# COURSE SCHEME
# EXAMINATION SCHEME
# ABSORPTION SCHEME
# &
# SYLLABUS

Of

First, Second, Third & Fourth Semester
Choice Base Credit System (CBCS)

Of
Master of Technology (M.Tech)

in
MECHANICAL ENGINEERING DESIGN (MED)

*Of*
RASHTRASANT TUKDOJI MAHARAJ
NAGPUR UNIVERSITY, NAGPUR

**Rashtrasant Tukadoji MaharajNagpur University, Nagpur**
**Faculty of Engineering & Technology**
**Course and Examination Scheme for Master of Technology**
**in**
**Mechanical Engineering Design (MED)**
**Choice Base Credit System (CBCS)**

## I Semester

| Subject code | Name of Subject | Teaching Scheme | | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marks | | | | |
| | | Hours per Week | | No. of Credits | Duration of Paper (Hrs.) | College Assessment | University Assessment | Total Marks | Minimum Passing Marks |
| | | L | P | | | | | | |
| PGMED101T | Advanced Mechanisms | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED102T | Dynamics of Machinery | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED103T | Mechanical Vibrations | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED104T | Elective -I (Discipline) | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED105T | Elective —II (Open) | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED106P | Advanced Mechanisms | - | 2 | 1 | - | 50 | 50 | 100 | 50 |
| PGMED107P | Mechanical Vibrations | - | 2 | 1 | - | 50 | 50 | 100 | 50 |
| **Total** | | **20** | **4** | **-** | - | **-** | **-** | **-** | **-** |
| **Semester Total** | | **24** | | **22** | | | | **700** | |

**Note:**

I) List of Elective-I (Discipline)
   1) Computer Aided Mechanical Design
   2) Reliability, Maintainability & Wear

II) Elective-II (open) is to be selected from the list attached in Annexure-

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## II Semester

| Subject code | Name of Subject | Teaching Scheme | | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marks | | | | |
| | | Hours per Week | | No. of Credits | Duration of Paper (Hrs.) | College Assessment | University Assessment | Total Marks | Minimum Passing Marks |
| | | L | P | | | | | | |
| PGMED201T | Advanced Mechanical Drives | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED202T | Stress Analysis | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED203T | Design Of Mechanical Handling System | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED204T | Elective —III (Discipline) | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED205T | Foundation Courses -I | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED206P | Stress Analysis | - | 2 | 1 | - | 50 | 50 | 100 | 50 |
| PGMED207P | Finite Element Analysis | - | 2 | 1 | - | 50 | 50 | 100 | 50 |
| **Total** | | **20** | **4** | **-** | **-** | **-** | **-** | **-** | **-** |
| **Semester Total** | | **24** | | **22** | | | | **700** | |

**Note:**

I) List of Elective-III (Discipline)
   1) Tribology And Bearing Design
   2) Design Of Hydraulic And Pneumatic System

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## III Semester

| Subject code | Name of Subject | Teaching Scheme | | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marks | | | | |
| | | Hours per Week | | No. of Credits | Duration of Paper (Hrs.) | College Assessment | University Assessment | Total Marks | Minimum Passing Marks |
| | | L | P | | | | | | |
| PGMED301T | Elective -IV (Open) | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED302T | Foundation Courses -II | 4 | - | 4 | 3 | 30 | 70 | 100 | 50 |
| PGMED303P | Project Seminar | - | 3 | 8 | - | 200 | - | 200 | 100 |
| **Total** | | **8** | **3** | **-** | **-** | **-** | **-** | **-** | **-** |
| **Semester Total** | | **11** | | **16** | | | | **400** | |

**Note:** Elective-IV (open) is to be selected from the list attached in Annexure-

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## IV Semester

| Subject code | Name of Subject | Teaching Scheme | | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marks | | | | |
| | | Hours per Week | | No. of Credits | Duration of Paper (Hrs.) | College Assessment | University Assessment | Total Marks | Minimum Passing Marks |
| | | L | P | | | | | | |
| PGMED401P | Project | - | 6 | 16 | - | - | 400 | 400 | 200 |
| **Total** | | **-** | **6** | **-** | **-** | **-** | **-** | **-** | **-** |
| **Semester Total** | | **6** | | **16** | | | | **400** | |

**Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur**
**Faculty of Engineering & Technology**
**Absorption Scheme for the Students of M. Tech. Mechanical Engineering Design from Old Semester Pattern to New CBCS Semester Pattern**

**I Semester M. Tech. Mechanical Engineering Design**

| Subject Code | Name of the subject in New CBCS Pattern | Subject Code | Name of the Subject in old Pattern |
|---|---|---|---|
| PGMED101T | Advanced Mechanisms | 1MED-02 | Advanced Mechanisms |
| PGMED102T | Dynamics of Machinery | 1MED-03 | Dynamics of Machinery |
| PGMED103T | Mechanical Vibrations | 1MED-05 | Vibration Analysis |
| PGMED104T | Elective -I (Discipline)<br>1) Computer Aided Mechanical Design | 1MED-04 | Computer Aided Mechanical Design |
| | 2) Reliability, Maintainability & Wear | 3MED-01 | Reliability, Maintainability & Wear |
| PGMED105T | Elective —II (Open)<br>1) Robotics | 2MED-03 | Robotics |
| | 2) Mechanization In Food Processing | 3MED-02 | Mechanization In Food Processing |
| PGMED106P | Advanced Mechanisms (Practical) | --- | --- |
| PGMED107P | Mechanical Vibrations (Practical) | 1MED-05 | Vibration Analysis (Practical) |

**II Semester M. Tech. Mechanical Engineering Design**

| Subject Code | Name of the subject in New CBCS Pattern | Subject Code | Name of the Subject in old Pattern |
|---|---|---|---|
| PGMED201T | Advanced Mechanical Drives | 2MED-01 | Advanced Mechanical Drives |
| PGMED202T | Stress Analysis | 2MED-04 | Stress Analysis |
| PGMED203T | Design of Mechanical Handling System | 3MED-02 | Design of Mechanical Handling System |
| PGMED204T | Elective —III (Discipline)<br>1)Tribology And Bearing Design | --- | --- |
| | 2) Design of Hydraulic And Pneumatic System | 3MED-02 | Design of Hydraulic & Pneumatic Systems |
| PGMED205T | Foundation Courses -I | --- | --- |
| PGMED206P | Stress Analysis (Practical) | 2MED-04 | Stress Analysis (Practical) |
| PGMED207P | Finite Element Analysis (Practical) | 2MED-05 | Finite Element Analysis (Practical) |

## III Semester M. Tech. Mechanical Engineering Design

| Subject Code | Name of the subject in New CBCS Pattern | Subject Code | Name of the Subject in old Pattern |
|---|---|---|---|
| PGMED301T | Elective -IV (Open)<br>1) Finite Element Analysis | 2MED-05 | Finite Element Analysis |
| | 2) Optimization In Engineering Design | 2MED-02 | Optimization In Engineering Design |
| PGMED302T | Foundation Courses -II | --- | --- |
| PGMED303P | Project Seminar | 3MED-03 | Seminar on Project Spade Work & Research Methodology |

## IV Semester M. Tech. Mechanical Engineering Design

| Subject Code | Name of the subject in New CBCS Pattern | Subject Code | Name of the Subject in old Pattern |
|---|---|---|---|
| PGMED401P | Project | --- | Thesis |

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## I Semester M. Tech. (Mechanical Engineering Design)

**Subject Code: - PGMED101T**
**Subject:-Advanced Mechanisms**

**Course Objectives:**

The overall objectives of this course is to understand kinematics synthesis of mechanism, to learn how to synthesis a given mechanism, when input and output is given with different methods optimal synthesis of mechanism, and synthesis of spatial mechanism along with application.

**Expected Outcomes:**

At the end of this course students will be able to understand various methods of synthesis, optimization of synthesis, graphical and analytical methods of synthesis along with computer application.

**Syllabus:**

**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.

**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 .

**III** Optimal synthesis of planar mechanisms, Powells search methods least square method penalty function computer approach.

**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.

**V** Introduction to kinematics synthesis of Robot arms.

**Tutorials: -** Based on above syllabus.

**References:-**


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

**Subject Code: - PGMED102T**
**Subject: - Dynamics of Machinery**

**Course Objectives:**

The overall objectives of this course is to understand quantitative kinematic analysis, static force analysis, dynamic force analysis, stress distribution in links, dynamics motion analysis which includes energy distribution method, the rate of change of energy method, variation mechanics, balancing of linkages by various methods, natural frequency of given system and balancing of rigid rotors.

