynamic Balancing Machine.	
33	Reciprocating Balancing: Concept of Primary and Secondary Unbalanced Forces in Reciprocating Machines	
34	Balancing of Locomotive Engines: Tractive Force, Swaying couple and Hammer Blow	
35	Problems	
36	Balancing of Inline Engines	
37	Balancing of Radial Engines	
38	Problems	
39	Problems	
40	Balancing of V Engines	
41	Balancing of Hybrid Engines	
42	Cam And followers: Basics, Terminology, Motion of the Followers	
43	Motion of the Follower with specified Contours: Tangent Cam with Roller Follower	
44	Circular Arc Cam with Flat Face Follower	
45	Problems	
46	Problems	
47	Analysis of Elastic Cam System	
48	Spring Surges, Unbalance and Wind Up	
49	Gyroscope: Gyroscopic Couple in a Plane Disc	
50	Effect of Gyroscopic couple in a Aero-plane	
51	Effect of Gyroscopic couple in a Navel Ships	
52	Effectof Gyroscopic couple in aTwo Wheelers	
53	Effectof Gyroscopic couple in aFour Wheeler.	
54	Problems	
55	Problems	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if ay		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
9	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		Master of Technology in Mechanical Engineering with specialization in Industrial Design	Semester: I / II	Year: I
Name of Course		Material selection in Mechanical design		
Course Code		ID24557		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	NIL			
Course Outcomes:				
1.	Identify different properties of engineering materials that are useful in materials selection for mechanical design purpose			
2.	Read material property chart, select a material using material indices and structural index			
3.	Optimize the material and final shape as required in design			
4.	Design hybrid materials from the given material property data and Requirements			
5.	Screen the material, process and property information for designing the product as per environmentand market requirements			
Description of Contents in brief:				
Unit 1.	Introduction: The design process, types of design, design tools, properties of engineering materials and materials data			
Unit 2.	Materials Selection- The selection strategy, attribute limits and material indices, the selection procedure, computer-aided selection, the structural Index			
Unit 3.	Selection of material and shape, case studies: Shape factors, Microscopic or micro-structural shape factors, limits to shape efficiency, exploring and comparing structural sections, material indices that include shape, co-selecting material and shape			
Unit 4.	Designing Hybrid materials and case studies: Filling holes in material property space, A + B + configuration scale, Composites, Sandwich structures, Lattices, segmented structures.			
Unit 5.	Information and knowledge sources for design: Information for materials and processes, screening information, supporting information, ways of checking and estimating data			
Unit 6	Materialsandindustrialdesign: The requirements pyramid, product character, using materials and processes to create product personality, Environmental factors			
List of Text Books:				
1.	M. F.Ashby, Materials Selection in Mechanical Design, Elsevier Butterworth-Heinemann, 3 rd Ed., 2005			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

2.	J. A. Charles,F. A. A.Crane, and J. A. GFurness, Selection and use of engineering materials, Oxford	
3.	N.A. Watermann and M.F. Ashby, Material Selection, Chapman and Hall, 1996	
List of Reference Books:		
1.	M.F. Ashby, The engineer’s guide to materials selection, Butterworth-Heinemann,	
2.	M.A. Meyers, K.K. Chawla, Mechanical Behaviour of Materials, Cambridge University Press, 2 nd Edition, New York	
URLs:		
1.	www.grantadesign.com	
2.	www.stanfordmaterials.com , www.twca.com	
3.	www.asminternational.org/alloycenter/index.jsp	
4.	www.cmwinc.com	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction to the course	
2.	Review of design process	
3.	Types of design and design tools	
4.	Correlation between function, material, process and shape, case study	
5.	Families of engineering materials, Definition of different materials properties.	
6.	Measurement of different materials property	
7.	Introduction to different materials property chart - 1	
8.	Introduction to different materials property chart - 2	
9.	Introduction to different materials property chart - 3	
10.	Practice session on reading the materials property chart	T
11.	Introduction to the steps in material selection strategy	
12.	Attribute limits and material indices	
13.	Derivation of material indices	
14.	Systematic selection procedure and structural index	
15.	Case studies on material selection - 1	
16.	Case studies on material selection - 2	
17.	Case studies on material selection - 3	
18.	Practice session on selection of materials	T
19.	Shape factors, microscopic and microstructural shape Factors	
20.	Limits of shape efficiency comparison of structural sections	
21.	Material indices that include shape, co-selecting material and shape	
22.	Case studies on selection of materials and shapes -1	
23.	Case studies on selection of materials and shapes -2	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

24.	Practice session on selection of materials and shape	T
25.	Filling holes in material property space	
26.	'A + B + configuration + scale' method	
27.	Composites: hybrids of Type I	
28.	Composites: hybrids of Type I	
29.	Sandwich structures: hybrids of Type II	
30.	Sandwich structures: hybrids of Type II	
31.	Lattice: hybrids of Type III	
32.	Lattice: hybrids of Type III	
33.	Segmented structures: hybrids of Type - IV	
34.	Case studies in Hybrids	
35.	Practice session on hybrids	T
36.	Format and type of data available for material property Selection	
37.	Screening of information	
38.	Ways of checking and estimating data	
39.	Case studies on information screening and data Estimation	
40.	Practice session	T
41.	The requirements pyramid and product character	
42.	Using materials and processes to create product Personality	
43.	Practice Session	T
44.	Forces for change in materials and processes	
45.	Population, science and technology advancements, miniaturization	
46.	Material life cycle	
47.	Material and energy consuming systems	
48.	The eco-attributes of materials	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	Two micro surprise quiz
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
9	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I / II	Year I
Name of Course	Advanced Operations Research		
Course Code	ID24558		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Operations Research		
Course Outcomes:			
1.	Analyse and synthesis the linear programming problem and non linear problems		
2.	Simulate the optimization problems and Develop decision making skills		
3.	Understanding goal programming and dynamic programming methods		
Description of Contents in brief:			
Unit 1.	Introduction of LP, Simplex Problem, Duality in Linear Programming, Dual Simplex Method, Revised Simplex Method, Sensitivity analysis,		
Unit 2.	Special Cases of Assignment Problem, Transportation Problem and Optimality Test, Transshipment Problem,		
Unit 3.	Integer Linear Programming, Branch and Bound Method, Goal Programming,		
Unit 4.	Decision Analysis: Decision Trees		
Unit 5.	Simulation, Monte-Carlo Method, Dynamic Programming,		
Unit 6	Non-Linear Programming, Multi Criteria Decision Making Tools		
List of Text Books:			
1.	Introduction to Operations Research, by Frederick S. Hillier and Gerald J. Lieberman, Tata McGraw Hill, New York.		
2.	Operations Research: An Introduction, by Hamdy A. Taha, Prentice-Hall, New York.		
3.	Operations Research by Heera& Gupta, S Chand Publications		
List of Reference Books:			
1.	Operations Research: Applications and Algorithms, Winston, W. L.Duxbury Press, Belmont		
2.	Operations Research by Ravindran and Phillip; Wiley publication		
3.	Quantitative Techniques in Management by N D Vohra; McGraw Hill Education		
URLs:			
1.	https://nptel.ac.in/courses/112/106/112106134/		
2.	https://freevideolectures.com/course/2365/fundamentals-of-operations-research		
3.	http://www.nptelvideos.in/2012/12/fundamentals-of-operations-		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

