TULSIRAMJI GAIKWAD-PATIL College of Engineering & Technology

Mohgaon, Wardha Road, Nagpur - 441 108

An Autonomous Institute

DEPARTMENT OF MECHANICAL ENGINEERING

M. Tech. course in Mechanical Engineering Design

Teaching Scheme

Considering

National Education Policy 2020

From

Academic Year 2024-25

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

M1: To strive for rearing standard and stature of the students by practicing high Standards of professional ethics, transparency and accountability.

M2: To provide facilities and services to meet the challenges of Industry and Society.

M3: To facilitate socially responsive research, innovation andentrepreneurship.

M4: To ascertain holistic development of the students and staff members by Inculcating knowledge and profession as work practices.

Vision of the Department

"To emerge as a premier centre in the field of Mechanical Engineering Education and produce competent Engineers".

Mission of the Department

- To impart quality Technical Education through effective teaching-learning process.
- To provide a better environment to encourage innovation and entrepreneurship.
- To strengthen industry institute interaction to meet the challenges of industry and society.
- To ensure overall development of students and staff members by inculcating knowledge and professional ethics.

Programme Education Objectives (PEO)

PEO-1: Demonstrate essential technical skills to identify analyze and solve problems and design issues in mechanical engineering.

PEO-2:Analyze the complex problems in the field of mechanical engineering by using modern tools.

PEO-3:Apply mechanical engineering concepts for the betterment of society and environment.

PEO-4: Develop professionals having administrative and managerial skills for mechanical engineering and allied industries.

PEO-5: Demonstrate the attributes of mechanical engineering in lifelong learning to Contribute towards societal needs.

Programme 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 the information 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 in formed 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 the set 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 inindependentandlifelonglearninginthebroadestcontextoftechnologicalchange.

Programme Specific Outcomes(PSO)

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

PSO2: Analyze and design mechanical components and its processes to meet the societal needs.

PSO3: Apply Engineering and Management principles to work professionally in the industry or as an entrepreneur.

Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

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SCHEME OF INSTRUCTION & SYLLABI

Programme: M. Tech. course in Mechanical Engineering Design (NBA Accredited)

Scheme of Instructions: First Year M. Tech. course in Mechanical Engineering Design (As Per NEP 2020)

Semester – I

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	MME21101	Advanced Mechanical Drives	4	-	-	4	4	20	20	-	60	100
2	PCC	MME21102	Mechanics of solid	4	-	-	4	4	20	20	-	60	100
3	PCC	MME21103	MechanicalVibrations	4	-	-	4	4	20	20	-	60	100
4	PCC	MME21104	Dynamics and Mechanisms Lab	-	-	4	4	2	-	-	25	25	50
5	PEC	MME21105-08	Programme Elective-I	4	-	-	4	4	20	20	-	60	100
6	PEC	MME21109-12	Programme Elective-II	4	-	-	4	4	20	20	-	60	100
			Total	**20**	**-**	**4**	**24**	**22**	**100**	**100**	**25**	**325**	**550**

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Programme: Mechanical Engineering

List of **Program Electives** offered By Mechanical Department (NBA Accredited)

Semester-I		**Semester-II**	
Programme Elective-I	**Programme Elective-II**	**Programme Elective-III**	**Programme Elective-IV**
MME21105:Computer Aided Mechanical Design	**MME21109**: Design for manufacturing and assembly	**MME21205**: Tribology	**MME21209**:Mechanicsof Composite Materials
MME21106: Reliability, Maintainability & Wear	**MME21110**:Robotics Drives	**MME21206**: Design of Hydraulic andPneumatic System	**MME21210** System Modelingand Analysis
MME21107:MEMS Design and Industrial Automation	**MME21111**:Mechanization In Food Processing	**MME21207**: Optimization Methods for MechanicalDesign	**MME21211**:Advance FractureMechanics
MME21108:Ergonomics for Mechanical Design	**MME21112**:Additive Manufacturing	**MME21208:** Product Designand Development	**MME21212**:Reverse Engineering

