

SYLLABUS

(With effect from 2024 -25)

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕ ವರ್ಷ 2024-25)

Bachelor Degree
In
Mechanical Engineering

VII & VIII Semester

Out Come Based Education
With
Choice Based Credit System

[National Education Policy Scheme]



P.E.S. College of Engineering, Mandya - 571 401, Karnataka

*[An Autonomous Institution affiliated to VTU, Belagavi,
Grant – in – Aid Institution (Government of Karnataka),
Accredited by NBA (All UG Programs), NAAC and Approved by AICTE, New Delhi]*

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

ಮಂಡ್ಯ-571 401, ಕರ್ನಾಟಕ

(ವಿ.ಟಿ.ಯು, ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)

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VISION

“PESCE shall be a leading institution imparting quality Engineering and Management education developing creative and socially responsible professionals.”

MISSION

- *Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching-learning practices.*
- *Impart engineering and managerial skills through competent and committed faculty using outcome based educational curriculum.*
- *Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs.*
- *Promote research, product development and industry-institution interaction.*

QUALITY POLICY

Highly committed in providing quality, concurrent technical education and continuously striving to meet expectations of stake holders.

CORE VALUES

Professionalism

Empathy

Synergy

Commitment

Ethics



About Department of Mechanical Engineering

The Department of Mechanical Engineering was established in the year 1962 during the origination of the institute. The department was granted academic autonomy in the year 2009. The department presently offers B.E in Mechanical Engineering, M Tech in Machine Design, M.Sc., (Engg.) by research and research leading to Ph.D. The present intake capacity of the department is 120 for BE, 24 for M Tech Machine Design. The department has a faculty-student ratio of 1:20 for UG courses and 1:12 for PG courses. The department has well established laboratories to meet the academic requirements of UG and PG programmes and a skilled technical faculty to train the students. The department has its own library which has a collection of about 4600 reference books. The department is accredited with NBA for 3Years in 2019. The department regularly organizes industrial visits, technical talk by experts from industries and institutes in contemporary areas to bridge the gap between syllabi and current corporate developments. The students are encouraged to undergo industrial training as well as to take up industry oriented projects during their academic course. Mechanical Engineering Association (MEA), formed by the students and faculty of the department regularly organizes co-curricular and extracurricular activities for the students.

Department Vision

“Be a department well recognized for its ability to develop competent mechanical engineers capable of working in global environment”

Department Mission

The Mission of the Department of Mechanical Engineering is to:

- ☐ ☐ Provide quality education by competent faculty.
- ☐ ☐ Provide adequate infrastructure and learning ambience for the development of essential technical skills.
- ☐ ☐ Inculcate a sense of higher education and research orientation.
- ☐ ☐ Foster industry interaction.

Program Educational Objectives (PEOs)

The Department of Mechanical Engineering has formulated the following programme educational objectives for the under-graduate program in Mechanical Engineering:

The Mechanical Engineering graduates will be able to:

PEO1: Use the fundamentals of basic science, mathematics and mechanical engineering, to pursue their career as engineers as well as to lead and manage teams in global organizations.

PEO2: Pursue advanced education, research and development and engage in the process of life-long learning.

PEO3: Become entrepreneurs in a responsible, professional and ethical manner to serve the society.

Program Specific Outcomes (PSOs)

Engineering graduates should be able to:



PSO1: Apply conceptual knowledge with practical engagement that has real life problems by integrating different domains of mechanical engineering.

PSO2: Utilize the modern tools and emerging technologies with technical skills to design, develop and analyse mechanical systems through multidisciplinary approach.

Program Outcomes (POs)

Engineering Graduates will be able to:

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 IT 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. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



P.E.S. College of Engineering, Mandya

Department of Mechanical Engineering

Bachelor of Engineering (VII –Semester)										
Sl. No.	Course Code	Course Title	Teaching Department	Hrs / Week			Credits	Examination Marks		
				L	T	P		CIE	SEE	Total
1	P21ME701	Operations Research	ME	3	-	-	3	50	50	100
2	P21ME702X	Professional Elective Course – IV	ME	3	-	-	3	50	50	100
3	P21ME703X	Professional Elective Course - V	ME	3	-	-	3	50	50	100
4	P21ME704	Theory of Machine-II (Integrated)	ME	3	-	2	4	50	50	100
5	P21RMI705	Research Methodology and IPR	ME	3	-	-	3	50	50	100
6.	P21ME706	Project Work Phase – I	ME	-	-	-	4	100	-	100
Total							20			

Professional Elective Course – IV (P21ME702X)	
Course Code	Course Title
P21ME7021	Computational Fluid Dynamics
P21ME7022	Condition Based Monitoring
P21ME7023	Hydraulics & Pneumatics
P21ME7024	Total Quality Management

Professional Elective Course – V (P21ME703X)	
Course Code	Course Title
P21ME7031	Advanced Manufacturing
P21ME7032	Composite Materials
P21ME7033	Robotics & Artificial Intelligence
P21ME7034	Tribology

Bachelor of Engineering (VIII –Semester)										
Sl. No.	Course Code	Course Title	Teaching Department	Hrs / Week			Credits	Examination Marks		
				L	T	P		CIE	SEE	Total
1	P21ME801	Self-Study Course	ME	-	-	-	2	100	-	100
2	P21INT802	Research / Industry Internship – III	ME	-	-	-	6	-	100	100
3	P21ME803	Project Work Phase – II	ME	-	-	-	8	100	100	200
Total							16			

*Allot Tutorial as per the course requirement subjected to the credits allotted.

L –Lecture, T – Tutorial, P- Practical/ Drawing, CIE: Continuous Internal Evaluation, SEE: Semester End Examination



OPERATIONS RESEARCH

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VII

Course Code: P21ME701	Semester: VII	L-T-P: 3-0-0	Credits: 03
Contact Period - Lecture: 40 Hrs; Exam: 3 Hrs.		Weightage % : CIE: 50, SEE:50	
Course Learning Objectives: The objectives of this course are to, • Understand the basic concepts of Operations Research. • Identify and develop operation research models from the verbal description of real life and optimize the solutions.			
Course Content			
Unit-1 Introduction: Definition, scope of Operations Research (OR) approach and limitations of OR models, characteristics and phases of OR, mathematical formulation of linear programming problems. Graphical solution for maximization and minimization problems. Advantages and applications of OR. 8 Hrs Self Study Component: History of Operations Research. Case study related to formulation problems			
Unit-2 Linear Programming Problems: Simplex method, slack, surplus and artificial variables, degeneracy and procedure for resolving degeneracy. Big M method, two phase method. 8 Hrs Self Study Component: Dual simplex method, program of simplex problem using C.			
Unit-3 Transportation and Assignment: Formulation of transportation problem, initial feasible solution methods, optimality test, degeneracy in transportation problem, assignment problem, Hungarian method, travelling salesman problem. 8 Hrs Self Study Component: Unbalanced transportation and assignment problems.			
Unit-4 Network Analysis in Project Planning (PERT and CPM): Project, project planning, project scheduling, project controlling, network terminologies, PERT and CPM. 8 Hrs Self Study Component: Crashing of networks. Case study related to network analysis in project planning problems.			
Unit-5 Game Theory: Formulation of games, two people-zero sum game, games with and without saddle point, graphical solution (2 x n, m x 2 game) and dominance property. Queuing Theory: Queuing system and their characteristics. The M/M/I Queuing system, steady state performance analyzing of M/M/I System. 8 Hrs Self Study Component: Competitive games. Case study related Game and queuing theory problems.			
Text Books: 1. Taha H.A, “ Operations Research and Introduction ”, Pearson Education, 9 th edition, 2017, ISBN:978-93-325-1822-3. 2. Prem Kumar Gupta and D.S. Hira,S Chand, “ Operations Research ”, 2014, Pub, New delhi.,7 th edition, ISBN:978-51-219-0281-6.			
Reference Books:			



