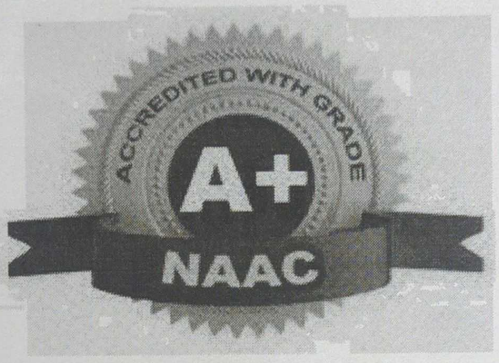
TULSIRAMJI GAIKWAD-PATIL
College of Engineering & Technology

Mohgaon, Wardha Road, Nagpur - 441 108

An Autonomous Institution



DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech.in Mechanical Engineering Design

Teaching Scheme

From

Academic Year 2022-23

Vision of Institute

To emerge as a learning Center of Excellence in the National Ethos in domains of Science, Technology and Management.

Mission of Institute

- To strive for rearing standard and stature of the students by practicing high standards of professional ethics , transparency and accountability.
- To provide facilities and services to meet the challenges of Industry and Society.
- To facilitate socially responsive research, innovation and entrepreneurship.
- To ascertain holistic development of the students and staff members by inculcating knowledge and profession as work practices.

Vision of the Department

To impart quality education for enabling youth to offer solutions for the challenges faced in the field of Mechanical Engineering domain.

Mission of the Department

- To provide education for enhancing competency amongst students to give technical based solutions.
- To develop as a leader to effectively work in a team to apply knowledge of Mechanical Engineering domain.
- To collaborate with industry to strengthen the students exposure towards industrial environment.
- To incorporate ethical values and to build personality traits to face the challenges in the society.
- To empower youth through lifelong learning.

Program Education Objectives (PEO)

- Apply principles of advanced mathematics and science to analyse and solve Mechanical Engineering problems.
- Design and execute ethically multidisciplinary projects in a dynamically changing environment.
- Develop professional leaders in Design, Thermal and Manufacturing fields.
- Provide exposure to the emerging techniques for lifelong learning.
- Create sustainable environment to plan and implement Computerized Numerical Control (CNC) technique for social concern.

Program Outcomes (PO)

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of theinformation to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and software tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

PSO1: Ability to work professionally and ethically in Thermal, Design, production and Manufacturing areas of Mechanical engineering.

PSO2: Ability to Model, Analyze, Design and Realize mechanical components and processes.

PSO3: Apply industrial engineering and management principles and consider public health and safety, cultural, societal, and environmental factors to work professionally in the industry or as an entrepreneur.

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Scheme of Instructions and Syllabus

Scheme of Instructions for First Year M. Tech. in Mechanical Engineering Design

Semester–I (w.e.f.: AY2022-23)

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs /week	Credits	Exam Scheme				
									CT- 1	CT- 2	TA/CA	ESE	TOTAL
1.	PCC	MMED1101	Advanced Engg Mathematics	3	-	-	3	3	15	15	10	60	100
2.	PCC	MMED 1102	Advanced Mechanics of solids	3	1	-	4	4	15	15	10	60	100
3.	PCC	MMED 1103	Mechanical Vibrations	3	-	-	3	3	15	15	10	60	100
4.	PCC	MMED 1104	Advanced Mechanics of solids Lab	-	-	2	2	1	-	-	25	25	50
5.	PCC	MMED 1105	Mechanical Vibrations Lab	-	-	2	2	1	-	-	25	25	50
6.	PEC	MMED1106-09	Professional Elective-I	3	-	-	3	3	15	15	10	60	100
7.	PEC	MMED 1110-13	Professional Elective-II	3	-	-	3	3	15	15	10	60	100
8.	MCC	MAU1101	Pedagogy Studies	2	-	-	2	Audit	-	-	-	-	-
			Total	**17**	**1**	**4**	**22**	**18**	**75**	**75**	**100**	**350**	**600**

L- Lecture T-Tutorial P-Practical CT1-Class Test 1 CT2- ClassTest2 TA/CA- Teacher Assessment / Continuous Assessment

ESE- End Semester Examination (For Laboratory: End Semester Performance)

*-Program Elective /Audit Course/ Open Elective (list is provided at the end of structure)

Chairman, BoS

Head
Department of Mechanical Engineering
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Engineering & Technology, NAGPUR.

Dean Academics

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Principal

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Scheme of Instructions for First Year M. Tech. in Mechanical Engineering Design

Semester– II (w.e.f.: AY2022-23)

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/week	Credits	Exam Scheme				
									CT- 1	CT- 2	TA/CA	ESE	TOTAL
1.	PCC	MMED 1201	Finite Element Analysis	3	1	-	4	4	15	15	10	60	100
2.	PCC	MMED 1202	Stress Analysis	3	1	-	4	4	15	15	10	60	100
3.	PCC	MMED 1203	Finite Element Analysis Lab	-	-	2	2	1	-	-	25	25	50
4.	PCC	MMED 1204	Stress Analysis Lab	-	-	2	2	1	-	-	25	25	50
5.	PCC	MMED 1205	Research Methodology#	2	-	-	2	2	-	-	25	25	50
6.	PEC	MMED 1206- 09	Professional Elective-III	3	-	-	3	3	15	15	10	60	100
7.	PEC	MMED 1210-13	Professional Elective–IV	3	-	-	3	3	15	15	10	60	100
8.	MCC	MAU1202	Research Paper Writing	2	-	-	2	Audit	-	-	-	-	-
			Total	**16**	**2**	**4**	**22**	**18**	**60**	**60**	**110**	**315**	**550**