Course Category	**PCC (Programme Core courses)**	**PEC (Programme Elective courses)**	**OEC (Open Elective courses From other discipline)**	**FC (Foundation Course)**	**Project/ Seminar/ Industrial Training**	**Semester Wise Credits**
Semester-I	14	08	-	-	-	**22**
Semester-II	10	08	-	2	-	**20**
Semester-III	-	03		-	15	**18**
Semester-IV	-	-	-	-	20	**20**
Cumulative Sum	**24**	**19**	-	**2**	**35**	**80**

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Program: M. Tech. in Mechanical Engineering Design

Semester-I | **MME21101:** Advanced Mechanical Drives

Teaching Scheme		Examination Scheme	
Theory	4 Hrs/week	**CT-I**	20 Marks
Tutorial	Nill	**CT-II**	20 Marks
Total Credits	**4**	**ESE**	60 Marks
Duration of ESE: 3Hrs		**Total Marks**	**100 Marks**

Course Objectives:

1.	To study the basic concepts of Belt drive and its merits.
2.	To study the applicability of Gear and Gear boxes used in industrial applications.
3.	To study the chain drives with its significance.
4.	To study the PIV Drives and Couplings.

Course Contents

Unit I	**Belt Drives:** Belt vibrations, additional stress due to vibration, modern development in toothed belt, fatigue, synchronization, slip due to wear. Dynamics & vibration of Arms of Pulleys by three Approaches (1), Equal sharing of load zone (2) Equilibrium of rim (3) FEM Approach.
Unit II	**Gears:** Detailed dynamics of gear tooth, spur tooth vibrations, Estimation of additional stress under vibration. Fatigue in tooth due to contact stress. Exact estimation of gear meshes frequencies in signature analysis. Gear Boxes, Kinematic Analysis of complex gear trains, Force Analysis including gyroscopic effects, Vibration Analysis of Gearboxes, Lubrication Methods.
Unit III	**Chain Drives** : Detailed dynamics of chains considering Rolling friction of hanging portion of tracks, Resistance of sprocket bearings, Resistance due to chain stiffness , chain vibrations Lateral & longitudinal, wear debris formation & effect on efficiency, impact loads in chains. Analysis of power & conveyor chains.
Unit IV	**PIV Drives:** Concept, Need, Classification & Types. Detailed kinematics & dynamics of 4/5 important drives.
Unit V	**Couplings:** Stress analysis of coupling bolts during one rotation, Rubbing of coupling pins & its effect on signature, Analysis due to misalignment, Degree of shock absorption due to flexible elements in flexible couplings.

Text Books

T.1	Engineering Design , George E.Dieter, Fourth Edition, McGraw Hill
T.2	M.P.Alexandrov, —Mateials Handing Equipment‖, MIR Publications, Moscow 1981.

Reference Books

R.1	Gear, Spur Helical ,Worm by Earle Buckingham ,Mc-Graw Hill.
R.2	Rothebirt —Mechanical Design & Systems Handbook‖ Mc-Graw Hill
R.3	Handbook of shaft Alignment.”

Useful Links
https://onlinecourses.nptel.ac.in/noc20_me69/preview
https://www.youtube.com/watch?v=9WPZStQp03Q&list=PLSGws_74K01-KPzaLUtCV7RCognwVoP8

Course Code	Course Outcomes	CL	Class Sessions
MME21101.1	**Learn** the Belt drive system design.	2	9
MME21101.2	**Design** the Gear and Gear Box systems.	4	9
MME21101.3	**Design** of Chain drive system	4	9
MME21101.4	**Describe** PIV Drives	4	9
MME21101.5	**Develop** Couplings for various systems.	4	9

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Program: M. Tech. in Mechanical Engineering Design

Semester-I | **MME21102: Mechanics of solid**

Teaching Scheme		Examination Scheme	
Theory	4 Hrs/week	**CT-I**	20 Marks
Tutorial	Nill	**CT-II**	20 Marks
Total Credits	**4**	**ESE**	60 Marks
Duration of ESE: 3Hrs		**Total Marks**	**100 Marks**

Course Objectives:

1.	To understand the mechanical behaviour of engineering materials subjected to various types of stresses.
2.	To understand the bending of various types of beams under static loading conditions ,shear stress distribution for different beams.
3.	To understand principal planes, stresses and strains and analyse the elastic deformation of members.
4.	To understand torsion for the circular shaft , the crippling load for various types of columns of different end conditions.
5.	To understand deflection of beams and shafts under static loading, stresses in thin walled cylindrical and spherical vessels.