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1. R Panneerselvam, “**Operations Research**”, PHI, 2nd edition, 2010, ISBN: 978-81-203-2928-7.
2. S.D. Sharma, “**Operations Research**”, Kedarnath Ramnath & Co , 2002 , ISBN: 978-93-325-1811-1.
3. H. A. Eiselt, Carl-Louis Sandblom, “**Operations Research: A Model-Based Approach**”, ISBN: 978-3-642-10325-4 (Print) 978-3-642-10326-1 (Online).
4. Frederick S. Hillier, Gerald J. Lieberman, 2018, “**Introduction to Operation Research**”, McGraw Hill, Seventh Edition.

e-Resources:

1. <https://www.youtube.com/watch>
2. <https://www.edx.org/course/quantitative-marketing-research>
3. <https://www.edx.org/course/uconn-cybersecurity-boot-camp>
4. <https://www.edx.org/professional-certificate>

Course Outcomes: After learning all the units of the course, the student will be able to,

COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	Formulate real world problems as a Linear programming model and demonstrate solution by graphical method and analysis technique.	Analyzing	L4
CO2	Apply the specific LPP like transportation and assignment and analyse the solution.	Applying	L3
CO3	Apply the different project mathematical model and analyze the solution.	Applying	L3
CO4	Apply the game and Queuing strategy with their characteristics and analyse the solutions.	Applying	L3



COMPUTATIONAL FLUID DYNAMICS [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VII			
Course Code: P21ME7021	Semester: VII	L-T-P: 3-0-0	Credits: 03
Contact Period-Lecture: 40 Hrs.	Exam: 3 Hrs.	Weightage: CIE: 50 %;	SEE: 50%
Course Learning Objectives: The objectives of this course are to, • Prepare students in the fundamentals of the computational approach to study fluid flow and heat transfer problems and will provide a deeper understanding of the physical models and governing equations of fluid dynamics. • Impart the knowledge of numerical techniques to the solution of fluid dynamics and heat transfer problems.			
Course Content			
UNIT-I Governing Equations: Need of CFD as tool, role in R&D, Overview of 3-D general mass conservation, momentum and energy equations in differential form and integral form. Partial Differential Equations (PDE): classification of PDE, hyperbolic, parabolic and elliptic forms of equations and their physical behavior, physical boundary conditions. 08 Hrs Self-Study Component: Comparison of experimental, Theoretical and computational approaches, CFD Applications, Concept of material or substantial derivative or total derivative.			
UNIT-II Finite Difference Method: Derivation of finite difference equations for first and second order accuracy, different numerical schemes-explicit and implicit approach-upwind, downwind, FTCS, etc., truncation error, round-off and discretization errors and analysis of stability, error propagation, application of numerical methods to selected model equations; wave equation, heat equation, Laplace equation. 08 Hrs Self-Study Component: Stability properties of explicit and implicit methods, Numerical dissipation and numerical dispersion.			
UNIT-III Finite Volume Method for Diffusion: Finite volume formulation of steady state one dimensional diffusion problems, finite volume methods for diffusion equation-one dimensional unsteady heat conduction through explicit, Crank-Nicolson and fully implicit. 08 Hrs Self-Study Component: Properties of discretization schemes-conservativeness, Boundedness, transportive.			
UNIT-IV Finite Volume Method for Convection Diffusion: Finite volume formulation of steady state one dimensional convection-diffusion problems- central, upwind, hybrid, power-law, QUICK differencing schemes. 08 Hrs Self-Study Component: Properties of discretization schemes-conservativeness, Boundedness, transportive.			
UNIT-V Finite Element Methods: Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications. 08 Hrs Self-Study Component: Computer Graphics in CFD, Future CFD-Enhancing the design process.			



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Text Books:

1. John C. Tannehill, Dule A Anderson and Richard H Pletcher, “**Computational Fluid Mechanics and Heat Transfer**”, CRC press, 3rd Edition, 2011, ISBN: 139781591690375.
2. SuhasV Patankar, “**Numerical Heat Transfer and Fluid Flow**”, CRC Press, 1980, ISBN: 139780891165224.

Reference Books:

1. T.J. Chung, “**Computational Fluid Dynamics**”, Cambridge University Press, 2nd edition, 2010, ISBN: 139780521769693.
2. John D. and Anderson, Jr., “**Computational fluid Dynamics- The basics with applications**”, McGraw-Hill, Inc.1995, ISBN:139780070016859.
3. Muralidhar, K., and Sundararajan, T., “**Computational Fluid Flow and Heat Transfer**”, Narosa Publishing House, New Delhi, 2ndedition, 2009, ISBN: 139788173195228.
4. Versteeg, H.K., and Malalasekera, W., “**An Introduction to Computational Fluid Dynamics- The finite volume Method**”, Pearson, 2nd edition, 2007, ISBN: 139780131274983.

e- Resources:

1. <https://archive.nptel.ac.in/courses/112/103/112103289/>

Course Outcomes: At the end of the course, students will be able to,

COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom’s Taxonomy Level	Level Indicator
CO1	Formulate mathematical models and apply them with suitable boundary conditions to engineering scenarios.	Analyzing	L4
CO2	Analyze the behavior of fluid flow in various systems for optimizing designs and performance.	Analyzing	L4
CO3	Predict and apply discretization schemes and implement them to solve engineering problems.	Applying	L3
CO4	Simulate and evaluate numerous design iterations quickly and cost-effectively.	Applying	L3