L- Lecture T-Tutorial P-Practical CT1-Class Test 1 CT2- ClassTest2 TA/CA- Teacher Assessment / Continuous Assessment ESE- End Semester Examination (For Laboratory: End Semester Performance)

*-Program Elective /Audit Course/ Open Elective (list is provided at the end of structure

Students are expected to complete it online by appearing NPTEL/Swayam Certification for 03 credits. Weekly 02 Hrs practical in which students areexpected to work on mathematical modeling, Seminar on IPR, Patent filing, Removing Plagiarisms, etc. will be done.

PROGRESSIVE CREDITS=18+18=**36**

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Semester– III (w.e.f.: AY2022-23)

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/week	Credits	Exam Scheme				
									CT- 1	CT- 2	TA/CA	ESE	TOTAL
1	PROJ	MMED 2301	Dissertation Phase-I	-	-	20	20	10	-	-	100	100	200
2	PEC	MMED 2302	MOOC course (8-12Hr)	-	-	-	-	3	-	-	-	-	-
3	OEC	M$$XX**01-06**	Open Elective -I	3	-	-	3	3	15	15	10	60	100
			Total	**3**	**-**	**20**	**23**	**16**	**-**	**-**	**100**	**100**	**200**

*$$-CS, SE, IP, MB,MED

Note:

1. MMED 2302 will be decided by respective Guide in Consultation with Program Coordinator. Course is mandatory is for student and hisdissertation phase I will be considered incomplete without this Mandatory MOOC Course.

2. In Case, the course offered online are not completely relevant with the topic of dissertation then any course suggested by NASSCOM on recent technologies can be opted by candidate.

3. Programme coordinator will provide list of 03 MOOC courses of minimum 08 weeks duration (as per availability). Students are expected to complete any one out of three courses in order to get the required credits.

L-Lecture T-Tutorial P-Practical
CT1- Class Test 1 TA/CA-Teacher Assessment/Continuous Assessment
CT2- ClassTest2 ESE- End Semester Examination (For Laboratory End Semester performance)
PROGRESSIVE CREDITS=36+16=**52**

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Scheme of Instructions and Syllabus

Scheme of Instructions for Second Year M. Tech. in Mechanical Engineering Design

Semester– IV (w.e.f.: AY2022-23)

Sr.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/week	Credits	Exam Scheme				
									CT- 1	CT- 2	TA/CA	ESE	TOTAL
1.	PROJ	MMED 2401	Dissertation Phase-II	-	-	32	32	16	-	-	100	200	300
			Total	**-**	**-**	**32**	**32**	**16**	**-**	**-**	**100**	**200**	**300**

TA/CA-Teacher Assessment/ Continuous Assessment

ESE- End Semester Examination (For Laboratory: End Semester Performance)

TOTAL CREDITS=52+16=**68**

List of Professional Elective Courses

Semester-I		Semester - II	
Professional Elective-I	**Professional Elective- II**	**Professional Elective- III**	**Professional Elective- IV**
MMED 1106: Computer Aided Mechanical Design	**MMED 1110**: Advanced Mechanical Drives (as per RTMNU)	**MMED 1206**: Tribology	**MMED 1210**: Mechanics of Composite Materials
MMED 1107: Reliability, Maintainability & Wear	**MMED 1111**: Robotics Drives (as per RTMNU)	**MMED 1207**: Design of Hydraulic And Pneumatic System	**MMED 1211**: System Modeling and Analysis
MMED 1108:MEMS Design and Industrial Automation	**MMED 1112**: Mechanization In Food Processing	**MMED 1208**: Optimization Methods for Mechanical Design	**MMED 1212**: Advance Fracture Mechanics
MMED 1109: Ergonomics for Mechanical Design	**MMED 1113**: Additive Manufacturing	**MMED 1209:** Product Design and Development	**MMED 1213**: Reverse Engineering

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Scheme of Instructions and Syllabus

Scheme of Instructions for M. Tech. in Mechanical Engineering Design List of

Audit Courses and Open Electives

Semester-I	Semester – II	Semester - III
Audit Course-I	**Audit Course-II**	**Open Electives**
MAU1101:Pedagogy Studies	MAU1201:Constitutionof India	MCSXX01:Business Analytics
MAU1102:Disaster Management	MAU1202:Research Paper Writing	MMBXX02:Cost Management of Engineering Projects
MAU1103:Sanskritfor Technical Knowledge	MAU1203:Stress Management by Yoga	MSEXX03:Composite Materials
MAU1104:Value Education	MAU1204: Personality Development through Life Enlightenment Skills	MIPXX04: Waste to Energy
		MED XX05: Industrial Safety
		MMBXX06:Operation Research

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Course Category	PCC (Professional Core courses)	PEC (Professional Elective courses)	OEC (Open Elective courses from other discipline)	Project / Seminar / Industrial Training	Semester Wise Credits
Semester -I	12	06	-	-	**18**
Semester -II	12	06	-	-	**18**
Semester -III	-	03	03	10	**16**
Semester -IV	-	-	-	16	**16**
Cumulative Sum	**24**	**15**	**03**	**26**	**68**