Course Contents

Unit I	**Stress Analysis:** Stress at a point, stress notations, symmetry of stress array and stress on an arbitrary oriented plane, transformation of stresses, principal stresses and other properties, Mohr's circle in 2D and 3D, differential equations of motion of a deformable body, Airy's stress function and its importance.
Unit II	**Members Subjected to Flexural Loads:** Theory of simple bending, bending moment and shear force diagrams for different types of static loading and support conditions on beams, bending stresses, section modulus and transverse shear stress distribution in circular, hollow circular, I, Box, T, angle sections etc. Strain energy due to bending.
Unit III	**Failure Theories:** Non-linear materials response, theories of failure and their significance, comparison of failure criterions and their interpretation for general yielding, deviatoric plane, yield locus and surfaces of Tresca and Von-Mises.
Unit IV	**Torsion:** Torsion of prismatic shafts, non-symmetrical bending, plane of loads, bending stresses in beams subject to non-symmetrical bending, deflection of straight beams subjected to non-symmetrical bending.
Unit V	**Transverse Deflection of Beams:** Relation between deflection, bending moment, shear force and load, transverse deflection of beams and shaft under static loading, area moment method, direct integration method. Thin-walled Pressure Vessels: Stresses in cylindrical and spherical vessels.

Text Books

T.1	Solid Mechanics, KazimiS. M. A., Tata McGraw Hi11, 1994.
T.2	M. H. Sadd, Elasticity: theory, applications, and numeric, 3rd edition, Academic Press,

Reference Books

R.1	Foundations of Solid Mechanics by Fung, Prentice Hall.
R.2	Elasticity by J. R. Barber, Springer.
R.3	Advanced Mechanics of Solids by L.S Srinath, McGraw Hill Education.

Useful Links
https://link.springer.com/article/10.1007/s00158-010-0500-3
https://www.researchgate.net/publication/4029306_ Kinematic_ synthesis_ of robotic_manipulators_from_task_descriptions

Course Code	Course Outcomes	CL	Class Sessions
MME21102.1	**Understand** advanced stress/strain correlations.	2	9
MME21102.2	**Analyse** simple mathematical and physical relationships between mechanics and materials.	4	9
MME21102.3	**Analyse** the bending of various types of beams under static loading conditions and compute the shear stress distribution for different cross sections of beams.	4	9
MME21102.4	**Analyse** the torsion for the circular shaft.	4	9
MME21102.5	**Analyse** the deflection of beams and shafts under static loading and stresses in thin walled cylindrical and spherical vessels.	4	9

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Semester-I	**MME21103: Mechanical Vibrations**

Teaching Scheme		**Examination Scheme**	
Theory	4 Hrs/week	**CT-I**	20 Marks
Tutorial	Nill	**CT-II**	20 Marks
Total Credits	**4**	**ESE**	60 Marks
Duration of ESE: 3Hrs		**Total Marks**	**100 Marks**

Course Objectives:

1.	Understand the causes of vibration in any system.
2.	Understand the concept of Mechanical system and Mechanics.
3.	Determine natural frequency for various degrees of freedom, Vibration Phenomenon for various continues and discrete system.
4.	Understand various Vibration analysis techniques.
5.	Understand FFT analyzer and Noise Control techniques.