Course Title: CONDITION BASED MONITORING [As per Choice Based Credit System (CBCS) & OBE Scheme]			
SEMESTER – VII			
Course Code: P21ME7022	Semester: VII	L-T-P: 3-0-0	Credits: 03
Contact Period-Lecture: 40 Hrs.	Exam: 3 Hrs.	Weightage: CIE: 50 %;	SEE: 50%
Course Learning Objectives: The objectives of this course is to, • To provide extensive knowledge of Condition Based Maintenance (CBM); The techniques & tools used, the diagnostics and advanced methods of CBM			
Course Content			
UNIT-I Condition Based Maintenance: Introduction, Principles, Economics and Application; Condition Monitoring Methods. Economics of Condition Monitoring, Setting up a CM Activity, Implementation of Condition Based Maintenance, Consequences of implementation of CBM. Information System, Selection of Monitoring Methods, Assessment of monitoring techniques. 8 Hrs Self-Study Component: Performance Trend Monitoring; Steam turbine performance parameters.			
UNIT-II Non-Destructive Testing: Introduction, Visual testing, Liquid Penetrant inspection and other methods, Radiographic examination, Electrostatic or Ven De Graff generators, Linear accelerators. Gamma-ray Radiography- Sources-Radium, Thallium 170, Iridium 192, Cobalt 62. Isotope Projectors-Geometric factors, Radiographic film, Radiograph. Safety Hazards and Government control; Cost. Sonics, Ultra Sonics, Ultra Sonic inspection and other techniques. Sound Monitoring: Introduction, sound frequencies, sound loudness measurement, acoustic power, sound measurement, sound level meters, sound analyzers. 8 Hrs Self-Study Component: Sound signal data processing.			
UNIT-III Specialized Techniques: Acoustic imaging, Ultra sonic triangulation fault location, Acoustic Emission Technique (AET) - Instrumentation, Transducers, Pre-amplifier and filter, Main amplifier and Signal processing/ Display unit, Signals and processing, Magnetic testing Methods, Current flow Magnetisation, Induction Magnetic Flow Method, Induction Threading bar method, Induction Magnetising Coil method, Induced Current flow method, Magnetic particle Inspection Inks, Strippable Magnetic film, Eddy Current apparatus. Thermography- Thermographic Equipment, Application of Thermography. 8 Hrs Self-Study Component: Corrosion monitoring, Need for corrosion monitoring			
UNIT-IV Vibration Monitoring and Analysis: Introduction, Machinery signatures, Selection of Transducers. Analysis Techniques, Machine failure modes, Measurement location, Vibration severity criteria, Vibration frequency analysis, Permanent Monitoring. Vibration Monitoring of Ball and Roller Bearings: Introduction, Shock pulse method, SPM for testing Antifriction bearings, Manual Monitoring Continuous monitoring, The Kurtosis method, Fiber optics system, Vibration signature analysis, Contact resistance method. 8 Hrs Self-Study Component: SPM & its Applications.			
UNIT-V Mechanical Fault Diagnosis By Wears Monitoring & Lubricant Analysis: Introduction, Source of Contamination, Significant oil contaminants, Used oil Contamination-time trends, Changes in			



the carrier fluid, Ferratic wear debris. Wear process monitoring techniques- Direct debris detection methods, Debris collection methods. Lubricant sampling & analysis-Sampling, Lubricant sampling methods, Lubricant analysis methods, Interpretation of results, Indications from the amount of debris present, Indication from the size distribution of debris, Application of chemical analysis of debris, Wear detection using proximity monitors.

8 Hrs

Self-Study Component: Condition Monitoring Case Studies; Failure of fan bearings- History of failures, Analysis of the failures, Solution.

Text Books:

- 1.R. Collacatt, “**Mechanical Fault Diagnosis and Condition Monitoring**”, Springer Netherlands, 1st Edition 1977, ISBN: 978-94-009-5725-1.

Reference Books:

1. L. F. Pau, “**Failure Diagnosis and Performance Monitoring**”, Marcel Dekker Inc., 1981, ISBN: 978-0824710187.
2. Mohammed Ben-Daya, Uday Kumar and D.N. Prabhakar Murthy, “**Condition Monitoring and Condition Based Maintenance**”, John Wiley & Sons, 2016, ISBN: 9781118926581.

e- Resources:

1. <https://www.youtube.com/watch?v=f58SW0Hwcf0>
2. https://www.youtube.com/watch?v=j_Xpzzo0iko

Course Outcomes: At the end of the course, students will be able to,

COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	Understand the fundamentals of Condition Based Maintenance & Performance Trend Monitoring.	Understanding	L2
CO2	Analyze and Apply the principles of Non-Destructive Testing, Safety Hazards and Government control to specific applications.	Applying	L3
CO3	Assess, Compare and Select the appropriate techniques of condition monitoring for real time applications.	Applying	L3
CO4	Analyze Professional and practical skills of fault diagnosis, machinery monitoring, and maintenance scheduling.	Analyzing	L4



Course Title: HYDRAULICS AND PNEUMATICS [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VII			
Course Code: P21ME7023	Semester: VII	L-T-P: 3-0-0	Credits: 03
Contact Period-Lecture: 40 Hrs.	Exam: 3 Hrs.	Weightage: CIE: 50 %;	SEE: 50%
Course Learning Objectives: The objectives of this course is to, • Understand the fundamental principles and applications of hydraulic and pneumatic systems. • Gain skill in the operation and control of hydraulic and pneumatic components. • Develop the ability to design and analyze hydraulic and pneumatic circuits for Industrial applications. • Acquire knowledge of auxiliary devices and understand their roles in system operation, maintenance and troubleshooting in hydraulic and pneumatic systems.			
Course Content			
UNIT-I Introduction to Hydraulic Power: Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. The source of Hydraulic Power: Pumps-classification of pumps, construction and working of Gear pumps, Vane pumps and Piston pumps, pump selection factors, hydraulic actuators- classification of cylinder, construction of double acting cylinder, hydraulic cylinder cushions, special types of cylinders. 8 Hrs Self-Study Component: Construction and working of screw pump, Gear motor, Vane and piston motors.			
UNIT-II Control Components in Hydraulic Systems: Classification of control valves, Directional control valves- constructional features of check valve, pilot-operated check valve, three-way valve, four-way valve, shuttle valve, symbolic representation. Pressure control valves - simple and compound pressure relief valve, pressure reducing valve and unloading valve. Flow control valves (FCV) - needle valve, non pressure compensated FCV and pressure compensated FCV. Hydraulic Circuit Design and Analysis: Control of single and double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, counterbalance valve application, double pump hydraulic system, locked cylinder using pilot check valves, cylinder synchronizing circuits using different methods, speed control of hydraulic cylinder. 8 Hrs Self-Study Component: Sequence valve, Counterbalance valve and hydraulic fuse.			
UNIT-III Ancillary Hydraulic Devices: Reservoir system-functions, types, reservoir sizing and construction, Accumulators, types, construction and applications with circuits, heat exchangers, pressure gages. Maintenance of Hydraulic Systems: Desirable properties of hydraulic fluids, types of hydraulic fluids causes of hydraulic system problems, filters and strainers-types, location of filters in hydraulic circuits, Beta Ratio of filters, wear of moving parts due to solid-particle contamination of the fluid, Problem caused by gases in hydraulic fluids, probable causes of hydraulic system problems. 8 Hrs Self-Study Component: Pressure Intensifier, Sealing devices			
UNIT-IV Introduction to pneumatic system: Definition of pneumatic system, advantages, limitations, applications, choice of working medium, characteristics of compressed air, Structure of pneumatic control System. Air Preparation and Components: Compressors- types, production of compressed			



air, Fluid conditioners- dryers, filters, pressure regulators, lubricators, FRL unit, distribution of compressed air, piping layout. Pneumatic Actuators: Linear cylinder - types, Rod - Less cylinders types, working, advantages, Rotary cylinders- types construction and application.

8 Hrs

Self-Study Component: Mounting arrangements for pneumatic cylinders, Mufflers

UNIT-V

Pneumatic Control Valves: Directional control valve-poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, quick exhaust valve, time delay valve, twin pressure valve, symbols, **Pneumatic control circuits:** Direct and indirect actuation of pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling, control of air motor.