	research.html	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction of advanced OR	
2.	Scope of LP	
3	Limitation of LP	
4	Simplex Problem,	
5	Simplex Problem	
6	Simplex Problem	
7	Duality in Linear Programming, ,	
8	Dual Simplex Method,	
9	Revised Simplex Method,	
10	Revised Simplex Method,	
11	Sensitivity analysis	
12	Sensitivity analysis	
13	Special Cases of Assignment Problem	
14	Special Cases of Assignment Problem,	
15	Transportation Problem	
16	Transportation Problem	
17	Optimality Test,	
18	Optimality Test,	
19	Transshipment Problem	
20	Transshipment Problem	
21	Integer Linear Programming,	
22	Branch and Bound Method,	
23	Goal Programming	
24	Goal Programming	
25	Goal Programming	
26	Goal Programming	
27	Decision Analysis	
28	Decision Trees	
29	Decision Trees	
30	Decision Trees	
31	Simulation,	
32	Simulation,	
33	Monte-Carlo Method,	
34	Dynamic Programming	
35	Dynamic Programming	
36	Dynamic Programming	
37	Non-Linear Programming,	
38	Non-Linear Programming,	
39	Non-Linear Programming	
40	Multi Criteria Decision Making Tools	
41	Multi Criteria Decision Making Tools	
42	Multi Criteria Decision Making Tools	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester: I / II	Year I
Name of Course		Concurrent Engineering		
Course Code		ID24559		
Core / Elective / Other		ELECTIVE		
Prerequisite if any:				
1.	Elementary Knowledge of conceptualization and idea generation			
2.	Improvised thought process to understand the design attributes			
Course Outcomes:				
1.	Ability to synthesis the information, analysis and interpretation of data to find valid conclusion of the problem.			
2.	Ability to synthesis the information, analysis and interpretation of data to find valid conclusion of the problem.			
3.	Ability to model, simulate and analyze engineering activities using software tools and to understand limitation of use.			
Description of Contents in brief:				
Unit 1.	Engineering Design			
Unit 2.	Concurrent Engineering Process			
Unit 3.	Design For X			
Unit 4.	Design For Experiments			
Unit 5.	Modeling and Simulation			
Unit 6	TQM Techniques and Tools			
List of Text Books:				
1.	Engineering Design by George E. Dieter and Linda C. Schmidt			
2.	Concurrent Engineering Fundamentals by Biren Prasad			
3.	Design And Analysis of Experiments by Douglas C. Montgomery			
List of Reference Books:				
1.	Concurrent Engineering by Chanan s. syan and UnnyMenon			
2.	Design For Manufacturability and Concurrent Engineering by Dr. David M.A			
3.	Product Design and Development by Karl T. Ulrich and Steven D. Eppinger			
URLs:				
1.	https://www.digimat.in/nptel/courses/video/112104230/Lo1.html			
2.	https://nptel.ac.in/courses/110/105/110105087/			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks
1.	Engineering Design Process			
2.	Types of Design			
3.	Problem Solving Methodology			
4.	Achievement of Performance Requirements			
5.	Total Life Cycle			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

6.	Conceptual Design	
7.	Embodiment Design	
8.	Detail Design	
9.	Planning for Manufacture	
10.	Planning for Distribution	
11.	Planning for Use	
12.	Planning for Retirement of the Product	
13.	Designing to Codes and Standards	
14.	Societal Considerations in Engineering Design	
15.	Concurrent Engineering Vs Sequential Engineering	
16.	Cross Functional Teams	
17.	Team Behavior and Tools part 1	
18.	Team Behavior and Tools part 2	
19.	Decision Making	
20.	Decision Making Tools	
21.	Parallel Design	
22.	Design for Manufacture	
23.	Design for Assembly	
24.	Design for Function Factors	
25.	Design With Materials	
26.	Design for Reliability	
27.	Design for safety	
28.	Design for Serviceability	
29.	Design for Quality and Robustness	
30.	Design for Economy and Marketing	
31.	Design for Environment	
32.	Design for Reuse and Recyclability	
33.	Quality Function Deployment	
34.	House of Quality	
35.	Design for Experiments	
36.	Pillars of DOE	
37.	Factorial Designs	
38.	Fractional Factorial Designs	
39.	Response Surface Methods	
40.	Central Composite Designs	
41.	Mixture Designs	
42.	Taguchi Fractional Factorial Designs	
43.	Statistical Techniques for Analysis	
44.	Analysis of 2D and 3D Plots and Graphs	
45.	Computational Modeling	
46.	Optimization Techniques Part 1	
47.	Optimization Techniques Part 2	
48.	Total Quality Management	
49.	Description of Quality Tools	
50.	Redesign Analysis	
	Summary of Subject	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I / II	Year I
Name of Course	Facility and Process Planning		
Course Code	ID24560		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.			
Course Outcomes:			
1.	Enables to understand Factory Planning, Plant Location and Location Theory		
2.	Enables to understand production system, types of layout and its characteristics.		
3.	Design and improve existing and new layout incorporating product, process as per requirements of organizations.		
4.	To select appropriate Materials Handling problems, types and selection of materials handling equipments.		
5.	Enables to understand Materials Flow, Facility Management and its application softwares.		
Description of Contents in brief:			
Unit 1.	Introduction to Factory Planning, factors to be considered. Levels of plant location, rural, urban and suburban location of plants, factors influencing the plant location, optimum plant location, location theories.		
Unit 2.	Introduction of production system, scope, objectives, importance, and types of plant layout, characteristics of a good plant layout.		
Unit 3.	Definition, objectives, planning, part families and machine cell formation, evaluation of machine cells, types of GT layout, benefits of GT, implementation of GT.		
Unit 4.	Definition, scope, objectives, principles, importance, factors in materials handling problem, analysis of materials handling, types and selection of materials handling equipments, aids and techniques in materials handling equipment selection.		
Unit 5.	Planning of material flow, advantages of planned material flow, flow planning principles, flow patterns, analysis of material flow.		
Unit 6	Computer aided facility management, application softwares, application areas, Application of CAFM in manufacturing sector and service sectors.		
List of Text Books:			
1.	Facility Planning, Tompkins, White		
2.	Facility Layout and Location, R.L. Francis, White		
List of Reference Books:			
1.	Computer Aided Processes, M Chidambaram		
2.	Computer Aided Process Control, S.K. Singh		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

3.	Computer Aided Facilities Planning, H Lee Hales	
4.	Automation, Production Systems and Computer Integrated Manufacturing, M.P Groover	
URLs:		
1.	https://nptel.ac.in	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction to Facility planning	
2.	Study of production facilities, including location, planning, design and maintenance	
3.	Study of production facilities, including location, planning, design and maintenance	
4.	Emphasis on production systems	
5.	Emphasis on machine selection	
6.	Emphasis on automation	
7.	Emphasis on material handling	
8.	Emphasis on storage and warehousing	
9.	Emphasis on quality and retrofitting	
10.	Emphasis on preventative maintenance	
11.	Introduction to Factory Planning	
12.	Factors to be considered	
13.	Plant Location and Site Selection	
14.	Plant Location and Site Selection	
15.	Levels of plant location	
16.	Levels of plant location	
17.	Rural, urban and suburban location of plants	
18.	Rural, urban and suburban location of plants	
19.	Rural, urban and suburban location of plants	
20.	Factors influencing the plant location	
21.	Factors influencing the plant location	
22.	Optimum plant location	
23.	Optimum plant location	
24.	Location theories	
25.	Location theories	
26.	Plant Layout	
27.	Plant Layout	
28.	Introduction of production system	
29.	Introduction of production system	
30.	Scope, objectives, importance	
31.	Scope, objectives, importance	
32.	Types of plant layout	
33.	Characteristics of a good plant layout	
34.	Characteristics of a good plant layout	
35.	Factors affecting plant layout	
36.	Procedure of developing a plant layout	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