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	CL	Class Sessions
MME21103.1	**Interpret** vibration phenomenon and its concept.	2	9
MME21103.2	**Apply** Laplace and Fourier transform methods to find out response of Systems.	3	9
MME21103.3	**Apply** vibration techniques to determine natural frequency of the system for any DOF system.	3	9
MME21103.4	**Analyze** vibration of system using finite element techniques.	4	9
MME21103.5	**Analyze** Frequency response using FFT analyzer.	4	9

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Program: M. Tech. course in Mechanical Engineering Design

Semester-I **MME21104: Dynamics and Mechanisms Lab**

Teaching Scheme	
Practical	4 Hrs/week
Total Credit	2

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

Course Outcomes (CO)

Students will be able to

1.	**Understand** various methods of synthesis.
2.	**Apply** the concept of planner mechanism to solve engineering problem.
3.	**Analyze** Kinematic & synthesis of spatial mechanisms.
4.	**Apply** the concept of two degree and multi degree of freedom system for free and forced vibration.
5.	**Analyze** natural frequency using matrix iteration method and Holzen's method.

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.	CO3
6	Experiment two degree of freedom system for forced vibration.	CO4
7	Experiment two degree of freedom system for free vibration.	CO4
8	Examine multi degree of freedom system for forced vibration.	CO4
9	Calculate natural frequency of the given system using matrix iteration method.	CO5
10	Calculate natural frequency using Holzen's method	CO5

Text Books

1	Solid Mechanics, KazimiS. M. A., Tata McGraw Hill,1994.
2	Mechanical Vibrations: Applications to Equipment, YvonMori,13 January 2017.

Reference Books

1	Tao, D.C.Applied Linkages.
2	Denavit & Hartenberg, —Kinematic Synthesis
3	N.L.Meirovitch, Elements of vibration Analysis,McGraw Hill NewYork1986.

Useful Links

1	https://www.sciencedirect.com/science/article/abs/pii/S0094114X12002091
2	https://archive.nptel.ac.in/courses/112/105/112105048/

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Semester-I	**MME21105: Program Elective-I: Computer Aided Mechanical Design**

Teaching Scheme		**Examination Scheme**	
Theory	4 Hrs/week	**CT-I**	20 Marks
Tutorial	Nill	**CT-II**	20 Marks
Total Credits	**4**	ESE	60 Marks
Duration of ESE: 3Hrs		**Total Marks**	**100 Marks**

Course Objectives:

1.	Acquire knowledge for generating high quality images of massive geometric models in a short time.
2.	Learn about the concepts of surface modeling, physically based modeling and surface visualization.
3.	Understand the need and concepts of design optimization.
4.	Learn the fundamental concepts of the finite element method .

Course Contents

Unit I	**Introduction To CAD/CAM And Product Cycle**: Representation of Line, Circle, & Other analytic curves, Algorithms & Programs. Graphic standards GKS [Graphical Kernel System] IGES [Initial Graphic Exchange Specifications].Product cycle.
Unit II	**Curve Design**: Fundamental of Curve Design, Parametric Space of a Curve, Blending Functions, Space Curves, Straight lines, Spline Curves, Bezier Curves, B-Spline Curve.
Unit III	**Solid Modeling:** : Topology and Geometry, Set Theory, Boolean Operators, Set-membership Classification, Sweep Representation, Constructive Solid Geometry, Boundary Representation, Assembly modeling: Representation, mating conditions, generation of assembly sequences .
Unit IV	**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 bar, truss and beam elements formulation by direct approach; development of elemental stiffness equations and their assembly, solution and its post processing.
Unit V	**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.

Text Books

T.1	Computer Aided Design: A Conceptual Approach, Jayanta Sarkar, CRC Press, 1st Edition.
T.2	CAD/CAM Theory and Practice, Zeid Ibrahim, Tata McGraw Hill, 4th edition, 2001.

Reference Books

R.1	Design Theory and Methods using CAD/CAE: The Computer Aided Engineering Design Series, Kuang-Hua Chang, Academic Press, 1st Edition.
R.2	Groover ,M.P.and Zimmers ,E.W CAD/CAM, Computer Aided Design and manufacturing, Prentice Hall of India 1986.