8 Hrs

Self-Study Component: Solenoid valves, Selection criteria of D C valves.

Text Books:

1. Anthony Esposito “**Fluid Power with applications**”, Pearson Education, 5th Edition, Inc. 2000, and ISBN: 9780130102256.
2. Andrew Parr “**Pneumatics and Hydraulics**”, Jaico Publishing Co., 1st Edition, 2000, ISBN: 9788172241896.

Reference Books:

1. S. R. Majumdar “**Oil Hydraulic Systems Principles and Maintenance**”, Tata McGraw Hill Publishing company Ltd., 2001, ISBN: 9780071406697.
2. S. R. Majumdar “**Pneumatic systems**”, by Tata McGraw Hill publishing Co, 1995, ISBN: 9780071359658.
3. Pippenger Hicks “**Industrial Hydraulics**”, McGraw Hill, New York, 2nd Edition, 1980, ISBN: 9780070664777.
4. Dr. H. D. Ramachandra “**Hydraulics and Pneumatics**”, Sudha Publications, 2013, ISBN: 9788193001042.

e- Resources:

1. <https://www.youtube.com/watch?v=p7kaKmw09g>
2. <https://www.youtube.com/watch?v=DW8vxeRB6KE>
3. <https://www.youtube.com/watch?v=hHrPKtK-fIA>
4. <https://www.youtube.com/watch?v=qw2CgdgocJ4>
5. <https://www.youtube.com/watch?v=zupVhX5bwZ0>
6. https://www.youtube.com/watch?v=2T-6jDm_ebl

Course Outcomes: After learning all the units of the course, the student will be able to,

COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	Understand the basic principles and components of hydraulic and pneumatic systems.	Understanding	L2
CO2	Apply knowledge of hydraulic and pneumatic components to design and analyze circuits for controlling Hydraulic and Pneumatic systems.	Applying	L3
CO3	Illustrate the ability in selecting, operating and maintaining hydraulic and pneumatic equipment.	Understanding	L2
CO4	Analyze hydraulic and pneumatic systems, diagnose typical issues, and develop solutions through logical reasoning and problem-solving abilities.	Applying	L3



Course Title: TOTAL QUALITY MANAGEMENT [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VII			
Course Code: P21ME7024	Semester: VII	L-T-P: 3-0-0	Credits: 03
Contact Period-Lecture: 40 Hrs.	Exam: 3 Hrs.	Weightage: CIE: 50 %;	SEE: 50%
Course Learning Objectives: The objectives of this course are to, • Enable the students to understand the basic concepts of Total Quality Management (TQM). • Identify and develop appropriate tools in TQM to solve real life problems.			
Course Content			
UNIT-I			
Introduction: Definition, basic approach, Gurus of Total Quality Management (TQM), awareness, defining quality, primary elements of TQM, historical review, obstacles, benefits of TQM. Leadership: Definitions, characteristics of quality leaders, leadership concepts, the seven habits of highly effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, quality council, core values, concepts and framework, quality statements, strategic planning, communications, decision making.			
8 Hrs			
Self-Study Component: Characteristics of successful teams.			
UNIT-II			
Customer Satisfaction: Introduction to customer, customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, additional comments. Continuous Process Improvement: Introduction, process, the Juran trilogy, improvement strategies, types of problems, Plan Do Study Adjust (PDSA) cycle, Kaizen reengineering. Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram check sheets, histograms.			
8 Hrs			
Self-Study Component: Objectives of performance measures.			
UNIT-III			
Benchmarking: Introduction, benchmarking, reasons to benchmark, process, deciding what to benchmark, understanding current performance, planning, studying others, learning from the data, using the findings, pitfalls and criticisms of benchmarking. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, sector-specific standards, ISO 9001 requirements, implementation, documentation, writing the documents internal audits, registration, closing comments.			
8 Hrs			
Self-Study Component: Limitations of quality of cost, TQM exemplary organization.			
UNIT-IV			
Total Productive Maintenance (TPM): Definition, types of maintenance, steps in introduction of TPM in an organization, pillars of TPM – 5S, Jishu Hozen, quality maintenance, planned maintenance. Environmental Management Systems (EMS): Definition, basic EMS, EMS under ISO 14001, costs and benefits of EMS. TQM Tools and Techniques: The seven traditional tools of quality, Six sigma, concepts, methodology, applications to manufacturing, service sector including IT.			
8 Hrs			
Self-Study Component: Applications and importance of Measurement System Analysis (MSA).			
UNIT-V			
Quality Function Deployment (QFD): Introduction, the QFD team, benefits of QFD, the voice of the customer, organization of information, house of quality, QFD process, examples and			



conclusion. **Quality by Design:** Introduction, rationale for implementation benefits, teams, communication models, implementation, tools, misconceptions and pitfalls.

8 Hrs

Self-Study Component: Computers and quality function (Data Collection), Kano model.

Text Books:

1. Dale H. Besterfield, Besterfield Carol, Besterfield Glen H, Besterfield Mary, Urdhwarsh Hemant, **“Total Quality Management”**, Pearson Publishers, 2018, ISBN – 13 : 9789353066314.
2. V K Khanna, **“Total Quality Management”**, New Age International Publishers, 2008, ISBN – 13 : 9788122417999.

Reference Books:

1. Dr. S Kumar, **“Total Quality Management”**, 1st Edition, Laxmi Publications, 2016, ISBN: 9789385935817.

e- Resources:

1. <https://archive.nptel.ac.in/courses/110/104/110104080/>
2. <https://www.youtube.com/watch?v=SMOQV2CyVQo>

Course Outcomes: After learning all the units of the course, the student will be able to,				
COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom's Taxonomy Level	Level Indicator	
CO1	Understand the concept of TQM, ethics and characteristics of TQM leaders. Explain customer, customer perception of quality.	Understanding	L2	
CO2	Apply Juran Trilogy, PDCA cycle, Kaizen re-engineering in manufacturing. Illustrate Benchmarking process, SPC tools and TPM.	Applying	L3	
CO3	Apply ISO standards and Analyze its effect on QMS and EMS systems.	Applying	L3	
CO4	Apply latest TQM Tools including Six Sigma to manufacturing and IT Sector. Develop a QFD team with respect to quality by design.	Applying	L3	