37.	Installation and evaluation of plant layout	
38.	Optimum plant layout	
39.	Group Technology: Definition, objectives and planning	
40.	Part families and machine cell formation	
41.	Evaluation of machine cells	
42.	Types of GT layout, benefits of GT, implementation of GT	
43.	Materials Handling: Definition, scope, objectives, principles and importance	
44.	Factors in materials handling problem, analysis of materials Handling	
45.	Types and selection of materials handling equipment's, aids	
46.	Techniques in materials handling equipment selection	
47.	Planning of material flow, advantages of planned material Flow	
48.	Flow planning principles, flow patterns, analysis of material Flow	
49.	Computer aided facility management, application software and application areas	
50.	Application of CAFM in manufacturing sector and service Sectors	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any	-	
5	Quiz if any	10	
6	Seminar, Viva voce if any	-	
7	End Semester Examination	50	
8	Experiments if any (for practical courses)	-	
8	Any other	-	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I / II	Year I
Name of Course	Additive Manufacturing		
Course Code	ID24561		
Core / Elective / Other	Elective		
Prerequisite if any: NIL			
Course Outcomes:			
1.	Understand the basic concepts of additive manufacturing (AM)		
2.	Select the suitable design and delivery systems for AM machines		
3.	Develop mathematical models to represent given part inAM file format		
4.	Applyvarious data processing concepts for AM part		
5.	Analyze the use of various AM and post processingtechniques		
Description of Contents in brief:			
Unit 1.	Additive manufacturing (AM), Background, Types of AM materials, Liquid, solid and powder based AM technologies, Steps of AM, Key considerations in AM steps: Orientation, Slicing and Supported/supportless building, Benefits of AM: manufacturing,medical and sociocultural sectors,Production planning and control:Pre-processing,Part build and post-processing		
Unit 2.	Design of basic AM machines: Machine structure, Drive units, Elements of transmission and positioning, AM machinesparameters, Energy delivery systems-laser, ultraviolet light and heaters system, etc., Material delivery systems- powder, resin and wire feeding systems, etc.,Part Programming, Tool and Safety		
Unit 3.	Geometric representation- Implicit, explicit, parametric equations,2D & 3D transformations of geometry, Design of curves: Cubic Hermite curves, Bezier curves, B-spline curves and NURBS curve,Design of surfaces:Hermite surface, Bezier surface, B-Spline surfaces, rational B-splines and NURBS surface, Topology of surfaces, Euler and modified form of equations, Representations - Quadtree, Octree, Halfspace, Boundary Representation (B-Rep), Constructive Solid Geometry (CSG) and Boolean operations, Data exchange formats, AM file format,Tessellated models, STL File issues, STL File manipulation and repair algorithms		
Unit 4.	AM data processing:Calculating and Sorting the intersection points,Constructing a two-dimensionalcontour and generating support structure,Fundamentals of adaptive slicing,AM Weakness/difficulties: Volumetric Error, Shape deviation,Surface roughness, Material shrinkage or swelling, Staircase effect, Warpage, etc.,Reverse engineering in AM:Point cloudand point cloud to the object, Software solutions for AM		
Unit 5.	AM benchmarks parts and types, Break-even analysis for product-AM technology fit, Post-processing: polishing, abrasive flow, chemical treatment,etc, Ease of post-processing: soluble and breakaway support,etc., Post-processing challenges, Rapid Tooling (RT): advantages and constraints,Methods of RT		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

List of Text Books:		
1.	Chua, C.K. and Leong, K.F., Rapid prototyping: Principles and applications in manufacturing, John Wiley and Sons Inc., 1997	
2.	Noorani, Rafiq, Rapid prototyping: Principles and Applications, John Wiley and Sons Inc., 2006	
3.	I. Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill, 2006.	
List of Reference Books:		
1.	Pham, D.T. and Dimov, S.S., Rapid Manufacturing: The technologies and applications of Rapid Prototyping and Rapid Tooling, Springer-Verlag London Limited., 2001	
2.	Gibson, I., Software Solutions for Rapid Prototyping, Professional Engineering Publishing Limited, 2002	
3.	Ali K. Kamrani, EmandAbouel Nasr, “Rapid Prototyping: Theory & Practice”, Springer, 2006.	
4.	D. F. Rogers and J. A. Adams, Mathematical Elements for Computer Graphics, McGraw Hill, 2002.	
5.	Gibson, Rosen, Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing. Springer, 2009.	
6.	Hopkinson, N., Hague, R.J.M. and Dickens P.M., Rapid Manufacturing: An Industrial Revolution for the Digital Age, John Wiley and Sons, Ltd., 2006	
7.	Venuvinod, P.K. and Ma, W., Rapid prototyping: Laser based and other technologies, Kluwer Academic Publishers, 2004	
URLs:		
1.	https://nptel.ac.in/courses/112/104/112104265/	
2.	http://www.nptelvideos.com/lecture.php?id=14981	
3.	https://www.youtube.com/watch?v=ICjQoUzE2Ao	
4.	https://www.youtube.com/watch?v=gciaoqZMfo	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Additive manufacturing (AM), Background	
2.	Types of AM materials	
3.	Liquid, solid and powder based AM technologies	
4.	Key considerations in AM steps: Orientation, Slicing and Supported/supportless building	
5.	Benefits of AM: manufacturing, medical and sociocultural sectors	
6.	Production planning and control:Pre-processing,Part build and post-processing	
7.	Design of basic AM machines: Machine structure	
8.	Drive units, Elements of transmission and positioning	
9.	AM machinesparameters	
10.	Energy delivery systems-laser	
11.	Energy delivery systems-ultraviolet light	
12.	Energy delivery systems- heaters system etc.	
13.	Material delivery systems- powder	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

14.	Material delivery systems- resin	
15.	Material delivery systems wire feeding systems etc.	
16.	Part Programming	
17.	Tool and Safety	
18.	Geometric representation- Implicit, explicit, parametric equations	
19.	2D transformations of geometry	
20.	3D transformations of geometry	
21.	Design of curves-Cubic Hermite curves	
22.	Design of curves-Bezier curves	
23.	Design of curves-B-spline curves	
24.	Design of curves-NURBS curve	
25.	Design of surfaces-Hermite surface, Bezier surface	
26.	Design of surfaces-B-Spline surfaces, rational B-splines, NURBS surface	
27.	Topology of surfaces, Euler and modified form of Equations	
28.	Representations- Quadtree, Octree, Halfspace, Boundary Representation (B-Rep)	
29.	Constructive Solid Geometry (CSG), Boolean operations	
30.	Data exchange formats, AM file format	
31.	Tessellated models, STL File issues	
32.	STL File manipulation and repair algorithms	
33.	AM data processing: Calculating and Sorting the intersection points	
34.	AM data processing: Constructing a two-dimensional contour and generating support structure	
35.	Fundamentals of adaptive slicing	
36.	AM Weakness/difficulties: Volumetric Error, Shape Deviation	
37.	AM Weakness/difficulties: Surface roughness, Material shrinkage or swelling	
38.	AM Weakness/difficulties: Staircase effect, Warpage, etc.,	
39.	Reverse engineering in AM: Point cloud	
40.	Reverse engineering in AM: point cloud to the object	
41.	Software solutions for AM	
42.	AM benchmarks parts and types	
43.	Break-even analysis for product-AM technology fit	
44.	Post-processing: polishing	
45.	Post-processing: abrasive flow	
46.	Post-processing: chemical treatment etc,	
47.	Ease of post-processing: soluble and breakaway support etc.	
48.	Post-processing challenges	
49.	Rapid Tooling (RT): advantages and constraints	
50.	Methods of RT	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		Project

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I/II	Year - I
Name of Course	DESIGN OF EXPERIMENTS		
Course Code	ID24562		
Core / Elective /Other	Elective		
Prerequisite if any:			
1.	Basic knowledge of statistics		
Course Outcomes:			
1.	Able to learn how to plan, design and apply experimental design techniques to practical problems.		
2.	Able to understand and build the appropriate models for designed experiments, perform data analysis using statistical methods		
3.	Able to improve quality of processes / products by optimizing the Parameters		
Description of Contents in brief:			
Unit 1	Introduction to design and analysis of experiments with basic conceptsand applications, fundamentals of statistics, Analysis of Variance (ANOVA)		
Unit 2	Mathematical modeling, regression analysis, generation of experimental designs		
Unit 3	Randomization, replication and blocking, randomized complete blockdesign (RCBD), Full factorial designs, design resolutions, fractional factorial designs		
Unit 4	Response surface methodology, central composite designs; CCRCD, CCRFCD, CCRID, Box – Behnken design, Plackett-Burman design		
Unit 5	Orthogonal designs, Taguchi robust designs, signal-to-noise (S/N) analyses, main effect plots		
Unit 6	Optimization of process / product parameters, Introduction to experimental design softwares		
List of Text Books:			
1.	Design and Analysis of Experiments, Douglas C. Montgomery, Eighthedition, Wiley, 2014		
2.	Design of Experiments for Engineers and Scientists, second Edition,Jiju Antony, Elsevier, 2014		
3.	Experiments, Planning, Analysis, and Optimization, C. F. JeffWu, Michael S. Hamada, Wiley, 2021		
List of Reference Books:			
1.	Statistics for Experimenters: Design, Innovation, and Discovery, George E. P. Box, J. Stuart Hunter, William G. Hunter, Wiley, 2005		
2.	DOE Simplified, Practical Tools for Effective Experimentation, Third Edition, Mark J. Anderson, Patrick J. Whitcomb, CRC Press, 2017		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