Useful Links

https://nptel.ac.in/courses/112/102/112102101/
https://nptel.ac.in/courses/112/102/112102102/

Course Code	Course Outcomes	CL	Class Sessions
MME21105.1	**Apply** Basics of CAD to Generate several alternate design options very easily	3	9
MME21105.2	**Analyze** the concept of various curve design.	4	9
MME21105.3	**Analyze** the various modeling Techniques using computer Software.	4	9
MME21105.4	**Analyze** the 1-D elements using FEM technique.	4	9
MME21105.5	**Analyze** mechanical design using optimization techniques.	4	9

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Program: M. Tech. in Mechanical Engineering Design

Semester-I	**MME21106 :Program Elective-I: Reliability, Maintainability & Wear**

Teaching Scheme		**Examination Scheme**	
Theory	4 Hrs/week	**CT-I**	20 Marks
Tutorial	Nill	**CT-II**	20 Marks
Total Credits	**4**	**ESE**	60 Marks
Duration of ESE: 3Hrs		**Total Marks**	**100 Marks**

Course Objectives:

1.	To understand the concept of reliability, availability and maintainability.
2.	To establish the relationship between reliability, availability and maintainability.
3.	To measure reliability of the system having components in series and components in parallel.
4.	To understand the factors affecting the maintainability and reliability.

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 Apportionment. Prediction and Analysis , problems
Unit V	**Maintenance Types/ Systems:** Planned and unplanned Maintenance, corrective Maintenance, Opportunistic Maintenance, Routine Maintenance, Preventive Maintenance , Predictive Maintenance, Condition base Maintenance (CBMS): Online offline Monitoring, Visual and Temparature 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.

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.

Useful Links

https://archive.nptel.ac.in/courses/127/105/127105234/
https://nptel.ac.in/courses/112105232

Course Code	Course Outcomes	CL	Class Sessions
MME21106.1	**Summarize** the life of machine and their components and various maintenance processes	2	9
MME21106.2	**Apply** the basic of reliability measures such as MTTF, MTBF, MTTR, availability, failure rate, Bathtub curve etc	3	9
MME21106.3	**Analyze** the defects and failure of different types of maintenance system	4	9
MME21106.4	**Analyze** the reliability and allocation in production system.	4	9
MME21106.5	**Analyze** various maintenance planning and scheduling techniques.	4	9

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(An Autonomous Institute Affiliated to RTM Nagpur University, Nagpur)

Program: M. Tech. in Mechanical Engineering Design

Semester-I | **MME21110: Program Elective-II: Robotics Drives**

Teaching Scheme			Examination Scheme	
Theory	4 Hrs/week		**CT-I**	20 Marks
Tutorial	Nill		**CT-II**	20 Marks
Total Credits	**4**		**ESE**	60 Marks
Duration of ESE: 3Hrs			**Total Marks**	**100 Marks**

Course Objectives:

1.	To understand the basic concepts associated with the design of Robots
2.	To understand the functioning of Robots
3.	To understand the applications of Robots
4.	To study about the drives and sensors used in Robots
5.	To analyze robot kinematics and robot programming

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.

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
https://archive.nptel.ac.in/courses/112/105/112105249/
https://nptel.ac.in/courses/112105249

Course Code	Course Outcomes	CL	Class Sessions
MMED21110.1	**Understand** the various drives of robotic system.	2	9
MMED21110.2	**Summarize** the application of electric drives in robotic system.	2	9
MMED21110.3	**Apply** pneumatic and hydraulic system in robotic application.	3	9
MMED21110.4	**Design** a robot using appreciates servo systems.	3	9
MMED21110.5	**Demonstrate** the application of various drives.	3	9

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Chairperson	**Dean Academics**	**Vice Principal**	**Principal**	**Date of Release**	**Version**	

Tulsiramji Gaikwad-Patil College of Engineering and Technology
Wardha Road, Nagpur-441 108
NAAC Accredited with A+ Grade and NBA
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Program: M. Tech. in Mechanical Engineering Design

Semester-I	**MME21112: Program Elective-II :Additive Manufacturing**

Teaching Scheme		**Examination Scheme**	
Theory	4 Hrs/week	**CT-I**	20 Marks
Tutorial	Nill	**CT-II**	20 Marks
Total Credits	**4**	**ESE**	60 Marks
Duration of ESE: 3Hrs		**Total Marks**	**100 Marks**

Course Objectives:

1.	To provide students with a comprehensive understanding of advanced additive manufacturing technologies, processes, materials, and applications.
2.	To create the design of an object suitable for addictive manufacturing processes.
3.	To Compare traditional versus next generation manufacturing.