Course Title: ADVANCED MANUFACTURING PROCESSES [As per Choice Based Credit System (CBCS) & OBE Scheme]			
SEMESTER – VII			
Course Code: P21ME7031	Semester: VII	L-T-P: 3-0-0	Credits: 03
Contact Period-Lecture: 40 Hrs.	Exam: 3 Hrs.	Weightage: CIE: 50 %; 50%	SEE:
Course Learning Objectives: The objectives of this course are to, • Advanced manufacturing process, which presents various machining processes such as fine finishing process, hybrid thermal process, additive manufacturing, micro and nano machining which is gradually commercial acceptance.			
Course Content			
UNIT-I			
Machining of Hard Materials: Basic Features of Hard Machining, Comparison with Grinding Operations, Technological Processes Including Hard Machining, Equipment and Tooling, Machining Using hybrid processes, characterization of Hard Machining processes, Cutting Forces, Chip, Cutting Temperature, Wear of Ceramic and PCBN Tools.			
			8 Hrs
Self-Study Component: Applications of Hard Machining Processes			
UNIT-II			
Ecological Machining: Introduction, Amount and Cost, Health and environmental aspects, Principal Directions in the Reduction of MWF Economical. Ecological and Health impacts, Nearly Dry Machining (NDM)- How NDM Operates.			
			8 Hrs
Self-Study Component: Applications of NDM.			
UNIT-III			
Fine Finishing Processes and Hybrid Thermal Processes: Abrasive Flow Machining (AFM), Magnetic Abrasive Finishing (MAF), Magnetic Float Polishing (MFP), Micromachining. Electrochemical Super Finishing, Electrochemical Buffing, Hybrid Thermal Processes: Introduction, Electro erosion Dissolution Machining, Electro discharge Grinding, Abrasive Electro discharge machining.			
			8 Hrs
Self-Study Component: Difference between Electro discharge Grinding, Abrasive Electro discharge machining			
UNIT-IV			
Micro and Nano-machining: Introduction, Machining effects at the Micro scale, Size Effects in Micromachining, Nano-machining-Nano-metric machining, Theoretical Basis of nano-machining, Comparison of Nano-metric machining and Conventional Machining.			
			8 Hrs
Self-Study Component: Comparisons between micro and nano machining.			
UNIT-V			
Additive Manufacturing system Introduction, Need for AM, Comparison of AM with Subtractive Manufacturing, Applications of AM, Development in CAD Technologies, Reverse Engineering, Generic AM Process, Development of AM technology, Classification of AM, VAT Polymerization techniques, UV curable photopolymers, Photopolymer chemistry, Resin formulations and reaction mechanism, Laser Scan photo polymerization.			
			8 Hrs
Self-Study Component: Roles of a Prototype			



Text Books:

1. J.PauloDavim, “**Machining: Fundamentals and Recent Advances**”, Springer Publications, 24th September 2008, ISBN:978-1848002128.
2. V.K.Jain, “**Advanced Machining Process**”, Allied Publisher Pvt., Ltd., 1st Edition,2007, ISBN:978-8177642940.
3. Paul F.Jacobs, “**Stereo Lithography and RP&M Technologies**”-SME,Ny 1995. ISBN-13:9780872634671.
4. **Additive Manufacturing Technologies**- Dr. Ian Gibson, Dr. David W. Rosen, Dr. Brent Stucker.
5. **Additive Manufacturing** – Amit Bandyopadhyay, Susmita Bose, CRC Press, 2016 Taylor & Francis Group ISBN:13: 978-1-4822-2360-6.
6. **Understanding Additive Manufacturing Rapid Prototyping** - Rapid Tooling – Rapid Manufacturing, Andreas Gebhardt, HANSER-GARDEN PUBLICATION.

Reference Books:

1. **Advanced Methods of Machining** by J.A McGeough. Springer.
2. **Micro Machining of Engineering Materials** by J.McGeough, CRC Press.
3. Hassan Abdel-Gawad El-hofy, “**Advanced Machining Processes: Nontraditional and Hybrid Machining Processes**”, McGraw-Hill Education, 1st April 2005, ISBN:978-0071453349.
4. Choi, Byoung K, Jerard, Robert B,”**Sculptured Surface Machining: Theory and Applications**”, Springer Publications,1999, ISBN:9780412780202.
5. Davim, J. Paulo, “**Machining of Hard materials**”,1st Edition, 7th Jan 2011, ISBN:97818499644.

e- Resources:

1. <http://acl.digimat.in/nptel/courses/video/112105231/L20.html>.
2. <https://www.youtube.com/watch?v=cpFRa7D48hY>.
3. <https://www.youtube.com/watch?v=hzJkCxoYTQg>.
4. <https://www.youtube.com/watch?v=6-niv4zFZWA>.
5. <https://www.youtube.com/watch?v=V7Is-0MNzFY>.

Course Outcomes: After learning all the units of the course, the student will be able to,

COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	Understand the different types of hard materials for machining.	Understanding	L2
CO2	Analyze Cost analysis.	Applying	L3
CO3	Compare: Types of fine finishing processes, Hybrid Thermal Processes.	Understanding	L2
CO4	Understand the concepts of micro and nano-machining.	Understanding	L2
CO5	Apply the raw materials used for AM systems	Applying	L3



Course Title: COMPOSITE MATERIALS [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VII			
Course Code: P21ME7032	Semester: VII	L-T-P: 3-0-0	Credits: 03
Contact Period-Lecture: 40 Hrs.	Exam: 3 Hrs.	Weightage: CIE: 50 % 50%	SEE:
Course Learning Objectives: The objectives of this course are to, • Train students on composite materials – definition, advantages and classification. • Equip students with knowledge on composite strengthening addition of components and their production routes. • Familiarize students about the properties and response of composite structures subjected to mechanical loading.			
Course Content			
UNIT-I			
Introduction: Introduction and overview of composite materials and their need, Enhancement of properties, classification of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), Application of composites.			
			8 Hrs
Self-Study Component: Fiber composites, laminated composites and particulate composites.			
UNIT-II			
Reinforcements Materials: Metallic, Polymer, Ceramic and Composite fibers, Whiskers and Particulates, Nano-fillers used in polymer composites, Reinforcement fibers.			
Types of matrix: Commonly used Matrices (Metal matrix, Polymer matrix, Ceramic matrix, Inter metallic matrix, Carbon-Carbon composites), Basic Requirements in Selection of constituents.			
			8 Hrs
Self-Study Component: Woven fabrics and Non-woven random materials.			
UNIT-III			
Production techniques and Properties: Processing of cast composites - XD process, Spray processes (Osprey Process, Rapid solidification processing), Liquid metal impregnation technique (Squeeze casting, Pressure infiltration, Lanxide process).			
Hand lay-up processes – Spray up processes, Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding, Pultrusion, Filament winding, Injection moulding.			
			8 Hrs
Self-Study Component: In-Situ Dispersion Processes (Stir-casting & Compo casting, Screw extrusion).			
UNIT-IV			
Mechanics of Composite Materials: Continuous fibres – iso-stress and iso-strain conditions, discontinuous fibres, Nature of stress vs. strain curves for different composite materials. Mechanical Properties: Mechanical testing of composites – tensile, flexure (3 point and 4 point bend tests), interfacial tests of laminates; Modes of fracture.			
			8 Hrs
Self-Study Component: Toughening mechanisms in composites.			
UNIT-V			



Recent developments in Composites: Self-healing composites, Molecular composites, Micro and Nano composites, Bio composites, Left handed composites, Stiffer than stiff composites, Carbon / carbon composites.

8 Hrs

Self-Study Component: Advantages and limitations of carbon matrix.