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Program: M. Tech. in Mechanical Engineering Design

Semester-I | **MMED1101:** Advanced Engg Mathematics

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	Nill	**CT-II**	15 Marks
Total Credits	3	**CA**	10 Marks
Duration of ESE: 3Hrs		**ESE**	60 Marks
Pre-Requisites: Applied science, Geometry, Basics of mathematics		**Total Marks**	**100 Marks**

Course Contents

Unit I	**Ordinary and Partial Differential Equations** and Concepts in Solution to Boundary Value Problems: Ordinary linear differential equations solvable by direct solution methods; solvable nonlinear ODE's.
Unit II	**First and second order partial differential equations**; canonical forms; space of Functions, projection of functions onto an orthogonal set; Fourier Series.
Unit III	Major Equation Types Encountered in Engineering and Physical Sciences Solution methods for wave equation, D'Alembert solution, and potential equation, properties of harmonic functions, maximum principle, and solution by variable separation method.
Unit IV	Methods for infinite and semi- infinite media, Fourier and Laplace Transforms. , heat (diffusion) equation, maximum principle for heat equation.
Unit V	Introduction to Probability Theory, Probability Theory and Sampling Distributions. Basic probability theory along with examples. Standard discrete and continuous distributions like Binomial, Poisson, and Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like x2, t, F.

Text Books	
T.1	1. J. B. Doshi, Differential Equations for Scientists and Engineers, Narosa, New Delhi, 2010 .
T.2	Ronald E, Walpole, Sharon L. Myers, Keying Ye, Probability and Statistics for Engineers and Scientists (8th Edition), Pearson Prentice Hall, 2007 .
Reference Books	
R.1	Advanced Engineering Mathematics (9th Edition), by Erwin Kreyszig, Wiley India (2013).
R.2	Douglas C. Montgomery, Design and Analysis of Experiments (7th Edition), Wiley Student Edition, 2009.
R.3	S. P. Gupta, Statistical Methods, S. Chand & Sons, 37th revised edition, 2008.
R.4	William W. Hines, Douglas C. Montgomery, David M. Goldsman, Probability and Statistics for Engineering, (4th Edition), Willey Student edition, 2006.
Useful Links	
1	https://archive.org/details/AdvancedEngineeringMathematicsKreyszigE.9thEdWiley20061245s
2	https://www.sultanchandandsons.com/images/BookImages/Chapters/59_Statistical%20Methods.

Course Code	Course Outcomes	CL	Class Sessions
MMED1101.1	**Apply** the knowledge of differential Equations to solve engineering problem.	3	9
MMED1101.2	**Interpret** the knowledge of First and second order partial differential equations to solve engineering problem.	3	9
MMED1101.3	**Demonstrate** D'Alembert solution and method of separation of variables to solve given wave equation.	3	9
MMED1101.4	**Analyze** the reliability and maintainability of the series and paralle thermal system.	4	9
MMED1101.5	**Compare** multivariable functions by applying statistical techniques.	4	9

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Program: M. Tech. in Mechanical Engineering Design

Semester-I | **MMED1102: Advanced Mechanics of solids**

Teaching Scheme		Examination Scheme	
Theory	4 Hrs/week	**CT-I**	15 Marks
Tutorial	Nill	**CT-II**	15 Marks
Total Credits	4	**CA**	10 Marks
Duration of ESE: 3Hrs		**ESE**	60 Marks
Pre-Requisites: Physics,Mechanics,CAD		**Total Marks**	**100 Marks**

Course Contents

Unit I	Introduction to kinematic synthesis type number and dimension synthesis practical applications, degree of freedom class -I, class-II chain Grumblers criteria, concept of transmission angle.
Unit II	Synthesis of planner mechanism: Introduction to function generation, path generation, path generation & rigid body guidance. Problems, accuracy points chebychev's spacing, Graphical approaches for synthesis for above problem Central point curve, circle point curve ,point position, inflection circle Bo-billior construction, Euler's savory equation, Hartman construction, vector approach &matrix approach, rotation matrix, displacement matrix, Freudenstein"s equation, computer approach for the above problem .
Unit III	Optimal synthesis of planar mechanisms, Powells search methods least square method penalty function computer approach.
Unit IV	Kinematic analysis & synthesis of spatial mechanisms Hi notations screw matrix, kinematic analysis for linkages like R-S-S-R, R-C-P-R-C etc.
Unit V	Kinematics synthesis of Robot arms: Endless Tendon-Driven Mechanisms, Tendon-Driven Robotic Arm mechanism, Kinematic solution of SCARA Manipulator, Kinematic solution of PUMA Manipulator.