3.	Design and Analysis of Experiments, Volume 1, Introduction to Experimental Design, Klaus Hinkelmann, Oscar Kempthorne, wiley, 2007
URLs:	
1.	https://nptel.ac.in/courses/110/105/110105087/
2.	https://nptel.ac.in/courses/111/104/111104075/

Evaluation Criteria:

Sl.No .	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any	05	
5	Quiz if any	05	
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I / II	Year I
Name of Course		Supply Chain Management		
Course Code		ID24563		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Nil			
Course Outcomes:				
1.	Understanding different types of supply chains			
2.	Design supply chain network and understating supply chain drivers			
3.	Analyse supply chain coordination parameters			
Description of Contents in brief:				
Unit 1.	Introduction Of Supply Chain Management, Inbound And Outbound Logistics, Efficient And Responsive Supply Chain, Supply Chain Case Studies			
Unit 2.	Different Types Of Supply Chains: Agile And Lean Supply Chains, Green Supply Chain Management, Food Supply Chain Management, Humanitarian Logistics, Local & Global Supply Chain Management			
Unit 3.	Supply Chain Drivers, Supply Chain Network Design, Warehousing, Facility Location			
Unit 4.	Inventory Strategies And Management, Inventory Models, Demand Forecasting			
Unit 5.	Transportation, Third Party Logistics, Reverse Logistics, Distribution Planning			
Unit 6	Supply Chain Coordination, Bullwhip Effect, Information Technology Tools In Supply Chains,			
List of Text Books:				
1.	Supply Chain Management Strategy, Planning And Operations, Chopra, S., And Meindl, P., Prentice Hall			
2.	Designing And Managing The Supply Chain: Simchi-Levi And Ravi Shankar: Tata Mcgraw Hill			
3.	Operations And Supply Chain Management: Russel And Taylor Wiley Publication			
List Of Reference Books:				
1.	Logistics And Supply Chain Management, Martin Christopher, Pearson.			
2.	Introduction To Supply Chain Management, R.B. Handfield And E.L. Nochols, Jr.. Prentice Hall.			
3.	Business Logistics And Supply Chain Management- R Ballou, Pearson (Indian Edition)			
URLs:				

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

1.	https://nptel.ac.in/courses/110/107/110107074/	
2.	https://nptel.ac.in/courses/110/105/110105141/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction Of Supply Chain Management	
2.	Scope Of Supply Chain Management	
3	Inbound And Outbound Logistics,	
4	Efficient And Responsive Supply Chain,	
5	Supply Chain Case Studies	
6	Supply Chain Case Studies	
7	Supply Chain Case Studies	
8	Agile And Lean Supply Chains,	
9	Green Supply Chain Management	
10	Food Supply Chain Management,	
11	Humanitarian Logistics,	
12	Local & Global Supply Chain Management	
13	Supply Chain Drivers,	
14	Supply Chain Drivers	
15	Supply Chain Network Design,	
16	Supply Chain Network Design,	
17	Warehousing,	
18	Facility Location	
19	Facility Location	
20	Inventory Strategies And Management,	
21	Inventory Models,	
22	Inventory Models,	
23	Inventory Models	
24	Demand Forecasting	
25	Forecasting Methods	
26	Forecasting Methods	
27	Forecasting Methods	
28	Transportation,	
29	Transportation,	
30	Third Party Logistics,	
31	Reverse Logistics,	
32	Distribution Planning	
33	Distribution Planning	
34	Supply Chain Coordination,	
35	Bullwhip Effect,	
36	Causes Of Bullwhip Effect	
37	Information Technology Tools In Supply Chains	
38	Supply Chain Softwares	
39	ERP	
40	ERP	
41	Seminar	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

42	Seminar	
43	Seminar	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I / II	Year I
Name of Course	Robotics & Robot Applications		
Course Code	ID24564		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Students should have knowledge on Theory of Machines		
2.	Students should have knowledge on Basic mathematics such as, Matrices, Differentiation and Integration		
Course Outcomes:			
1.	Discuss the concept of brief history of robot and calculate the forward and inverse kinematics for various configurations of the robotic manipulators.		
2.	Understand the concept of various end effectors; determine the jacobian matrix and dynamics of the 2-DOF serial manipulators.		
3.	Acquire knowledge about various sensors, actuators and robots used in various industrial and non-industrial applications.		
Description of Contents in brief:			
Unit 1.	Introduction to Robotics, History, Laws, Classifications by coordinate system, Robot components, Concept of work space, Basic robot motions - Point to point control - Continuous path control.		
Unit 2.	Coordinate frames, Mappings: Changing descriptions from frame to frame, Translations, Rotations and Transformations, Kinematic Modelling of the manipulator, D-H Representation, Forward Kinematics and Inverse Kinematics.		
Unit 3.	Classification of end effectors, Tools as end effectors, Drive system for grippers, Mechanical, Adhesive, Vacuum, Magnetic grippers. Gripper force analysis and gripper design. Active and passive grippers.		
Unit 4.	Introduction to Jacobian, Jacobians for serial manipulators, Inverse Jacobian, Lagrangian formulation for equations of motion for serial manipulators, Lagrangian-Euler dynamic model, Trajectory planning.		
Unit 5.	Introduction to actuators and sensors, Pneumatic, Hydraulic and Electrical actuators, Sensors. Types and applications, Position sensors, Potentiometers, Force sensors, Encoders, Introduction to control systems, Open loop and closed loop systems.		
Unit 6	Robot applications in Machining – Welding – Assembly – Material handling – Loading and unloading – spray painting – Medical – Mining – Space – Underwater- Defence.		
List of Text Books:			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

1.	R.K. Mittal & I.J.Nagrath, “Robotics and Control”, 2 nd ed., Tata McGraw Hill, 8 th reprint 2014.	
2.	Spong M. and Vidyasagar M., “Robot Dynamics and Control”, 2 nd ed., John Wiley & Sons, 2014.	
3.	Mikell P. Groover, Mitchell Weiss, “Industrial Robotics, Technology, Programming and Applications”, 2 nd ed., Mc.Graw Hill International, 2008.	
List of Reference Books:		
1.	K.S. Fu., R.C.Gonzalez and C.S.G.Lee, “Robotics Control sensing, Vision and Intelligence”, 1 st ed., McGraw Hill International, 2 nd reprint 2008.	
2.	SaeedB.Niku, “Introduction to Robotics Analysis, Systems, Applications”, 2 nd ed., PHI Learning Publication, 2009.	
3.	S.K. Saha, “Introduction to Robotics”, 2 nd ed., Tata McGraw Hill, 2009.	
4.	D. K Pratihar, “Fundamentals of Robotics”, Narsa Publishers, 2018.	
URLs:		
1.	https://youtu.be/rYWJdZ5qg6M	
2.	https://nptel.ac.in/courses/112/101/112101099/	
3.	https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/lecture-notes/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Introduction to Robotics, History, Laws.	
2.	Classifications by coordinate system,	
3.	Robot components, Concept of work space,	
4.	Basic robot motions – Point to point control – Continuous path control.	
5.	Coordinate frames,	
6.	Mappings: Changing descriptions from frame to frame	
7.	Translations, Rotations and Transformations,	
8.	Kinematic Modelling of the manipulator, D-H Representation,	
9.	Forward Kinematics	
10.	Forward Kinematics	
11.	Forward Kinematics	
12.	Inverse Kinematics	
13.	Inverse Kinematics	
14.	Classification of end effectors, Tools as end effectors	
15.	Drive system for grippers, Mechanical	
16.	Adhesive, Vacuum, Magnetic grippers.	
17.	Gripper force analysis and gripper design.	
18.	Gripper force analysis and gripper design.	
19.	Active and passive grippers.	
20.	Introduction to Jacobian, Jacobians for serial manipulators,	
21.	Jacobians for serial manipulators	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