Text Books:

1. Chawla K.K., “**Composite materials**”, Springer, New York, 1998.

Reference Books:

1. Mathews F.L. and Rawlings R.D., “**Composite materials: Engineering and Science**”, Chapman and Hall, London, England, 1st edition, 1994.
2. Strong A.B., “**Fundamentals of Composite Manufacturing**”, SME, 1989.
3. Sharma S.C., “**Composite materials**”, Narosa Publications, 2000.
4. Mallick, P.K., “**Composite Materials Technology: Process and Properties**”, Hanser, New York, 1990.

e- Resources:

1. <https://archive.nptel.ac.in/courses/112/104/112104229/>.
2. <https://archive.nptel.ac.in/courses/112/104/112104221/>
3. <https://archive.nptel.ac.in/courses/112/104/112104249/>

Course Outcomes: After learning all the units of the course, the student will be able to,

COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	Identify and understand the basic mechanical behaviour of composite materials and make sound prediction on the likely behaviour of new combinations of materials.	Remember	L1
CO2	Apply the choices made for using certain types of composites in certain applications with reference to composite properties.	Applying	L3
CO3	Demonstrate a practical understanding of composite properties and fabrication techniques, and to be able to make realistic suggestions for the evaluation of composite behaviour, where appropriate.	Understanding	L2
CO4	Analyse the micromechanical properties of fibre reinforced composites.	Applying	L3



Course Title: ROBOTICS & ARTIFICIAL INTELLIGENCE [As per Choice Based Credit System (CBCS) & OBE Scheme]			
SEMESTER – VII			
Course Code: P21ME7033	Semester: VII	L-T-P: 3-0-0	Credits: 03
Contact Period-Lecture: 40 Hrs.	Exam: 3 Hrs.	Weightage: CIE: 50 %;	SEE: 50%
Course Learning Objectives: The objectives of this course are to, • Understand the basic concepts of robots & Artificial Intelligence. • Make the students familiar with various applications of robots in industry. • Understand basic principles of AI toward problem solving.			
Course Content			
UNIT-I			
Introduction: Automation and robotics, brief history of robotics, classifications of robots, geometrical configuration, advantages and applications of each, work volume, wrist and its motions, links and joints. End Effectors: Types of grippers and tools, resolution, accuracy and repeatability, numerical.			
8 Hrs			
Self-Study Component: Latest developments in robots.			
UNIT-II			
Structure of Robotic System: Robot drive system, hydraulic, electric and pneumatic drive system, advantages and disadvantages, feedback components, position and velocity sensors, types of actuators, internal state sensors, encoders, potentiometers and resolver, external state sensors, tactile sensing, proximity sensing, range sensing, and force-torque sensors. Introduction to Arduino, Types Of Arduino and its Features, Software Required For Arduino, control structure in Arduino, applications.			
8 Hrs			
Self-Study Component: Applications of hydraulic, electric and pneumatic drive system.			
UNIT-III			
Autonomous Mobile Robots: Locomotion, key issues for locomotion, legged mobile robots, leg-types and configurations and stability, examples of legged robot locomotion, gaits-biped, quadruped and hexaped, wheeled mobile robots, wheeled locomotion, design space. Applications of Robots in Manufacturing: Material transfer, general considerations in robot material handling pick and place, palletizing operations, machine loading and unloading; die casting, plastic moulding, forging, machining and stamping press operations.			
8 Hrs			
Self-Study Component: Applications of robots in processing operations.			
UNIT-IV			
Introduction to Artificial Intelligence: Overview, foundations, scope, problems, and approaches of AI. Intelligent agents: reactive, deliberative, goal driven, utility-driven, and learning agents, Artificial Intelligence programming techniques			
8 Hrs			
Self-Study Component: Applications of AI			
UNIT-V			
Problem-solving through Search: Problem – Solving Agents : Problem Definitions, Formulating Problems, Searching for solutions – measuring Problem – Solving Performance with examples. Search Strategies : Uninformed search strategies – Breadth – first Search, Uniform – Cost Search, depth –first search, depth – limited search, Iterative deepening depth – first search, bidirectional search, comparing uninformed search strategies.			
8 Hrs			



Self-Study Component: Informed search strategies – heuristic information.

Text Books:

1. Michell Grover, Mitchel Weiss and Roger Nagel, “**Industrial Robots**”, McGraw Hill, 2nd Edition, 2012, ISBN: 139780070265097.
2. Yoramn Koren, “**Robotics for Engineers**”, Mc Graw hill Intl. Book Co., 1987, ISBN: 139780070353992.
3. Russell, Stuart and Norvig, Peter, “**Artificial Intelligence**”: A Modern Approach" Prentice Hall, 2003.
4. Dan.W.Patterson, “**Introduction to Artificial Intelligence and Expert Systems**” PHI Learning 2009.

Reference Books:

1. K.S. Fu, R.C. Gonzales and Lee, “**Robotics**”, McGraw Hill, 1st edition, 2008, ISBN: 139780070265103.
2. Robert J. Schilling, “**Fundamentals of Robotics**”, PHI, 1 st Edition, 2011, ISBN: 139788120310476.
3. Richard D. Klafter, C Thomas A, “**Robotic Engineering**”, PHI, 1993, ISBN: 139788120308428.
4. Bench-Capon, T. J. M., “**Knowledge Representation: An approach to artificial intelligence**” Academic Press, 1990.
5. Michael Negnevitsky, “**Artificial Intelligence: A Guide to Intelligent Systems**”, (3rd Edition), 2011.
6. Vinod Chandra S.S., Anand Hareendran S, “**Artificial Intelligence and Machine Learning**”, 2014.

e- Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ge29/preview
2. <https://youtu.be/rYWJdZ5qg6M>

Course Outcomes: After learning all the units of the course, the student will be able to,

COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	Identify robots based on geometrical configuration, work volume, resolution, and accuracy of various configurations of robot.	Remember	L1
CO2	Identify different types of drive system and sensors required for specific applications.	Remember	L1
CO3	Apply the concepts of different autonomous mobile robot systems in manufacturing industries.	Applying	L3
CO4	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning.	Applying	L3