Text Books	
T.1	Solid Mechanics, KazimiS. M. A., Tata McGraw Hill,1994.
T.2	M. H. Sadd, Elasticity: theory, applications, and numeric, 3rd edition, Academic Press, 2014.
Reference Books	
R.1	Tao, D.C.Applied Linkages.
R.2	Erdman & Sandor ,Advanced Mechanisms, Vol.- I,II.
R.3	Denavit & Hartenberg, —Kinematic Synthesis
Useful Links	
1	https://link.springer.com/article/10.1007/s00158-010-0500-3
2	https://www.researchgate.net/publication/4029306_Kinematic_synthesis_of_robotic_manipulators_from_task_descriptions

Course Code	Course Outcomes	CL	Class Sessions
MMED1102.1	**Summarize** various methods of synthesis.	2	9
MMED1102.2	**Apply** the concept of planner mechanism to solve engineering problem.	3	9
MMED1102.3	**Interpret** optimal synthesis of planar mechanisms to solve complex engineering problem.	3	9
MMED1102.4	**Analyze** Kinematic & synthesis of spatial mechanisms.	4	9
MMED1102.5	**Examine** of Robotic arms using concept of Kinematics synthesis.	4	9

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Program: M. Tech. in Mechanical Engineering Design

Semester-I	**MMED 1103: Mechanical Vibration**

Teaching Scheme	
Theory	3 Hrs/week
Tutorial	Nill
Total Credits	3
Duration of ESE: 3Hrs	

Examination Scheme	
CT-I	15 Marks
CT-II	15 Marks
CA	10 Marks
ESE	60 Marks
Total Marks	100 Marks

Pre-Requisites: Applied Mechanics, KOM ,DOM,FEM

Course Contents

Unit I	**Review of Fundamentals:** Vibration problems in engineering causes and effects of vibration relevance of vibration analysis continuum and discrete modeling lumped parameter systems free vibration and response to damped single degree freedom systems. Frequency response function-amplitude and phase plots mechanical impedance and mobility – vibration isolation.
Unit II	**Response of Systems to Arbitrary Periodic Excitation:** Duhamel's integral impulse response function – shock spectra –Laplace and Fourier transform methods.
Unit III	**Multi Degree Freedom Systems:** Matrix formulation Eigen values and Eigen formulation matrix iteration techniques – normal modes and orthgonality transient response of multidegree freedom system mode superposition technique tensional oscillations of malty rotor systems.
Unit IV	**Continuous Systems:** Longitudinal and transverse vibration of beams-forced response of beams. Vibration of plates –finite element techniques in vibration analysis.
Unit V	**Vibration Instrumentation:** Vibration measurements, instrumentation amplification, real time analysis digital Fourier transforms FFT analysis structural frequency response measurement random sinusoidal and transient test methods model testing of beams. Noise Control Techniques, Sound absorption, sound insulation, methods.

Text Books	
T.1	Mechanical Vibrations: Applications to Equipment, Yvon Mori, 13 January 2017
T.2	Mechanical Vibrations: Theory and Application, S. Graham Kelly.
Reference Books	
R.1	J.S. Rao and K. Gupta Advanced theory of vibration. Willey Eastern. 1992
R.2	P.Srinivasan Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi 1982.
R.3	N. L. Meirovitch , Elements of vibration Analysis, Mc Graw Hill New York 1986.

Course Code	Course Outcomes	PO/PSO	CL	Class Sessions
MMED1103.1	**Interpret** vibration phenomenonl and its concept.	PO1,PO2,PO3,PO12,PSO1, PSO2.	2	9
MMED1103.2	**Apply** Laplace and Fourier transform methods to find out response of Systems.	PO1,PO2,PO3,PO12,PSO1, PSO2.	3	9
MMED1103.3	**Apply** vibration techniques to determine natural frequency of the system for any DOF system.	PO1,PO2,PO3,PO12,PSO1, PSO2.	3	9
MMED1103.4	**Analyze** vibration of system using finite element techniques.	PO1,PO2,PO3,PO4,PO12,P SO1,PSO2.	4	9
MMED1103.5	**Analyze** Frequency response using FFT analyzer.	PO1,PO2,PO3,PO4,PO12,P SO1,PSO2.	4	9

(Dr. Vijay Tolodhikar)

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Program: M. Tech. course in Mechanical Engineering Design

MMED 1104: Advanced Mechanics of solids Lab

Teaching Scheme	
Practical	2 Hrs/week
Total Credit	1

Examination Scheme	
CA	25 Marks
ESE	25 Marks
Total	50 Marks
Duration of ESE: 02 Hrs	

Sr. No.	List of Experiment	COS
1	Synthesis using function generation.	CO1
2	Synthesis using path generation.	CO1
3	Synthesis using path generation & rigid body guidance.	CO1
4	One numerical on chebychev's spacing.	CO2
5	Kinematic analysis and synthesis of spatial mechanisms.	CO4
6	Kinematic synthesis of robot arm.	CO5
7	Graphical approaches for synthesis of mechanisms.	CO4
8	Study of Powell's search methods.	CO3
9	Study of least square method.	CO3
10	One numerical on Freudenstein's equation	CO3

Text Books

1	Solid Mechanics, KazimiS. M. A., Tata McGraw Hill,1994.
2	M. H. Sadd, Elasticity: theory, applications, and numeric, 3rd edition, Academic Press, 2014.