22.	Jacobians for serial manipulators	
23.	Inverse Jacobian,	
24.	Inverse Jacobian,	
25.	Lagrangian formulation for equations of motion for serial manipulators (Energy method)	
26.	Lagrangian formulation for equations of motion for serial manipulators (Energy method)	
27.	Lagrangian-Euler dynamic model (Matrix Method),	
28.	Lagrangian-Euler dynamic model (Matrix Method),	
29.	Lagrangian-Euler dynamic model (Matrix Method),	
30.	Trajectory planning	
31.	Trajectory planning	
32.	Trajectory planning	
33.	Introduction to actuators and sensors,	
34.	Pneumatic actuators	
35.	Hydraulic actuators	
36.	Electrical actuators	
37.	Sensors. Types and applications	
38.	Position sensors,	
39.	Potentiometers,	
40.	Force sensors,	
41.	Encoders	
42.	Introduction to control systems, Open loop and closed loop systems.	
43.	Robot applications in Machining	
44.	Robot applications in Welding	
45.	Robot applications in Assembly and Material handling	
46.	Robot applications in Loading and unloading and spray Painting	
47.	Robot applications in Medical, Mining and Space	
48.	Robot applications in Underwater and Defence.	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I /II	Year 1
Name of Course		Nature of Materials and Processes		
Course Code		ID24565		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	NIL			
Course Outcomes:				
1.	Identify set of mechanical properties required for a particular application			
2.	Explain constitution of metallic alloy and select a suitable metallic alloy as per the design requirement			
3.	Explain mechanical behavior and select a suitable ceramic as per the design requirement			
4.	Explain the mechanical behavior of polymer and composites and select suitable polymer as per the design requirement			
Description of Contents in brief:				
Unit 1.	Selection of materials based in properties: Elastic moduli, mechanical properties, fatigue failure, creep deformation and fracture, friction, abrasion and wear			
Unit 2.	Metal structures, Equilibrium constitution and phase diagrams, Driving force and kinetics of structural changes, Overview of steels and light alloys			
Unit 3.	Ceramics and glasses, Structure and mechanical properties of ceramics, Statistics of brittle fracture, Overview of production, forming, joining of ceramics			
Unit 4.	Structure and mechanical behavior of polymers, overview of production, forming and joining of polymers, Composites			
Unit 5.	State of the art materials: Smart materials, high performance materials like superalloys, cermets, high temperature ceramics			
List of Text Books:				
1.	M.F. Ashby and D.R.H. Jones, Engineering Materials 1, An introduction to microstructures, processing and design, 3 rd Ed., Elsevier, 2005			
2.	M.F. Ashby and D.R.H. Jones, Engineering Materials 2, An introduction to microstructures, processing and design, 3 rd Ed., Elsevier, 2006			
3.	M.F. Ashby, Materials Selection in Mechanical design, 3 rd Ed. Elsevier, 2005			
List of Reference Books:				
1.	R. Abbaschian, L. Abbaschian, Robert E. Reed-Hill, Physical Metallurgy Principles, Cengage Learning, 4 th Edition, 2005			
2.	J.R. Fried, Polymer Science and technology, Prentic Hall, 3 rd Ed. 2014,			
3.	C.B. Carter, M.G. Norton, Ceramic materials, science and engineering, 2 nd Ed., 2013			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

4.	J. Roesler, H. Harders, M. Baeker, Mechanical behavior of engineering materials, Springer, 1 st Ed., 2007	
URLs		
1.	www.grantadesign.com	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Review of structure of materials - 1	
2.	Review of structure of materials - 2	
3.	Physical basis of Elastic moduli, Measurement of Young's modulus, comparison for different materials, Case studies on modulus limited design	
4.	Problem solving session on Young's modulus	T
5.	Elastic, anelastic and plastic behavior of materials, Comparison of mechanical strength and ductility of different materials	
6.	Physical basis of strength and ductility: dislocation movement and its resistance, Importance of onset of yielding and plastic instability	
7.	Various strengthening mechanisms, Case studies in Yield limited design	
8.	Problem solving session	T
9.	Energy criterion for fast fracture, value of G _c and K _{IC} for different materials	
10.	Mechanisms of crack propagation – 1, case studies on fast fracture	
11.	Overview of fatigue mechanisms, Fatigue data, Stress concentration and notch sensitivity factors	
12.	Fatigue data and fatigue improvement techniques,	
13.	Case studies in fatigue failure	
14.	Problem solving session for Fatigue design	T
15.	Creep testing and creep curves, creep relaxation,	
16.	Creep damage and creep fracture, creep resistant materials	
17.	Case studies for creep design	
18.	Problem solving session for creep design	T
19.	Friction between materials, Data coefficients of friction	
20.	Lubrication, wear of materials, surface properties	
21.	Case studies on friction and wear	
22.	Review of equilibrium and phase diagrams	
23.	Case studies in phase diagrams	
24.	Driving force and nucleation theory	
25.	Kinetics of structural transformation –diffusive transformation	
26.	Kinetics of structural transformation –displacive transformation	
27.	Case studies in phase transformations	
28.	Problem solving session on phase transformations	T
29.	Application of phase transformation in Light alloys:	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

	precipitation strengthening and work hardening	
30.	Application of phase transformation low carbon steels and alloy steels	
31.	Case studies on steels and light alloys	
32.	Problem solving session on light alloys and steels	T
33.	Structure of ceramics	
34.	Mechanical properties of ceramics	
35.	Statistics of brittle fracture in ceramics	
36.	Overview of production and joining of ceramics	
37.	Problem solving session on ceramics	T
38.	Polymers: Thermoplastics, Thermosets, elastomers, natural polymers, Comparative data	
39.	Structure of polymers: molecular length and degree of polymerization, the molecular architecture	
40.	Packing of polymer molecules, glass transition temperature, polymer crystals	
41.	Mechanical behavior of polymers: various stages of polymer deformation	
42.	Problem solving session on polymers	T
43.	An overview of smart materials and their applications	
44.	Metallurgy of superalloys and their applications, some commercially used superalloys	
45.	Cermets production and their applications, overview of commercially used cermets	
46.	High temperature ceramics development and their applications, overview of commercially used ceramics	
47.	Case studies on state of the art materials – 1	
48.	Case studies on state of the art materials – 2	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	Two surprise micro test
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester: I/II	Year: I
Name of Course		Computational Methods		
Course Code		ID24566		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	NIL			
Course Outcomes: At the end of the course, the student shall be able to:				
1.	Understand of the fundamental theory of the finite element methods.			
2.	Generate the governing FE equations for systems governed by partial differential equations.			
3.	Understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements.			
4.	Demonstrate the ability to evaluate and interpret FEA analysis results for design and evaluation purposes.			
5.	Ability to create models for trusses, frames, plate structures, machine parts, and components using ANSYS general-purpose software.			
Description of Contents in brief:				
Unit 1.	Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method.			
Unit 2.	Variational methods: calculus of variation, the Rayleigh-Ritz and Galerkin methods; Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its post-processing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame.			
Unit 3.	Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics			
Unit 4.	Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems.			
Unit 5.	Discussion about preprocessors, postprocessors and finite element packages <i>namely</i> ANSYS, ABAQUS, LS Dyna, Simufact.			
List of Text Books:				
1.	U.S. Dixit, Finite element methods for engineer, Cengage Learning, 2009.			
2.	K.J. Bathe, Finite element procedures, Second Edition, Prentice Hall, 1996.			
3.	J. N. Reddy, An introduction to the finite element method, 3rd edition, McGraw-Hill, 2006.			
4.	R.D. Cook, D. S. Malkus and M. E. Plesha, Concepts and Applications of Finite Element Analysis, 4th edition, John Wiley, 2007			
List of Reference Books:				
1.	O. C. Zienkiewicz and R. L. Taylor, The Finite Element Method, 7th edition, Butterworth-Heinemann, 2013.			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