Course Title: TRIBOLOGY [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VII			
Course Code: P21ME7034	Semester: VII	L-T-P: 3-0-0	Credits: 03
Contact Period-Lecture: 40 Hrs.	Exam: 3 Hrs.	Weightage: CIE: 50 %;	SEE: 50%
Course Learning Objectives: The objectives of this course are to, • Strengthen the capability of students to integrate friction, wear, and lubrication theories in the design, manufacturing, and operation of sustainable machine elements. • Enhance their understanding of maintenance practices related to these principles.			
Course Content			
UNIT-I Introduction to Tribology: Introduction, friction, laws of friction, friction theories, surface contaminants and frictional heating, classification of wear, abrasive wear and adhesive wear, corrosive wear, fatigue and fretting wear, mechanisms of wear, basic wear testing methods- pin on disc wear tester and dry sand rubber wheel abrasion tester, wear resistant materials, Lubricants, types of lubricants, lubrication, types of sliding lubrication-fluid-film lubrication, boundary lubrication and extreme boundary lubrication, properties of oils and equation of flow- viscosity, effect of temperature and pressure on viscosity, viscosity index, viscosity measuring apparatus: U-tube viscometer, Saybolt universal viscometer and Redwood viscometer. 8 Hrs			
Self-Study Component: Industrial importance of tribology.			
UNIT-II Lubrication: Newton's law of viscous flow, Hagen-Poiseuille law, flow through capillary tube, flow between parallel stationary plates. Hydrostatic Lubrication: Introduction to hydrostatic lubrication, types of hydrostatic lubrication systems, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical on hydrostatic lubrication. 8 Hrs			
Self-Study Component: Types of additives.			
UNIT-III Hydrodynamic Lubrication: Friction forces and power loss in lightly loaded bearing, coefficient of friction for a lightly loaded bearing (Petroff's equation), limits of hydrodynamic lubrication, numerical examples of lightly loaded full-journal bearing, tower's experiments, Reynold's investigations, mechanism of pressure development in an oil film, application of converging oil film in thrust bearing, formation of a converging oil film in a partial and full journal bearings, Reynold's equation in two dimensions. 8 Hrs			
Self-Study Component: Concept of Navier- Stokes.			
UNIT-IV Idealized Hydrodynamic Bearings: Definition of idealized bearings, idealized plane-slider bearing with a fixed shoe-pressure distribution, load carrying capacity, coefficient of friction, idealized slider bearing with a pivoted shoe-load carrying capacity, frictional resistance, coefficient of friction, location of the pivot point of a slider bearing with a pivot shoe, Numerical. 8 Hrs			
Self-Study Component: Location of center of pressure of idealized slides bearing.			
UNIT-V Hydrodynamic Journal Bearing: Idealized journal bearings- infinitely long-full journal bearing- oil film thickness, Sommerfeld substitution, pressure distribution (description only), load carrying capacity, Sommerfeld number, viscous friction, modified Sommerfeld solution. Infinitely short-full journal bearing- pressure distribution (description only), load capacity and friction force, numerical on			



idealized hydrodynamic journal bearing. **Nanotribology:** Introduction, Measurement tools, Measurements, Fabrication Techniques for MEME/NEMS, Atomic scale simulations.

8 Hrs

Self-Study Component: Porous Bearings.

Text Books:

1. Basu S K., Sengupta S. N. and Ahuja B. B., “**Fundamentals of Tribology**”, PHI, 1st Edition, 2009, ISBN: 9788120327238.
2. B. C. Mujumdar, “**Introduction to Tribology of Bearings**”, S. Chand (G/L) and Company Ltd, 2nd Edition, 2010, ISBN: 9788121929875.

Reference Books:

1. E. I. Redzimirskay, “**Lubrication of Bearings Theoretical Principles and Design**”, The Ronald Press Company, 1st edition, 1959, ASIN: B0000EGL66.
2. Dudley D. Fuller, “**Theory and Practice of Lubrication for Engineers**”, John Wiley and Sons, 2nd Edition, 1984, ISBN: 9780471047032
3. Desmond F. Moore, “**Principles and Applications of Tribology**”, Pergamaon Press, 1 st edition, 1975, ISBN: 9780080179025
4. Sushil Kumar Srivastava, “**Tribology in Industries**”, S Chand and Company Limited, 2004, ISBN: 9788121920452.
5. Prasanta Sahoo, “**Engineering Tribology**”, PHI Learning Private Limited, Eighth edition, July 2019, ISBN: 9788120327245.

e- Resources:

1. https://www.youtube.com/watch?v=aoWBUh1N30&list=PLSGws_74K01_by6WhykOkiWitJLcSL9Ah
2. <https://youtu.be/7XBeRGmpLrE?si=oZvhXeVfo12xGjM3>
3. https://www.youtube.com/playlist?list=PLLy_2iUCG87Bhld-RXqBIAwKCLaLjOzX

Course Outcomes: After learning all the units of the course, the student will be able to,

COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	Apply fundamental principles of friction	Applying	L3
CO2	Examine viscosity characteristics through the utilization of diverse viscometers	Analyzing	L4
CO3	Analyze the various parameters in hydrodynamic lubrication for both lightly loaded partial and full journal bearings	Applying	L3
CO4	Analyze various parameters in infinitely long and short-full journal bearings	Applying	L3



Course Title: THEORY OF MACHINE- II (Integrated) [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VII			
Course Code: P21ME704	Semester: VII	L-T-P: 3-0-2	Credits: 04
Contact Period-Lecture: 40 Hrs. Practical: 24 Hrs.	Exam: 3 Hrs.	Weightage: CIE: 50 %;SEE: 50%	
Course Objectives: The objectives of this course are to, • Understand the basic concepts of dynamic force analysis of flywheel, rotating and reciprocating masses under the application of external load, analysis of gyroscopic couple. • Apply the basic concepts of undamped, damped Free Vibrations and forced vibrations of mechanical systems and structures.			
Course Content			
Unit-1			
Undamped Free Vibrations: Introduction, types of vibration, equivalent stiffness of springs; series and parallel, single degree of freedom systems, determination of natural frequency using Newton's and Energy methods. Damped Free vibrations: Introduction, types of damping, free vibration with viscous damping, under-damped, over-damped and critically damped systems and logarithmic decrement. 08 Hrs			
Self-study component: Determination of natural frequency using Rayligh's method, Eddy current damping.			
Unit-2			
Forced Vibrations: Introduction, forced vibration with constant harmonic excitation, steady state vibrations, forced vibration with rotating and reciprocating unbalance, force transmissibility, forced vibrations due to excitation of the support; absolute motion and relative motion. Whirling of Shafts: Introduction, critical speed of a light shaft having a single disc without damping, critical speed of a light shaft having a single disc with damping. 08 Hrs			
Self-study component: vibration isolation, Frequency and Vibration measuring instruments.			
Unit-3			
Flywheels: Introduction, turning moment diagrams, Fluctuation of Energy and speed, energy stored in a flywheel, determination of size of flywheels. 08 Hrs			
Self-study component: Comparison between flywheels and Governors, and application of fly wheels.			
Unit-4			
Balancing of rotating and reciprocating masses: Introduction, Static and dynamic balancing, balancing of several masses revolving in the same and different planes. Inertia force of the reciprocating mass of a slider crank mechanism, primary balancing, secondary balancing, balancing of single cylinder engine, balancing of multi cylinder-inline engine, balancing of radial engines. 08 Hrs			
Self-study component: Comparison between inline and radial engine.			
Unit-5			
Gyroscopes: Introduction, vectorial representation of angular motion, basic definitions, gyroscopic couple, Effect of gyroscopic couple on plane disc, aero plane, ship, stability of two wheelers and			



four wheelers.

08 Hrs

Self-study component: Effect of gyroscopic couple on bearings (with numerical).

Practical Content

24 Hrs

1. Determination of natural frequency of single DOF undamped spring-mass free vibration system.
2. Determination of natural frequency of single DOF undamped equivalent spring-mass free vibration system.
3. Study of single DOF damped torsional free vibration system.
4. Determination of critical speed of a rotating shaft.
5. Determination of gyroscopic torque in a Gyroscope.
6. Determination of Fringe constant of Photo elastic material using a Circular disc subjected To diametric compression.
7. Determination of stress concentration using Photo elasticity for a circular disk with circular hole under compression.
8. Determination of vibration characteristics of rotor (Demonstration only).
9. Determination of a Pressure distribution in Journal bearing (Demonstration only).