Reference Books

1	Tao, D.C.Applied Linkages.
2	Erdman & Sandor ,‖Advanced Mechanisms, Vol.- I,II‖
3	Denavit & Hartenberg, —Kinematic Synthesis

Useful Links

1	https://www.sciencedirect.com/science/article/abs/pii/S0094114X12002091
2	https://link.springer.com/article/10.1007/s00158-010-0500-3

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Program: M.Tech.in Mechanical Engineering Design

Semester-I | **MMED 1106**: Computer Aided Mechanical Design

Teaching Scheme	
Theory	3 Hrs/week
Tutorial	Nill
Total Credits	3
Duration of ESE: 3Hrs	

Examination Scheme	
CT-I	15 Marks
CT-II	15 Marks
CA	10 Marks
ESE	60 Marks
Total Marks	100 Marks

Pre-Requisites: Engineering Graphics, Auto-CAD

Course Contents

Unit I	**Introduction To CAD/CAM And Product Cycle:** Representation of Line, Circle, & Other analytic curves, Algorithms & Programs. Drafting of machine elements with dimension and tolerances using 2-D drafting packages. Graphic standards GKS [Graphical Kernal System] IGES [Initial Graphic Exchange Specifications].
Unit II	**CAD of Machine Elements:** Development of interactive design programs [with drafting] for machine elements, incorporating choice of materials and other parameters, Generation of several alternate designs and evaluation.
Unit III	**Geometric Modeling:** Mathematical representation of Hermite cubic, Bezeir & B-spline curves. Introduction to difference t y p e o f surfaces and solids generated in surface and solid model respectively. Assembly modeling and interference checking.
Unit IV	**Mechanical Design Analysis and Optimization:** Design analysis for mass properties, Stress, Thermal stress, using CAD/CAE packages, Optimum design of machine components using multivariable non linear optimization techniques using iterative CAD/CAE software tools.
Unit V	**Finite Element Analysis:** Basic concept of the finite element method, comparison of FEM with direct analytical solutions; Steps in finite element analysis of physical systems, Finite Element analysis of 1-D problems like spring, bar, truss and beam elements formulation by direct approach; development of elemental stiffness equations and their assembly, solution and its post processing.

Text Books	
T.1	Ranky, P.G. Computer Integrated Manufacturing,Prentice Hall,1986.
T.2	Radhakrishanan,P. and Kothandaraman, C.P. Computer Graphics & Design, Dhanpat Rai & Sons, Delhi, 1990.
T.3	Groover ,M.P.and Zimmers ,E.W CAD/CAM, Computer Aided Design and manufacturing, Prentice Hall of India 1986
Reference Books	
R.1	Dimarogons, A.D. Computer Aided Machine Design, Prentice Hall,1986.
R.2	Ibrahim Zeid, CAD/CAM Theory and Pratice, Mc Graw Hill, 1991.
R.3	Software Manuals on GEODRAW, GEOMOD, and SUPERTAB, Structural Dynamics Research Corporation, U.S.A. 1986
Useful Links	
1	https://aktu.ac.in/pdf/syllabus/Syllabus1617/Mechanical/SYLLABUS%20_CORE%20SUBJECT.pdf
2	https://personal.utdallas.edu/~yonas.tadesse/data/SylabusCADUGFall2014.pdf

Course Code	Course Outcomes	CL	Class Sessions
MMED 1106.1	**Analyze** the modeling, drafting and dimensioning of machine elements by using computer Software.	4	10
MMED 1106.2	**Apply** Basics of CAD to Generate several alternate design options very easily	3	10
MMED 1106.3	**Examine** the requirements of hardware & software for computer aided design process.	3	10
MMED 1106.4	**Interpret** Mechanical Design Analysis and Optimization	3	10
MMED 1106.5	Solve FEM Technique to analyze the Spring, truss and beam element.	3	10

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Program: **M.Tech.in Mechanical Engineering Design**

Semester-I | **MMED 1108**:MEMS Design and Industrial Automation

Teaching Scheme	
Theory	3 Hrs/week
Tutorial	Nill
Total Credits	3
Duration of ESE: 3Hrs	

Examination Scheme	
CT-I	15 Marks
CT-II	15 Marks
CA	10 Marks
ESE	60 Marks
Total Marks	**100 Marks**

Pre-Requisites: Mechatronics ,Automation in production, Computer Integrated Manufacturing

Course Contents

Unit I	**Introduction**: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.
Unit II	**Detroit-Type Automation**: Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Computer Simulation of Automated Flow Lines.
Unit III	**Material Handling And Identification Technologies** : Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc.
Unit IV	**Control Technologies In Automation**: Industrial Control Systems, Process Industries Verses Discrete Manufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation System: LAN, Analog & Digital I/O Modules, SCADA System & RTU.
Unit V	**Automated Assembly And Testing:** Analysis of a Single Station Assembly Machine. Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods.

Text Books	
T.1	MEMS & Microsystems Design and Manufacture/ Tai-Ran Hsu/ Tata Mc Graw Hill
T.2	Microelectromechanical Systems / Bhattacharyya / Cengage
Reference Books	
R.1	Krishna Kant, "Computer Based Industrial Control", EEE-PHI, 2 nd Edition, 2010.
R.2	Tiess Chiu Chang & Richard A. Wysk, "An Introduction to Automated Process Planning Systems". Prentice-Hall, 1985.
R.3	Viswanandham N & Narahari Y, Performance Modeling of Automated Manufacturing Systems, PHI, 1 st Edition, 2009.
Useful Links	
1	https://nptel.ac.in/content/storage2/courses/108105063/pdf/L01(SM)(IA&C)%20((EE)NPTEL).pdf
2	https://www.cynohub.com/jntuh-b-tech-r18-4-1-syllabus-for-automation-in-manufacturing-pdf-2022/