2.	T. J. R. Hughes, The Finite Element Method, Prentice-Hall, 1986.	
URLs:		
1.	https://nptel.ac.in/courses/112/104/112104116/	
2.	https://nptel.ac.in/courses/112/104/112104115/	
3.	https://nptel.ac.in/courses/112/106/112106135/	
4.	https://nptel.ac.in/courses/112/106/112106130/	
5.	https://nptel.ac.in/courses/105/108/105108141/	
Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Finite element method: a quick introduction	
2.	Direct FEM formulation of axial rod problem	
3.	Direct FEM formulation of beam problem	
4.		
5.	Some classical function approximation methods for solving differential equations: Ritz method, Galerkin method, Least square method, Collactive methods.	
6.		
7.		
8.		
9.	Ritz FEM formulation	
10.		
11.	Galerkin FEM formulation	
12.		
13.	Developing elemental equations by Ritz method	
14.	Developing element equations by Galerkin method	
15.	Some one-dimensional C⁰ continuity FEM formulation: steady-state heat conduction; longitudinal deformation of a rod; fluid flow problem	
16.		
17.	Finite element formulation for bending of beams: Galerkin FEM formulation; weak form; choose suitable approximating shape functions; Hermitian shape function; elemental equation, application of boundary conditions and solution	
18.		
19.	Finite element formulation for trusses and frames	
20.		
21.	Introduction to 2-D and 3-D FEM	
22.	Triangular elements, Tetrahedral element, Rectangular elements, Bricks element	
23.	Governing heat conduction equation for 2D heat conduction problems	
24.	Weak form and FEM formulation	
25.	Assembly procedure of 2D problems in FEM	
26.	Poisson equation for 3D FEM	
27.	Torsion of circular and non-circular cross section	
28.		
29.	Numerical integration: One-dimensional integration formula; Two dimensional integration formula	
30.	Integration over square region; Integration over triangular Region	
31.	Natural coordinates and iso-parametric, sub-parametric	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

	and super parametric elements	
32.	Four noded quadrilateral elements and serendipity Elements	
33.	Eight noded curvilinear elements	
34.	FEM Formulation for Plane Stress and Plane Strain Problems	
35.		
36.		
37.	Free Vibration Problems: Vibration of A Rod and vibration of a beam	
38.		
39.	Finite Element Formulation of Time Dependent Problems	
40.	FEM formulation of plate problem	
41.		
42.	FEM formulation of 2D flow problem	
43.		
44.	Error analysis in finite element methods: errors measure	
45.	Types of errors, Super convergent patch recovery (SPR) technique	
46.	Higher order of approximations of primary variables	
47.	Error estimates by recovery	
48.	Miscellaneous topics: Difference between FEM and FDM, Essential and Natural boundary conditions, Solving the problem of fracture mechanics using FEM, Ill condition system, patch test.	
49.		
50.		

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if any	--	
7	End Semester Examination	50	
8	Experiments if any (for practical courses)	--	
8	Any other	--	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I/II	Year I
Name of Course	Product Planning and Design for Market		
Course Code	ID24567		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Basic knowledge of design process		
2.	Basic knowledge of Management and Marketing Management		
Course Outcomes:			
1.	Understand the concepts of product planning and launching into the market.		
2.	Gain the necessary knowledge about the Aesthetic considerations and Reliability consideration for product to be successful in market		
3.	Understand the concept of Management Information Systems to be useful to forecast and judge the competition and to handle data related to the product.		
Description of Contents in brief:			
Unit 1.	Product Planning for Market		
Unit 2.	Product planning for Launching		
Unit 3.	Aesthetic Consideration for DFMarket.		
Unit 4.	Design for Reliability for Design for Market		
Unit 5.	Management Information Systems for Product Planning		
List of Text Books:			
1.	Agarwal, I : Product planning: Seminars on Product Planning held in IDC, IIT Bombay 1982		
2.	Kotler Philips: Marketing management, 5th ed. Prentice Hall, New Delhi, 1984		
3.	O'Brien James: Management Information Systems, Tata McGrawHills, Edition 2004		
List of Reference Books:			
1.	Levitt Theodore: Marketing Imagination, Free Press, New York, 1986		
2.	Ebeling Charles: An Introduction to Reliability and Maintainability Engineering, Edition 2000		
3.	Reliability Engineering By Balaguruswamy Roy, McGraw Hills.		
URLs:			
1.	https://blog.indiefolio.com/the-importance-of-aesthetics-in-design/		
2.	https://boltgroup.com/aesthetics-in-product-design		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Lecture Plan (about 40-50 Lectures):		
*Lecture No.	Topic	Remarks
1.	Management thinking on new products	
2.	Seeing product as part of the image of the company	
3.	Defining companies business, Technology	
4.	SWOT analysis, Analysis of strength, weakness, opportunities and threat	
5.	Study of product life cycle	
6.	Monitoring of sale and competition, when to introduce new products	
7.	Assessing market potentials for new, products	
8.	Market research	
9.	Market research cont.	
10.	Consumer research and its demographic aspects	
11.	Setting up a questionnaire for these aspects	
12.	Product Planning for Launching	
13.	Developing a strategy to introduce new products	
14.	Using market gaps as competitive edge	
15.	Cost considerations and profitability of new products	
16.	Developing a product plan and product mix	
17.	Price policy and product positioning	
18.	Evolving a design brief by interlinking with market/product plan	
19.	Seeing product design as a part of a scheme to develop brand image	
20.	Developing product specifications for different products within the range	
21.	Market communication methods and launching the product.	
22.	Monitoring the market performance	
23.	Aesthetics Consideration for Design for Market: Introduction to Aesthetics	
24.	Concepts and Objectives	
25.	Significance of Aesthetics in Design of products	
26.	Aesthetics in consideration for target Markets	
27.	Various consideration in Design for Aesthetics	
28.	Value Analysis	
29.	Quality and Quality dimensions	
30.	Design for reliability for Design for market: ,	
31.	Reliability and Reliability Engineering	
32.	Maintainability, Availability	
33.	Product Life Cycle Curve	
34.	Failure rate curve	
35.	Design for Reliability	
36.	Functional Analysis	
37.	System and interfaces	
38.	System reliability	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