Course Contents

Unit I	**Introduction to Additive Manufacturing**: Introduction to Additive Manufacturing (AM), Historical background and evolution of AM. Basic principles and processes of AM, Design considerations for AM, Post-processing techniques in AM, Applications of AM in various industries, Current trends and future prospects in Additive Manufacturing. Advantages and limitations of Additive Manufacturing compared to traditional manufacturing methods.
Unit II	**Additive Manufacturing Technologies**: 1. Fused Deposition Modeling (FDM) - Principles, process, materials, applications 2. Selective Laser Sintering (SLS) - Working principle, materials used, advantages, limitations 3. Stereo lithography (SLA) - Technology overview, resin curing process, post-processing techniques 4. Direct Metal Laser Sintering (DMLS) - Metal additive manufacturing process, material properties, industrial applications 5. Electron Beam Melting (EBM) - Powder bed fusion technology, electron beam melting process, aerospace and medical applications 6. Binder Jetting - Powder-based 3D printing process, binder deposition, postprocessing methods
Unit III	**Various materials in Additive Manufacturing (AM) processes**, including polymers, metals, ceramics, composites, and bio-materials. The properties, characteristics, and performance of each material in the context of AM, considering factors such as strength, durability, thermal properties, and chemical resistance. Design considerations for AM, including geometric complexity, support structures, layer thickness, and surface finish requirements to optimize the manufacturing process and ensure the quality of the final product.
Unit IV	**Liquid based and solid based addictive manufacturing system** :Stereo lithography Apparatus,Principle,Pre build process, Part building and post building processes, photo polymerization of SL resins, part quality and process planning, Recoating issues,material advantage, limitation and advantage and application. Fused deposition of modeling :Process, details of processes,processes variable,types,product material and application.
Unit V	**Overview of Current Trends in Additive Manufacturing :** Advanced Materials and Processes in Additive Manufacturing. Industry Applications and Case Studies in Additive Manufacturing. Additive Manufacturing in Aerospace, Medical, and Automotive Industries.

Text Books	
1	Additive Manufacturing and 3D Printing Technology: Principles and Applications, Dr. G.K. Awari, Dr.D.P.Kothari, Prof. Vishwjeet Ambade, Dr. C. S. Thorat, CRC Press, Taylor & Francis Group
2	Additive Manufacturing Technologies 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing , Ian Gibson • David Rosen • Brent Stucker, Springer New York Heidelberg DordrechtLondon
3	Additive Manufacturing Innovations, Advances, and Applications , t.S. Srivatsan • t.S. Sudarshan,CRC Press, Taylor & Francis Group
Reference Books	
1	Understanding Additive Manufacturing Rapid Prototyping · Rapid Tooling · Rapid Manufacturing Andreas Gebhardt, Hanser Publishers, Munich Hanser Publications, Cincinnati
2	Additive Manufacturing of Metals: The Technology, Materials, Design and Production , Li Yang Keng Hsu • Brian Baughman Donald Godfrey • Francisco Medina Mamballykalathil Menon SoerenWiener, Springer Series in Advanced Manufacturing
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc21_me115/preview
2	https://onlinecourses.nptel.ac.in/noc20_me50/preview

Course Code	Course Outcomes	CL	Class Sessions
MME21112.1	**Estimate** the life of machine and their components and various maintenance processes	3	9
MME21112.2	**Apply** the basic of reliability measures such as MTTF, MTBF, MTTR, availability, failure rate, Bathtub curve etc	3	9
MME21112.3	**Demonstrate** the defects and failure analysis and different types of maintenance system	3	9
MME21112.4	**Analyze** the reliability and allocation in production system.	4	9
MME21112.5	**Analyze** various maintenance planning and scheduling techniques.	4	9

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