**Expected Outcomes:**

The expected outcomes are students will be able to understand the effect of dynamic forces on various links of a mechanism, dynamic motion analysis, balancing of linkages and flywheel requirement, determination of natural frequency of various systems using different methods.

**Syllabus:**

**I** **Dynamics of Mechanisms:** Forces in mechanisms, friction in links connection, stress distribution in links. Various approaches for dynamic analysis: Lagranjes, Recursive Lagranjes.

**II** **Dynamic Motion Analysis:** Energy distribution method, the rate of change of energy method, Balancing of linkages and flywheel requirements. Lagranjian Euler formulation, Hamilton's Formulation, variation Mechanics.

**III** **Rotor Dynamics :** Torsional Vibration in reciprocating machines, Critical speed, bending vibration of rotating shaft .Out of balance, balance of rigid rotors, whirling speed of shaft, hydrodynamic instability

**Tutorial: -** Based on above syllabus.

**References:**


1. S.Timoshenko ,"Vibration Problems in Engineering".
2. Marplex ,"Dynamics of machinery".
3. J.S.Rao,"Rotor Dynamics".
4. Housner ,"Advanced Dynamics".

**Subject Code: - PGMED103T**
**Subject: - Mechanical Vibrations**

**Course Objectives:**

The study of Vibration is concerned with understanding of cause of vibration in any system also it is concerned with determination of natural frequency for various degrees of freedom.The overall object of this course is to learn, understand meaning of vibration relevant to Mechanical system and Mechanics. It also helps to know Vibration Phenomenon for various continues and discrete system.This course includes various Vibration analysis techniques, Vibration response, longitudinal and transverse Vibration for various structures, Vibration Instrumentation devices, introduction of FFT analyzer and Noise Control techniques.

**Expected Outcomes:**

The students will able to understand "vibration phenomenon" and its concept, disadvantages and advantages of vibration various techniques to determine natural frequency of the system for any DOF system.

**Syllabus:**

**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.

**II Response of Systems to Arbitrary Periodic Excitation:** Duhamel's integral impulse response function – shock spectra –Laplace and Fourier transform methods.

**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.

**IV Continuous Systems:** Longitudinal and transverse vibration of beams-forced response of beams. Vibration of plates –finite element techniques in vibration analysis.

**V Vibration Instrumentation:** Vibration measurements – instrumentation –electrodynamics exciters – impact hammers piezoelectric accelerometers signal conditioning and amplification preamplifiers and power amplifiers real time analysis digital Fourier transforms FFT analysis structural frequency response measurement random sinusoidal and transient test methods model testing of beams.

**VI Noise Control :** Sound and Noise parameters prorogation of sound noise in carious machinery's noise measurements techniques. Noise
Control Techniques, Sound absorption , sound insulation , methods.

**Tutorial: -** Based on above syllabus.

**REFERENCE :**


1. J.S. Rao and K. Gupta Advanced theory of vibration.Willey Eastern.1992.
2. P.Srinivasan Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi 1982.
3. N. L. Meirovitch , Elements of vibration Analysis, Mc Graw Hill New York 1986.
4. J.P.Den Hartog Mechanical Vibration ($4^{th}$ edition Mc Graw Hill, New York 1985.
5. Timoshenko, Engineering vibration.
6. Irwin & Garf , industrial Noise & Vibration Control.
7. R.A. Collacott, Vibration Monitoring and diagnosis, John Willey, New York, 1979.
8. M. Petyt , Introduction to Finite Element Vibration Analysis Cambridge University Press,Cambridge 1990.

**Subject Code: - PGMED104T**
**Elective -I (Discipline)**
**Subject: Computer Aided Mechanical Design**

**Course Objectives:**

The subject deals with the solid and 2-D modeling of machine elements by using computers which was earlier were carried out manually. The objective of the course is to study 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.

**Expected Outcomes:**

The student will learn modeling, drafting and dimensioning of machine elements by using computer software and will be able to generate several alternate design options very easily. Also students will understand the requirements of hardware & software for computer aided design process.

**Syllabus:**

**I Introduction To CAD/CAM And Product Cycle:** Role of Computers in the design process. Requirement of Hardware & Software in CAD. 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].