39.	Failures and failure modes	
40.	Introduction FMECA, FTA and Cause & Effect Analysis	
41.	Introduction to FMECA, FTA and Cause & Effect Analysis cont.	
42.	Management Information System for product planning	
43.	Need of IS & MIS in product design, Data, Information and knowledge.	
44.	Importance of MIS in the competitive business Environment	
45.	Hardware and Software Resources	
46.	Types of information systems: Transaction Processing System	
47.	Management Information Systems, Decision Support System	
48.	Executive Support System, Executive Information System, Knowledge Work System	
49.	Functional Information systems: Production subsystem	
50.	Marketing, Finance and sales subsystems.	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any	--	
5	Quiz if any	10	
6	Seminar, Viva voce if any	--	
7	End Semester Examination	50	
8	Experiments if any (for practical courses)	--	
8	Any other	--	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M Tech in Mechanical Engineering with Specialization in Industrial Design	Semester I/II	Year I
Name of Course		Advance Computer Graphics		
Course Code		ID24568		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	Computer graphics			
2.	C- Language			
Course Outcomes:				
1.	To understand concept of geometric, mathematical and algorithmic concepts necessary for programming computer graphics.			
2.	To understand and gain proficiency in 3D computer graphics programming, windows clipping and viewports object.			
3.	To understand the software utilized in constructing computer graphics applications.			
4.	To understand basic principles of computer animation and desktop publishing page.			
Description of Contents in brief:				
Unit 1.	Introduction to application of computer graphics for visualizing concepts, Introduction of hardware including operating systems			
Unit 2.	File management and hardware limitations introduction to the concepts of programming through by per media			
Unit 3.	Exploration of various packages for illustration, drawing			
Unit 4.	Desk top publishing page composition and animation			
List of Text Books:				
1.	Mars Bell G.R. Computer Graphics In Application Prentice Hall			
2.	Kerlow L.V. And Rosebush J. Computer Graphics For Designers And Artist			
List of Reference Books:				
1.	Grieman A. The Fusion of Technology And Computer Graphic Design – Hybrid Imagery Architecture, Design And Technology Press.			
Lecture Plan (about 40-50 Lectures):				
*Lecture No.	Topic			Remarks
1.	Introduction, A Look at Computer Aided Engineering			
2.	The Process of Analysis and Visualization			
3.	The Impact of Visualization in Engineering Design			
4.	Trends in Visualization Environments for Analysis			
5.	Traditional Picture Making			
6.	The Graphics Process			
7.	The Modern Era			
8.	Transformations			
9.	Display			
10.	Pixel Driven Rendering			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

11.	Architecture of Display Systems	
12.	Scientific Visualization Techniques	
13.	Analysis Data for Visualization	
14.	Numerical Analysis Techniques	
15.	Mapping Analysis Results to Visualizations	
16.	Scalar Visualization Techniques	
17.	One, two and three Dimensional Scalar Fields	
18.	A Unified Framework for Flow Visualization	
19.	Vector Mappings	
20.	Continuum Volume Display	
21.	Animation and the Examination of Behavior Over Time	
22.	Parameters to Animate	
23.	Assembling a Complete Animation	
24.	Producing Animations	
25.	Animating Online	
26.	Applications Issues and Future Trends	
27.	User Interfaces	
28.	Data Management	
29.	Graphics Systems	
30.	Interactive Data Exploration	
31.	Parallel and Distributed Visualization	
32.	Visualization Systems	
33.	Applications of Engineering Visualization to Analysis and Design	
34.	Geometric Modeling as the Core of Computer Aided Engineering	
35.	The Role of Visual Thinking in the Design and Analysis Process	
36.	Trends in Computing Hardware	
37.	Animation, Video and Multimedia	
38.	Distributed Network Visualization	
39.	Software Trends in Visualization	
40.	Improvements in Visualization Techniques	

Evaluation Criteria:

Sl.No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any		
5	Quiz if any	10	
6	Seminar, Viva voce if any		
7	End Semester Examination	50	
8	Experiments if any (for practical courses)		
8	Any other		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M. Tech. in Mechanical Engineering with Specialization in Industrial Design	Semester: I/II	Year: I
Name of Course		Universal Human Values and Professional Ethics		
Course Code		ID24569		
Core / Elective / Other		Elective		
Prerequisite if any:				
1.	N/A			
2.	N/A			
Course Outcomes:				
1.	The students start exploring themselves; get comfortable to each other and to the teacher and start finding the need and relevance for the course.			
2.	The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases.			
3.	The students are able to use their creativity to educate children. The students are able to see that they can play a role in providing valuable education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of a holistic model for social science and compare it with the existing model.			
4.	The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate to the different units and levels. Also they are able to make out how these courses can be made appropriate and holistic.			
5	The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant. They are also able to make use of their understanding in the course for a happy and prosperous society.			
Description of Contents in brief:				
Unit 1.	Introduction - Need, Basic Guidelines, Content and Process for Value Education			
Unit 2.	Understanding Harmony in the Human Being - Harmony in Myself!			
Unit 3.	Understanding Harmony in the Family and Society- Harmony in Human Relationship			
Unit 4.	Understanding Harmony in the Nature and Existence - Whole existence as Co-existence			
Unit 5.	Implications of the above Holistic Understanding of Harmony on Professional Ethics			
List of Text Books:				
1.	R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2			
2.	R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics – Teachers Manual, Excel books, New Delhi, 2010			
3.	Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991			
4.	Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome’s Report, Universe Books.			
List of Reference Books:				
1.	PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.			

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

2.	E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3.	A.N. Tripathy, 2003, Human Values, New Age International Publishers.
4.	B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
5.	Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA

URLs:

1.	www.nptel.ac.in
2.	https://swayam.gov.in/nc_details/NPTEL

Lecture Plan (about 36-40 Lectures):

*Lecture No.	Topic	Remarks
11.	Understanding the need, basic guidelines, content and process for Value Education	
12.	Self Exploration–what is it? - its content and process; ‘Natural Acceptance’ and Experiential Validation- as the mechanism for self exploration	
13.	Continuous Happiness and Prosperity- A look at basic Human Aspirations	
14.	Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority	
15.	Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario	
16.	Method to fulfill the above human aspirations: understanding and living in harmony at various levels	
17.	Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’	
18.	Understanding the needs of Self (‘I’) and ‘Body’ - Sukh and Suvidha	
19.	Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer)	
20.	Understanding the characteristics and activities of ‘I’ and harmony in ‘I’	
21.	Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs	
22.	Meaning of Prosperity in detail	
23.	Programs to ensure Sanyam and Swasthya - Practice Exercises and Case Studies will be taken up in Practice Sessions	
24.	Understanding Harmony in the family – the basic unit of human interaction	
25.	Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship	
26.	Understanding the meaning of Vishwas; Difference between intention and competence	
27.	Understanding the meaning of Samman	
28.	Difference between respect and differentiation; the other salient values in relationship	
29.	Understanding the harmony in the society (society being an extension of	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

	family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals	
30.	Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj)	
31.	Universal Order (Sarvabhaum Vyawastha)- from family to world family	
32.	Practice Exercises and Case Studies will be taken up in Practice Sessions.	
33.	Understanding the harmony in the Nature	
34.	Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature	
35.	Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space	
36.	Holistic perception of harmony at all levels of existence	
37.	Practice Exercises and Case Studies will be taken up in Practice Sessions	
38.	Natural acceptance of human values	
39.	Definitiveness of Ethical Human Conduct	
40.	Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order	
41.	Competence in professional ethics: Ability to utilize the professional competence for augmenting universal human order	
42.	Competence in professional ethics: Ability to identify the scope and characteristics of people-friendly and eco friendly production systems,	
43.	Competence in professional ethics: Ability to identify and develop appropriate technologies and management patterns for above production systems.	
44.	Case studies of typical holistic technologies, management models and production systems	
45.	Strategy for transition from the present state to Universal Human Order: At the level of individual: as socially and ecologically responsible engineers, technologists and managers	
46.	Strategy for transition from the present state to Universal Human Order: At the level of society: as mutually enriching institutions and organizations	