Course Code	Course Outcomes	CL	Class Sessions
MMED 1108.1	**Apply** the basics Fundamentals of automation and analyze the cost effective of automated system	3	9
MMED 1108.2	**Identify** the suitable flow lines and he computer simulation for the automation of given application	3	9
MMED 1108.3	**Describe** material handling and relevant technologies for the automation	3	9
MMED 1108.4	**Differentiate** various control aspects of automation	4	9
MMED 1108.5	**Analyze** the automation for assembly line and testing of manufacturing industry	4	9

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Program: M.Tech.in Mechanical Engineering Design

Semester-I | **MMED 1107:** Reliability, Maintainability & Wear

Teaching Scheme	
Theory	3 Hrs/week
Tutorial	Nill
Total Credits	3
Duration of ESE: 3Hrs	

Examination Scheme	
CT-I	15 Marks
CT-II	15 Marks
CA	10 Marks
ESE	60 Marks
Total Marks	**100 Marks**

Pre-Requisites: Industrial Engineering, Material Handling System

Course Contents

Unit I	**Introduction to reliability** availability and maintainability failure distributions, Weibull distribution and its applications to industries.
Unit II	**Defect list Generation and Defect/Failure Analysis:** Defect Generation: types of failure, defect reporting and recording, defect analysis, failure analysis, equipment downtime analysis, breakdown analysis: FTA, FMTA, FMECA)
Unit III	**Maintenance Planning and Scheduling:** Factors involved in effective planning of maintenance work, Various methods of scheduling work, Categorization of plant/equipment for the purpose of priorities. Short term and Long Term Maintenance Plans: Major repair, Capital Repair and Annual Overhauls, Renovation, Revamping and Modernization.
Unit IV	**Reliability Improvement and Allocation:** Difficulty in achieving reliability, Methods for improving reliability during design, Different techniques available to improve reliability, Optimization, Reliability-Cost trade off, Elements of a typical reliability program, setting overall reliability goals, Reliability Apportionment, Prediction and Analysis, Problems.
Unit V	**Maintenance Types/Systems:** Planned and unplanned Maintenance, Breakdown Maintenance, corrective Maintenance, Opportunistic Maintenance, Routine Maintenance, Preventive Maintenance, Predictive Maintenance, Condition Base Maintenance System (CBMS): Online offline Monitoring, Visual and Temperature Monitoring, Leakage Monitoring, Vibration Monitoring: causes,

Text Books	
T.1	Reliability Engineering –E. Bala guruswamy –Tata Mc. Graw Hill
T.2	Reliability Engineering –D.J. Smith- Pitman Publishing
T.3	Reliability Engineering –L.S. Srinath –Affiliated East West Press Pvt. Ltd.
Reference Books	
R.1	Reliability & Maintainability Engineering Charles E. Ebeling – Tata Mc Graw Hill
R.2	Reliability Methods Engineering and its application – G.P. Chhalotra –Khanna
R.3	Introduction to Reliability in Design –Charles O. Smith – Mc. Graw Hill
Useful Links	
1	https://s3-ap-southeast-1.amazonaws.com/gtusitecirculars/Syallbus/3161913.pdf
2	https://ldrp.ac.in/images/syllabus/BE-Mechanical/ME%20706%20D-Quality%20and%20Reliability%20Engineering.pdf

Course Code	Course Outcomes	CL	Class Sessions
MMED 1107.1	**Estimate** the life of machine and their components and various maintenance Processes.	3	9
MMED 1107.2	**Apply** the basic of reliability measures such as MTTF, MTBF, MTTR, availability, failure rate, Bathtub curve, etc.	3	9
MMED 1107.3	**Demonstrate** Defects and Failure analysis and different types of maintenance system	3	9
MMED 1107.4	**Analyze** the reliability and allocation in production system	4	9
MMED 1107.5	**Differentiate** various Maintenance Planning and Scheduling techniques.	4	9

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Program: **M.Tech.in Mechanical Engineering Design**

Semester-I	**MMED 1109**: Ergonomics for Mechanical Design

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	Nill	**CT-II**	15 Marks
Total Credits	3	**CA**	10 Marks
Duration of ESE: 3Hrs		**ESE**	60 Marks
Pre-Requisites: Industrial Engineering, Environmental Science		**Total Marks**	**100 Marks**

Course Contents

Unit I	**Ergonomics and Production:** Ergonomics and product design –ergonomics in automated systems- expert systems for ergonomic design. Anthropometric data and its applications in ergonomic, design- limitations of anthropometric data- use of computerized database. Case study
Unit II	**Aesthetic Concepts:** Concept of unity- concept of order with variety - concept of purpose style and environment-Aesthetic expressions. Style components of style- house style, observation style in capital goods, case study
Unit III	**Ergonomics and Industrial Safety (EIS): Introduction** - general approach to the man-machine relationship-workstation design-working position and posture. An approach to industrial design - elements of design structure for industrial design in engineering applications in manufacturing systems.
Unit IV	**Control and Displays:** configurations and sizes of various controls and displays;- design of controls in automobiles, machine tools etc., - design of furniture, design of instruments
Unit V	**Safety & Occupational Health and Environment:** Application of Ergonomics in industry for Safety, Health and Environment Control; Prevention and specific safety measures for manufacturing and processing industry – safety in the use of machines, precaution for certain chemical industry. Environmental Safety and ISO 14000 System. Occupational Health – Health and Safety consideration; Personal protective Equipment.