**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.

**III Geometric Modeling:** Mathematical representation of Hermite cubic, Bezeir & B-spline curves. Introduction to difference type of surfaces and solids generated in surface and solid model respectively. Assembly modeling and interference checking .

**Tutorial: -** Based on above syllabus.

**Reference:**


1. Groover ,M.P.and Zimmers ,E.W CAD/CAM, Computer Aided Design and manufacturing, Prentice Hall of India 1986
2. Ibrahim Zeid, CAD/CAM Theory and Pratice, Mc Graw Hill, 1991.
3. Dimarogons, A.D. Computer Aided Machine Design, Prentice Hall,1986.
4. Ranky, P.G. Computer Integrated Manufacturing,Prentice Hall,1986.
5. Radhakrishanan,P. and Kothandaraman, C.P. Computer Graphics & Design, Dhanpat Rai & Sons, Delhi, 1990.
6. Software Manuals on GEODRAW, GEOMOD, and SUPERTAB, Structural Dynamics Research Corporation, U.S.A. 1986

**Subject Code: - PGMED104T**
**Elective -I (Discipline)**
**Subject: Reliability, Maintainability & Wear**

**Course Objective:**

The course deals with study of reliability, availability, maintainability and wear of machine and its components. The objective of this course is to perform reliability engineering analysis, to understand the maintainability and estimate wear of machines and their components.

**Expected Outcomes:**

The student will be able to estimate the life of machine and their components and various maintenance processes. Also student will understand basic reliability measures such as MTTF, MTBF, MTTR, availability, failure rate, Bathtub curve, etc.

**Syllabus:**

**I** Introduction to reliability availability and maintainability failure distributions, Weibull distribution and its applications to industries.

**II** Design and manufacturing for reliability, reliability assessment of mechanical systems FMES and FTA techniques.

**III** Monte carlo simulation method, markov chains in reliability. Maintenance policies and philosophies conditions based antennae , Vibration monitoring non destruction testing.

**Tutorial: -** Based on above syllabus.

**References:**


1. Reliability & Maintainability Engineering Charles E. Ebeling – Tata Mc Graw Hill
2. Reliability Methods Engineering and its application – G.P. Chhalotra –Khanna
3. Introduction to Reliability in Design –Charles O. Smith – Mc. Graw Hill
4. Reliability Engineering –E. Bala guruswamy –Tata Mc. Graw Hill
5. Reliability Engineering –D.J. Smith- Pitman Publishing
6. Reliability Engineering –L.S. Srinath –Affiliated East West Press Pvt. Ltd.
7. Mechanical Reliability – A.D.S. Carter- Mc Millan
8. Friction and Waer of Material –Ernest Rabinowicz-John Wiley & Sons
9. Kapur K. C. , Lamberson L.R. Reliability in engineering Design.
10. Thomson A. Reliability Based Mechanical Design
11. Hull B. , Jhon V. , Non Destructive testing.

**Subject Code: - PGMED105T**
**Elective —II (Open)**

**Subject Code: - PGMED106P**
**Subject:-Advanced Mechanisms**

**List of Practical:**

1. Synthesis using function generation.
2. Synthesis using path generation.
3. Synthesis using path generation & rigid body guidance.
4. Kinematic analysis and synthesis of spatial mechanisms.
5. Kinematic synthesis of robot arm.
6. Graphical approaches for synthesis of mechanisms.
7. Study of Powell's search methods.
8. Study of least square method.
9. One numerical on Freudenstein's equation

**Subject Code: - PGMED107P**
**Subject: - Mechanical Vibrations**

Based on syllabus of mechanical vibrations mention in subject code MT103T with emphasis on vibration measurement on equipment and machinery.

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## II Semester M. Tech. (Mechanical Engineering Design)

**Subject Code: - PGMED201T**
**Subject: - Advanced Mechanical Drives**

**Course Objectives:**

The study of Mechanical Drives concerned with understanding of its various design techniques and its detail analyzer by virtue of vibration. The overall objective of this course is to learn and understand practical use of various applications with its detail design and vibration analysis. This course include belt Vibration with pulley design its vibration response, detail dynamics of gear tooth, spur gear tooth vibration, kinematic analysis of complex gear trains, detailed dynamics and vibration analysis of chains, concept of PIV drive and coupling misalignment.

**Expected Outcomes:**

The students will be able to understand critical and detailed analysis of various mechanical drives along with its Vibration analysis.