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	10	
4	Tutorial if any	Nil	
5	Quiz if any	10	
6	Seminar, Viva voce if any	Nil	
7	End Semester Examination	50	
8	Experiments if any (for practical courses)	Nil	
9	Any other	Nil	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program		M. Tech. in Mechanical Engineering with Specialization in Industrial Design		Semester: I	Year: I
Name of Course		Communication Skill			
Course Code		HUM24511			
Core / Elective / Other		Other			
Prerequisite: Nil					
Course Outcomes:					
1.	To help postgraduate students improve their technical communication skills related to listening, speaking, reading, writing				
2.	To enable students to organize, comprehend, write, and present short and long forms of any technical work within the broad framework of the scientific method				
3.	To help students adhere to ethical norms of scientific communication				
Description of Contents in brief:					
Unit 1.	Scientific Method and its Relationship to Technical Communication Basics of technical communication, formulation of hypothesis, paragraph organisation, argument development, evidence and elaboration				
Unit 2.	Listening and Reading Skills Note taking, survey of literature, different reading strategies				
Unit 3.	Writing Skills Report writing, peer review skills, summary and abstract writing, bibliography and references, data analysis and presentation, visual communication				
Unit 4.	Speaking Skills Elevator pitch, oral presentation, slides for presentation, group discussions, interview skills				
Unit 5.	Ethics in Communication Ethics in education and research, copyrights and plagiarism, authorship, gender and diversity, net etiquettes and workplace communication				
List of Text Books:					
1.	V.N. Arora, Lakshmi Chandra. Improve Your Writing, Oxford University Press, 2013				
2.	Graff Gerald, Birkenstein Cathy. They Say I Say-The Moves That Matter in Academic Writing, Fourth Edition, W. W. Norton and Company, 2018				
3.	V. Raymond, E. Marie, Flatley Lesikar. Basic Business Communication Skills for Empowering the Internet Generation, Ninth Edition, McGraw-Hill, 2002				
List of Reference Books:					
1.	Graff Gerald, Birkenstein Cathy. They Say I Say-The Moves That Matter in Academic Writing, Fourth Edition, W. W. Norton and Company, 2018				
2.	Sanjay Kumar, Pushp Lata. Communication Skills, Oxford University Press, 2011				
3.	Meenakshi Raman, Sangeeta Sharma. Technical Communication: Principles and Practice, Oxford University Press, 2015				
URLs: Nil					
Lecture Plan (about 40-50 Lectures):					
Lecture No.	Topic				
1-2	Basics of technical communication				
3.	Formulation of hypothesis				
4-5	Paragraph organization				
6.	Argument development				
7.	Evidence and elaboration				
8.	Note taking				
9-10	Survey of literature				

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

11.	Different reading strategies
12-13	Report writing
14-16	Peer review skills
17-18	Summary and abstract writing
19-20	Bibliography and references
21-25	Data analysis and presentation
26-27	Visual communication
28.	Elevator pitch
29-33	Oral presentation
34.	Slides for presentation
35-37	Group discussions
38-40	Interview skills
41.	Ethics in education and research
42-43	Copyrights and plagiarism
44.	Authorship
45.	Gender and diversity
46.	Net etiquettes
47- 48	Workplace communication

Evaluation Criteria:

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	20	
4	Tutorial if any	Nil	
5	Quiz if any	Nil	
6	Seminar, Viva voce if any	Nil	
7	End Semester Examination	50	
8	Experiments if any (for practical courses)	Nil	
9	Any other	Nil	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Name of Program	M.Tech.	Semester: I/II	Year: I
Name of Course	RESEARCH METHODOLOGY		
Course Code	ME 24524		
Core / Elective / Other	Elective		
Prerequisite if any:			
1.	Graduation in a sciences		
2.	Graduation in a Technologies		
Course Outcomes:			
1.	Student will be able to apply knowledge Research Methodology different field and research		
2.	Student will be able to design always the research problem with different quantities and qualitative method of data collection tool and techniques		
3.	Student will be able to apply knowledge and Research Methodology to write research paper.		
4	Student will be able to identified the tools , software and techniques for data analysis and data validation.		
Description of Contents in Brief:			
Unit 1.	Research Meaning, Objectives, Motivation, Types of Research, Research Approach, Research and Scientific Methods, Identification of Problem, Significance of Defining Research Problem, Research Design, Research Ethics		
Unit 2.	Data Collection Methods, Primary Data, Secondary Data, Questionnaire Preparation, Case Study Method, Measurement Scales, Levels of measurement – Nominal, Ordinal, Interval, Ratio Measures of Central Tendency (Mean, medium, Mode), Measures of Dispersion (range, mean deviation, standard deviation), Graphical Representation of Data, Tabular Presentation of Data, Oral Presentation, Posters Presentation		
Unit 3.	Sampling Design, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample, Research Question, Normal Probability Curve, Standard Error, Confidence Intervals		
Unit 4.	Significance of correlation, Pearson’s Product Moments Correlation. Regression and Multiple Regression equations, Hypothesis Formation, Hypothesis Testing, Testing the Significance of difference between means(z and ‘t’ test), Analysis of Variance (ANOVA) -concept and applications, Chi Square Test steps, Type I and Type II errors,		
Unit 5.	Writing Research Report:, Interpretation, Significance of Report Writing, Steps In Writing Report, Types of Report, Technical Report Writing, Review of Related Literature, Structure of The Research Report, Precaution In Writing Report, Layout of Research Paper, Format and Style, Impact Factor of Journals, Suitability of Journal for Publication, Plagiarism, Citation, Reference Writing, IPR, Copyright, Patents,		

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Unit 6	Introduction of Softwares used for Research like Matlab,SPSS, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism, Google Scholar, Research Gate,	
List of Text Books:		
1.	Research Methodology: Methods and Techniques, Kothari, C.R, New Age International Publishers, 2010 , 2010	
2.	Fundamentals of Mathematical Statistics, Gupta, S. C. and Kapoor, V. K, Sultan Chand and Sons, New Delhi. , 2010	
3.	Theory and Application of Statistics, Bruce E. Wampold and Difford J. Drew, McGraw-Hill International Editions. , 2010	
List of Reference Books:		
1.	Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition	
2.	Business Research Methods – Alan Bryman& Emma Bell, Oxford University Press	
3.	Business Research Methods, Naval Bajpai, Pearson	
URLs:		
2.	https://swayam.gov.in/nd1_noc19_ge21/preview	
3.	https://www.youtube.com/watch?v=Yzfl3rtFoSM	
Lecture Plan (about 40-50 Lectures):		
Lecture No.	Topic	Remarks
1-2	Research Meaning,Objectives	
3-4	Motivation	
5-6	Types of Research, Research Approach,Research and Scientific Methods	
7-8	Identification of Problem, Significance of Defining Research Problem,	
9-10	Research Design, Research Ethics	
11-12	Data Collection Methods, Primary Data, Secondary Data,	
13	Questionnaire Preparation, Case Study Method,	

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

14-15	Measurement Scales, Levels of measurement – Nominal, Ordinal, Interval,	
16-17	Ratio Measures of Central Tendency (Mean, median, Mode), Measures of Dispersion (range, mean deviation, standard deviation),	
18	Graphical Representation of Data, Tabular Presentation of Data,	
19-20	Oral Presentation, Posters Presentation	
21	Sampling Design, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling.	
22	Determining size of the sample, Research Question, Normal Probability Curve, Standard Error, Confidence Intervals	
23	Significance of correlation, Pearson's Product Moments Correlation.	
24	Regression and Multiple Regression equations,	
25-26	Hypothesis Formation, Hypothesis Testing, Testing the Significance of difference between means (z and 't' test),	
27-28	Analysis of Variance (ANOVA) -concept and applications, Chi Square Test steps, Type I and Type II errors,	
29-30	Writing Research Report:, Interpretation, Significance of Report Writing, Steps In Writing Report, Types of Report,	
31	Technical Report Writing, Review of Related Literature, Structure of The Research Report, Precaution In Writing Report,	
32-33	Layout of Research Paper, Format and Style, Impact Factor of Journals, Suitability of Journal for Publication, Plagiarism, Citation, Reference Writing, IPR, Copyright, Patents,	
34	Introduction of Softwares used for Research like Matlab, SPSS,	
35	Reference Management Software like Zotero/Mendeley,	
36	Software for paper formatting like LaTeX/MS Office,	
37	Software for detection of Plagiarism, Google Scholar, Research Gate,	

***Min 36 (for three credit course)**

Evaluation Criteria:

**MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY,
BHOPAL - 462003**

Sl. No.	Name of Examination	Marks Allotted	Remarks
1	Mini Test	10	
2	Mid Semester Test	20	
3	Assignment if any	20	
4	Tutorial if any	Nil	
5	Quiz if any	Nil	
6	Seminar, Viva voce if any	Nil	
7	End Semester Examination	50	
8	Experiments if any (for practical courses)	Nil	
9	Any other	Nil	