Text Books	
T.1	Product Design and Development Karl T. Ulrich, Steven G. Eppinger; Irwin McGraw Hill..
T.2	2. Product Design and Manufacturing A.C. Chitale and R.C. GuptaPHI
T.3	3. Introduction to Ergonomics R.C. Bridger McGraw Hill Pub
T.4 .	4. Industrial Design for Engineers, Mayall W.H London, Hiffee booksLtd.
Reference Books	
R.1	Industrial Design for Engineers: Mayall W.H, London, Hiffee books Ltd, 1988.
R.2	2. Applied Ergonomics, Hand Book: Brien Shakel (Edited) Butterworth Scientific, London 1988
R.3	3. Introduction to Ergonomics – R.C.Bridger, McGraw-Hill Pub.
R.4	4. Human Factor Engineering – Sanders & McCormick, McGraw-Hill Publications
Useful Links	
1	http://www.pccoepune.com/pdf/syllabi/Minor-Product-Design-and-Development-2022-23.pdf
2	

Course Code	Course Outcomes	CL	Class Sessions
MMED 1109.1	**Apply** basics of ergonomics and aesthetics in product design.	3	9
MMED 1109.2	**Implement** aesthetic concepts such as styles controls while designing product	3	9
MMED 1109.3	**Interpret** Measures of Ergonomics and Industrial Safety (EIS):.	3	9
MMED 1109.4	**Analyze** field failure and reliability tests data using a suitable software package	4	9
MMED 1109.5	**Use** safety and occupational health and environment in industry.	3	9

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Program: M.Tech In Mechanical Engineering Design

Semester-I | **MMED1112 :** Mechanization in Food Processing

Teaching Scheme	
Theory	3 Hrs/week
Tutorial	Nill
Total Credits	3
Duration of ESE: 3Hrs	

Examination Scheme	
CT-I	15 Marks
CT-II	15 Marks
CA	10 Marks
ESE	60 Marks
Total Marks	**100 Marks**

Pre-Requisites:

Course Contents

Unit I	**Screening; types of screens** ; Grizzly; Revolving screen; Shaking screen; Rotory screen; Vibratory screen; Horizontal screen; Perforated metal screens; wire mesh screen; Ideal and Actual screen; Effectiveness of screen; Air screen cleaners
Unit II	**Definition and Introduction to Separation;** Types of Separator- Disk, Indented cylinder, Spiral, Specific Gravity, Destoner, Inclined Draper, Velvet roll, Pneumatic & aspirator, separation based fluidization technique, Magnetic and Cyclone Separator.
Unit III	**Size reduction procedures-** Crushing, Impact, Shearing, Cutting; Cereal grinding, Degree of grinding; Size reduction machinery- crusher, grinder, attrition mills, hammer mill, ball mills, rietz mill & oil expression and extractions- hydraulic press, screw press
Unit IV	**Utilities of Drying;** thermal properties; Equilibrium moisture content (EMC); Drying theories; methods of drying;- Contact drying, Convective drying, freeze drying, radiation drying, Superheated steam, Drying rate period; types of dryers-Deep bed, Flat bed, Continuous, Recalculating, LSU, Fluidized bed, Rotary, Tray, Tunnel and solar, Etc
Unit V	**Material handling & transportation-** Belt conveyor, bucket elevator, screw conveyor, pneumatic conveyor; transportation. Applications of Unit operations to the food industry.

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Program: M. Tech. in Mechanical Engineering Design

Semester-I | **MMED 1111: Robotics Drives**

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	Nill	**CT-II**	15 Marks
Total Credits	3	**CA**	10 Marks
Duration of ESE: 3Hrs		**ESE**	60 Marks
		Total Marks	**100 Marks**

Pre-Requisites: Physics,Mechanics,CAD

Course Objectives:

1. To introduce the various drives systems used in robots.

Course Contents

Unit I	**Introduction to Robot Drives**: Introduction Robot Drives, classification of drive systems, open loop control, closed loop control with feedback, functions and classification of drive systems, chain and linkages, lead screw, ball screws, belt drives, gear drives, precision gear boxes, harmonic drives, speed reducers, classification of grippers.
Unit II	**Electric Drives:** Introduction, classification, AC motors, DC motors, stepper motors, types of stepper motors, half step mode operation, micro step mode, linear actuators, direct drive actuators.
Unit III	**Pneumatic Drives**: Introduction, advantages and disadvantages, components of pneumatic control drives, linear pistons, rotary pistons, flow control valves, pneumatic proportional controller, applications.
Unit IV	**Hydraulic Drive :**Introduction, advantages and disadvantages, components of hydraulic control drives, piston and transfer valves, hydraulic circuit with control amplifiers, fluid consideration, rotary and linear hydraulic actuators, hydraulic components in robots.
Unit V	**Servo Systems:** Introduction, arrangement of actuators in robots, fundamentals of control techniques, modelling of robot servos, error response, steady state errors in robot servos, feedback and feed forward compensations, hydraulic position servo, computer controlled servo systems, selection of robot drives.

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Text Books	
T.1	Knapczyk, J. (2014). Basics of Robotics: Theory and Components of Manipulators and Robots. Austria: Springer Vienna.
T.2	De Silva, C. W. (2015). Sensors and Actuators: Engineering System Instrumentation, Second Edition. United States: CRC Press.