**Syllabus:**

**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.

**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.

**III** **Gear Boxes:** Kinematic Analysis of complex gear trains, Force Analysis including gyroscopic effects, Vibration Analysis of Gearboxes, Lubrication Methods, Contamination of Lubrication Oils, wear debris analysis.

**IV** **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.

**V** **PIV Drives:** Concept, Need, Classification & Types. Detailed kinematics & dynamics of 4/5 important drives.

**VI** **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.

**Tutorial: -** Based on above syllabus.

**References:**


1. Gear, Spur Helical ,Worm by Earle Buckingham ,Mc-Graw Hill.
2. Rothebirt "Mechanical Design & Systems Handbook" Mc-Graw Hill
3. Handbook of shaft Alignment
4. M.P.Alexandrov, "MATEIALS HANDING EQUIPMENT", MIR Publications, Moscow 1981.
5. Fairs, "Mechanisms" McGraw Hill.
6. J.S. Beggs, " Mechanisms" Prentice Hall.
7. David W. South & Jon R. Mancuso" Mechanical Power Transmission Components" Marcel Dekker inc New York.

**Subject Code: - PGMED202T**
**Subject: - Stress Analysis**

**Course Objectives:**

The overall objectives of this course is to understand the fundamental of stress and strain, application of equation of equilibrium, compatibility, Airy's stress function for determining stress field in Cartesian co-ordinate and polar co-ordinate for two dimensional problems, various methods of experimental stress analysis using strain gauges, strain rosettes and photoelasticity, evaluation of thermal loads and thermal stress in simple object and given systems, fundamental of fracture mechanics.

**Expected Outcomes:**

At the end of this course students will be able to understand how to determine stress field a given object, various strain gauges and strain rosettes for determination of stress field, direction of principle stresses by isoclinic fringer, magnitude of principal stress using isochromatic, stress optic law, evaluation of thermal stresses in a given object and fracture mechanics.

**Syllabus:**

**I** Fundamentals of stress & strain, stress strain relationship, Elastic constant , plane stress, plane strain. Stress Analysis for two dimensional problems in Cartesian co-ordinate system, equations of Equilibrium, compatibility equation, Airy „s stress function, Analysis of rectangular plates by polynomials.

**II** Two dimensional problems in polar co-ordinates, general equations in polar co-ordinates for any symmetric case, pure bending of curved beams, crane hooks , bending of beams with initial curvature , Analysis of piston rings, stresses in rotating discs, with variable and constant sections , Effect of holes on stress distribution in plates, contact stresses.

**III** Torsion: Torsion of non circular section , St. Venants theory, Membrane analogy , Torsion of thin walled tubes.

**IV** Experimental stress analysis by strain gauge & photo elasticity technique, strain rosettes, recording instruments, Brittle coating techniques, poloriscope, Isochromatic & isoclinic fringes, compensation techniques.

**V** Thermal stresses: Thermo elasticity, thin circular discs, thermal stresses in turbine rotors, Analysis of beams under thermal load.

**VI** Introduction to fracture Mechanics.

**Tutorial: -** Based on above syllabus.

**References :**


1. Timoshanko & Goodier, "Theory of Elasticity" .
2. Dalley & Raillery , "Experimental stress analysis".
3. Dove & Adams , "Experimental Stress Analysis".

**Subject Code: - PGMED203T**
**Subject: - Design of Mechanical Handling System**

**Course Objectives:**

The study of Design of various Mechanical handling system is concerned with understanding of various industrial system and devices with its basic design. It includes various based use in practical design field. The overall objectives of this course is to understand and learn about various industrial mechanical handling devices starting from their basic design for any desired condition and its safety analysis with its theoretical knowledge. This curse includes designed considerations of conveying mechanics like trucks, trolleys, Rope ways, Cranes, Elevators, Draglines, Robotics handling, Belt conveyers, Chain conveyers, screw conveyers, pneumatic conveying system.

**Expected Outcomes:**

Students will able to understand the practical basic design of various material handling systems for various loading conditions along with various material loading conditions.

**Syllabus:**

**I** Constructional features, operation, operational characteristics advantages Disadvantages, limitations, Design considerations of following conveying machines.

**II** Unit Load conveying: Fork lift Trucks, Trolley, conveyers. Cableways, Rope ways, Cranes , Over head cranes , Elevators, Drag lines , Robotic Handling , AGV Bulk solid us conveying: Belt conveyers , chain conveyers, Roller conveyers, ( Gravity & Powered ), Screw conveyers, Tubular screw conveyers, Escalators, Vibrating conveyers, (Crank type & spring type), Pneumatic conveying.

**Tutorial: -** Based on above syllabus.

**References:**


1. Aleczandow : “Materials Handling”, MIR Publ.
2. Acma, Reference book for Belt conveyers .
3. “Conveyaing Machings “, by CITADINOV, MIR publ.

**Subject Code: - PGMED204T**
**Elective -III (Discipline)**
**Subject: Tribology and Bearing Design**

**Course Objective:**

The course deals with the study of lubrication and its role in bearing design. The course objective is to provide the knowledge of friction, wear and lubrication process, to learn about tribological modeling and simulation and to create an awareness of the importance of tribology in design and selection of machine elements.

**Expected Outcomes:**

The student will be able to apply the basic theories of friction, wear and lubrication to predictions about the frictional behavior of commonly encountered sliding interfaces as bearings and wheel on rail contact.

**Syllabus:**

**I** Friction and wear Friction control and wear prevention, boundary lubrication, tribological properties of bearing materials and lubricants, theories of friction and wear, instabilities and stick-slip motion .

**II** Lubrication of bearings Mechanics of fluid flow, Reynold's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), finite bearings - hydrostatic, hydrodynamic and thrust oil bearings, heat in bearings Hydrostatic squeeze film Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings

**III** Elasto-hydrodynamic lubrication Pressure-viscosity term in Reynold's equation, hertz theory, Ertel-Grubin equation, lubrication of spheres Air lubricated bearings Tilting pad bearings, hydrostatic, hydrodynamic and thrust bearings with air lubrication Tribological aspects of rolling motion Mechanics of tire-road interaction, road grip and rolling resistance

**IV** The Design of Aerostatic Bearings, Gas Bearings, tribological aspects of wheel on rail contact.

**Tutorial: -** Based on above syllabus.

**Reference Books** :


1) Principles of Lubrication, Camaron, Longman's Green Co. Ltd.
2) B. C. Majumdar, "Introduction to Tribology and Bearings", S.Chand and Company Ltd. New Delhi
3) Fundamental of Friction and Wear of Metals – ASM
4) The Design of Aerostatic Bearings – J. W. Powell
5) Gas Bearings – Grassam and Powell
6) Theory Hydrodynamic Lubrication, Pinkush and Sterrolicht

7) Tribology in Machine Design, T. A. Stolarski
8) “Surface Engineering of Metals: Principles, Equipments, Technologies”, Taylor and Francis

**Subject Code: - PGMED204T**
**Elective -III (Discipline)**
**Subject: Design of Hydraulic and Pneumatic System**

**Course Objective:**

The course deals with the study of various hydraulic and pneumatic systems. The course objective is to provide the understanding of hydraulic and pneumatic circuits, their specifications and characteristics, various components and their maintenance.

**Expected Outcomes:**

The students will be able to design and select the proper hydraulic or pneumatic circuits as per application. Also student will be able to install these system and can recognize any maintenance problem if any in the system.

**Syllabus:**

**I Oil Hydraulic Systems:** Hydraulic Power Generator, selection and specification of pumps, pump characteristics.

**II Hydraulic Actuators:** Linear & Rotary Actuators, Selection, Specification and Characteristics.

**III Control & Regulation Elements:** Pressure, direction and flow control valves, relief valves, non return and safety valves actuation systems.

**IV Hydraulic Circuits :** Reciprocating quick return, sequencing synchronizing circuits, accumulator circuits, industrial circuits, press circuits, hydraulic milling machine, grinding ,planning copying, forklift earthmover circuits, design and selection of components, safety and emergency modules.

**V Pneumatic System, and Circuits :**Pneumatic fundamentals ,control elements, position and pressure sensing, logic circuits, switching circuits, fringe condition modules and their integration, sequential circuits , cascade methods, mapping methods, step counter method, compound circuit design, combination circuit design .

**VI Installation, Maintenance and Special Circuits:** Pneumatic equipments, selection of components, design calculations, application, fault finding, hydro pneumatic automation, robotic circuits .