Reference Books	
R.1	Agrawal, S. K., Kinzel, G. L., Waldron, K. J. (2016). Kinematics, Dynamics, and Design of Machinery. United Kingdom: Wiley.
R.2	Norton, R. L. (2014). Machine Design: An Integrated Approach. United Kingdom: Prentice Hall.

Useful Links	
1	https://archive.nptel.ac.in/courses/112/105/112105249/
2	https://nptel.ac.in/courses/112105249

Course Code	Course Outcomes	PO/PSO	CL	Class Sessions
MMED 1111.1	**Understand** the various drives of robotic system.	PO1,PO2,PO3,PO12,PSO 1,PSO2.	2	9
MMED 1111.2	**Summarize** the application of electric drives in robotic system.	PO1,PO2,PO3,PO12,PSO 1,PSO2.	2	9
MMED 1111.3	**Apply** pneumatic and hydraulic system in robotic application.	PO1,PO2,PO3,PO12,PSO 1,PSO2.	3	9
MMED 1111.4	**Design** a robot using appreciates servo systems.	PO1,PO2,PO3,PO12,PSO 1,PSO2.	3	9
MMED 1111.5	**Demonstrate** the application of various drives.	PO1,PO2,PO3,PO12,PSO 1,PSO2.	3	9

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Program: M.Tech.in Mechanical Engineering Design

Semester-I	**MMED 1106**: Computer Aided Mechanical Design

Teaching Scheme		Examination Scheme	
Theory	3 Hrs/week	**CT-I**	15 Marks
Tutorial	Nill	**CT-II**	15 Marks
Total Credits	3	**CA**	10 Marks
Duration of ESE: 3Hrs		**ESE**	60 Marks
Pre-Requisites: Engineering Graphics, Auto-CAD		**Total Marks**	**100 Marks**

Course Objectives:

1.	To Analyze the solid and 2-D modeling of machine elements by using computers, which were earlier carried out manually.
2.	To Analyze the representation of geometrical entities like line, circle, curves, surfaces and solid parts mathematically and hence computer software can be used for modeling of any engineering entities.

Course Contents

Unit I	**Introduction To CAD/CAM And Product Cycle:** Representation of Line, Circle, & Other analytic curves, Algorithms & Programs. Drafting of machine elements with dimension and tolerances using 2-D drafting packages. Graphic standards GKS [Graphical Kernal System] IGES [Initial Graphic Exchange Specifications].
Unit II	**CAD of Machine Elements:** Development of interactive design programs [with drafting] for machine elements, incorporating choice of materials and other parameters, Generation of several alternate designs and evaluation.
Unit III	**Geometric Modeling:** Mathematical representation of Hermite cubic, Bezeir & B-spline curves. Introduction to difference t y p e o f surfaces and solids generated in surface and solid model respectively. Assembly modeling and interference checking.
Unit IV	**Mechanical Design Analysis and Optimization:** Design analysis for mass properties, Stress, Thermal stress, using CAD/CAE packages, Optimum design of machine components using multivariable non linear optimization techniques using iterative CAD/CAE software tools.
Unit V	**Finite Element Analysis:** Basic concept of the finite element method, comparison of FEM with direct analytical solutions; Steps in finite element analysis of physical systems, Finite Element analysis of 1-D problems like spring, bar, truss and beam elements formulation by direct approach; development of elemental stiffness equations and their assembly, solution and its post processing.

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Text Books	
T.1	Ranky, P.G. Computer Integrated Manufacturing,Prentice Hall,1986.
T.2	Radhakrishanan,P. and Kothandaraman, C.P. Computer Graphics & Design, Dhanpat Rai & Sons, Delhi, 1990.
T.3	Groover ,M.P.and Zimmers ,E.W CAD/CAM, Computer Aided Design and manufacturing, Prentice Hall of India 1986
Reference Books	
R.1	Dimarogons, A.D. Computer Aided Machine Design, Prentice Hall,1986.
R.2	Ibrahim Zeid, CAD/CAM Theory and Pratice, Mc Graw Hill, 1991.
R.3	Software Manuals on GEODRAW, GEOMOD, and SUPERTAB, Structural Dynamics Research Corporation, U.S.A. 1986
Useful Links	
1	https://nptel.ac.in/courses/112102101.
2	https://nptel.ac.in/courses/112102102.

Course Code	Course Outcomes	PO/PSO	CL	Class Sessions
MMED 1106.1	**Analyze** the modeling, drafting and dimensioning of machine elements by using computer Software.	PO1,PO2,PO3,PO12, PSO1,PSO2	4	9
MMED 1106.2	**Apply** Basics of CAD to Generate several alternate design options very easily.	PO1,PO2,PO3,PO5, PO12,PSO1,PSO2,PSO3	3	9
MMED 1106.3	**Examine** the requirements of hardware & software for computer aided design process.	PO1,PO2,PO3,PO12, PSO1, PSO2	3	9
MMED 1106.4	**Interpret** Mechanical Design Analysis and Optimization	PO1,PO2,PO3, PO12,PSO1,PSO2	3	9
MMED 1106.5	**Solve** FEM Technique to analyze the Spring, truss and beam element.	PO1,PO2,PO3, PO5,PO12,PSO1,PSO2, PSO3.	3	9

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