**Tutorial:** Based on above syllabus.

**References:**


1. Peter Rohner, "Fluid power logic circuits design" the Macmillan Press Limited ,1979.
2. Stewart,H.L., "Hydraulic and pneumatic power for production", Industrial press, New York 1955.
3. Walter Ernest, "Oil hydraulic power and industrial applications", Mc Graw Hill Book,Co 1962.
4. Pease ,D.A. "Basic fluid power", Prentice Hall ,1987.

**Subject Code: - PGMED205T**
**Subject: - Foundation Courses –I**

**Subject Code: - PGMED206P**
**Subject: - Stress Analysis**

**List of Practical:**

1. Measurement of stress for different types of loading by using strain gauges.
2. Models making for poloriscope.
3. Molding for model material.
4. Verifying theoretical stress distributions on poloriscope.
5. Study of stain gauge.
6. Study of stain analysis using torque gauge.
7. Study of stain analysis using three element rectangle rosettes.
8. Determination of principal stresses using tardy method.
9. Study of plain poloriscope.
10. Study of circular poloriscope.
11. To determine material fringe value by using diffused light research poloriscope.

**Subject Code: - PGMED206P**
**Subject: - Finite Element Analysis**

Practical on the standard CAE packages like ANSYS, NASTRAN, ABAQUS,MATLAB, CATIA, UNIGRAPHICS, PRO-E or any other relevant software.

**List of Practical:**

1. Static structural analysis of bar with 1-D elements using standard FEA package.
2. Static structural analysis of truss with 2-D elements using standard FEA package.
3. Static structural analysis with 2-D CST element using standard FEA package.
4. Static structural analysis with 2-D Axis-symmetric element using standard FEA package.
5. Static structural analysis of a beam in transverse loading using standard FEA package.
6. Dynamic structural analysis to determine natural frequency and mode shapes, using standard FEA package.
7. Analysis of 3-D truss using standard FEA package.
8. Thermal analysis to estimate nodal temperatures using standard FEA package.
9. Application of finite element analysis in the areas like Contact Mechanics, drop test, Crash Analysis, MEMS etc.
10. Finite Element Analysis of live problem/case reported or identified by an Industry.

**Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur**
**Faculty of Engineering & Technology**
**Course and Examination Scheme of Master of Technology**
**Choice Base Credit System (CBCS)**

**III Semester M. Tech. (Mechanical Engineering Design)**

**Subject Code: - PGMED301T**
**Elective -IV (Open)**

**Subject Code: - PGMED302T**
**Subject: - Foundation Courses –II**

**Subject Code: - PGMED303P**
**Subject: - Project Seminar**

**Research Concept :-** process of growth of knowledge Mechanical & Industrial Engineering Department generation/realization of new facts , Establishing logic for the generated facts, Scope of quantification of cause effect relationship , Evaluation of hypotheses.

**Approach Of Formulation Of The Research Task**: - Literature review: Sources, Discussions Field studies, Critical analysis of generated facts. Hypothetical proposals for future development, Constraints for proposal selection, Prioritization.

**Research Approaches:** Conceptual research, Theoretical research, applied research, Experimental research: Experimental validation of proposed logic, Experimentation to generate design data.

**Modeling & Simulation:** Concept of modeling, Concept of simulation, Types of simulation ( quantitative Experimental, Computer , Fuzzy based , statistical ) Process of Model optimization.

Formulation of Hypothesis
Literature survey work of the topic selected for dissertation.

**References :**


1. T.S. Wilkinson & P.L. Bhandarkar , Methods & Techniques of Social Research" Himalaya Publishing , Bombay.
2. Averill M.Law & W. David Kelton "Simulation,Modelling & Analysis"
3. H. Schenck, Jr. "Theories of Engg. Experimentation" Mc-graw Hill "Design of Experiments" Montgomery.
4. Bart Kasko & Klir "Nural Network & Fuzzy Systems" Prentice Hall T.J.Roft" Fuzzy logic with Engg. . Application "Tata mc-Graw Hill " Fuzzy sets, Uncertainties & Information" Prentice Hall.
5. S.S. Rao "Optimization Theory & Applications" Wiley Eastern Back Volimes of Journal
6. "Modelling & Simulation" AMSE Press France .

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**Choice Base Credit System (CBCS)**

## IV Semester M. Tech. (Mechanical Engineering Design)

**Subject Code: - PGMED401P**
**Subject: - Project**

**Student should publish at least two research papers in National/ International journals on project spade work and research.**