Textbooks:

1. S.S. Rattan “**Theory of Machines**” Tata McGraw-Hill, New Delhi, 4th edition, 2015, ISBN: 9789351343479.
2. V.P. Singh, “**Theory of Machines,**” Dhanpat Rai & Co., 3rd Edition, 2013, ISBN: 9788177000528.
3. V. P. Singh, “**Mechanical Vibrations**”, Dhanpat Rai and Company Pvt.Ltd., 2016, ISBN: 9788177004014

Reference Books:

1. Singiresu S Rao, “**Mechanical Vibrations**”, Pearson Education India, 4th Edition, 2003, ISBN: 978-8177588743.
2. John J. Uicker, Jr., Gordon R. Pennock and Joseph E. Shigley, “**Theory of Machines and Mechanisms,**” Oxford University Press, 4th Edition, 2014, ISBN: 9780199454167.
3. P. L. Ballaney, “**Theory of Machines and Mechanisms,**” Khanna Publishers., 25th Edition, 2003, ISBN: 978-8174091222.
4. Robert L. Norton, “**Kinematics & Dynamics of Machinery,**” Tata Mc Graw Hill, 1st Edition, 2009, ISBN: 9780071278522.
5. Khurmi R S and Gupta J K, “**Theory of Machines,**” S Chand & Company Pvt..Ltd Edition Re print 2015,ISBN978-81-219-2524-X.

e-Resources:

1. <https://archive.nptel.ac.in/courses/112/107/112107212/>
2. <https://archive.nptel.ac.in/courses/112/103/112103112/>
3. https://onlinecourses.nptel.ac.in/noc22_me76/preview
4. <https://www.youtube.com/watch?v=swgvKwyOnYk>
5. <https://www.youtube.com/watch?v=Yozgk1xlIW4>
6. <https://www.youtube.com/watch?v=aRulDXMuNDc>
7. <https://www.youtube.com/watch?v=FydJu1A1oeM>
8. <https://www.youtube.com/watch?v=oMxLYKtxhGE>



P.E.S. College of Engineering, Mandya

Department of Mechanical Engineering

Course Outcomes: After learning all the units of the course, the student will be able to,

COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	Understand the dynamic forces of flywheel, rotating and reciprocating masses and analyze the performance of flywheel, reciprocating and rotating mechanical components.	Understanding	L2
CO2	Apply the principle of gyroscopic effect to analyze the stability of aeroplane, ship, two wheeler and four wheeler.	Applying	L3
CO3	Apply the basic concepts of undamped, damped free vibrations and forced vibrations to analyze the resonance condition of mechanical systems and structures.	Applying	L3
CO4	Make use of experimental data for writing a report as an individual or as a team member to communicate effectively.	Applying	L3



Research Methodology and IPR [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VII			
Course Code:	P21RMI705	Credits:	03
Teaching Hours/Week (L:T:P):	3:0:0	CIE Marks:	50
Total Number of Teaching Hours:	40	SEE Marks:	50
Course Learning Objectives: This course will enable the students to: CO1. Gain comprehensive understanding of research methodology & IPR importance CO2. Create a framework for literature review and data sample collection CO3. Interpret and write research reports CO4. Understand the life cycle of IPR and its related legal aspects			
UNIT – I			8 Hours
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Research Problem: Introduction, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.			
Self-study component:	Case study to define research problem in the area of your interest.		
UNIT – II			8 Hours
Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs,.			
Self-study component:	Know about Important Experimental Designs		
UNIT – III			8 Hours
Design of Sampling: Introduction, Steps in Sample Design, Criteria of Selecting a Sampling Procedure, Characteristics of Good Sample Design. Measurement Technique: Introduction, Measurement Scales, Sources of Error in Measurement, Technique of Developing Measurement Tools. Data Collection: Collection of Primary Data, Difference between Questionnaires and Schedules, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Experiment and Survey.			
Self-study component:	Case Study on Method of data collection		



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UNIT – IV			8 Hours
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.			
Intellectual Property: Introduction, Intellectual Property Regime in India, Copyrights, Trademarks, Patents, Designs, Trade Secrets, Geographical Indications and their Salient Features, Berne Convention, Paris Convention, Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement, Issues Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Paris Convention for the Protection of Industrial Property, Berne Convention for the Protection of Literary and Artistic Works.			
Self-study component:	Patent Cooperation Treaty (PCT)		
UNIT – V			8 Hours
Indian Patent Law: Introduction, Concept of Patent, Product/Process Patents and Terminology, Patents Act 1970, Amendments to the Patent Act 1970, Patent Rules, Patentable Subject Matter and Patentability Criteria, Duration of Patents - Law and Policy Consideration, Elements of Patentability, Procedure for Filing Patent applications and Types of Applications.			
Self-study component:	Ownership and Maintenance of Patents		
Course Outcomes: On completion of this course, students are able to:			
COs	Course Outcomes with <i>Action verbs</i> for the Course topics	Bloom’s Taxonomy Level	Level Indicator
CO1	To know the meaning of Research Methodology and the technique of defining the Research Problem.	Understand	L2
CO2	Describe the framework of Literature Review, research design and report writing.	Understand	L2
CO3	Illustrate the Sampling Design and Data Collection and Procedure of Report Writing	Understand	L2
CO4	Understand the fundamentals of Intellectual Property, Patent and Drafting Procedure.	Understand	L2
Text Book(s): 1. C.R. Kothari and Gaurav Garg, “Research Methodology: Methods and Techniques”, New Age International 4 th Edition, 2018. 2. Ranjit Kumar, “Research Methodology a step by-step guide for beginners”, SAGE Publications, 3rd Edition, 2011. 3. Study Material, “Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament (e-book)			
Reference Book(s): 1. Trochim, “Research Methods: the concise knowledge base”, Trochim Atomic Dog Publishing 2005. 2. Fink A, “Conducting Research Literature Reviews: From the Internet to Paper”, Sage Publications, 2009.			



Project Work Phase – I [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VII			
Course Code:	P21ME706	Credits:	04
Teaching Hours/Week (L:T:P):	0:0:0	CIE Marks:	100
Total Number of Teaching Hours:	-	SEE Marks:	-
Project Work: The Project Work (Phase I + Phase II) carries 12 credits (4 credits+8 credits) and spreads over TWO semesters, i.e. during 7th and 8th semesters. I. Project Phase – I and Project seminar Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and seminar presentation skill. II. The Assessment marks (CIE) in the case of Project Work - Phase I, shall be based on the evaluation at the end of the 7th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department, one of them may be the internal guide. The work may be evaluated by the committee for award of Assessment marks (CIE) based on a Report [comprising of synopsis, Introduction, Literature survey, Objective and Methodology], presentation and viva voce. III. The project work shall be carried out by candidate(s) independently/in a group (maximum of four) during the seventh and eighth semester under the guidance of one of the faculty members of the Department of study. If the project work is of inter-disciplinary nature, a co-guide shall be taken from the same or any other relevant Department. If a project work has to be carried out in any industry / factory / organization, outside the campus, the permission for the same and the name of co-guide at any of these organizations shall be intimated to the authorities at the beginning of seventh semester by the Head of the Department.			



P.E.S. College of Engineering, Mandya

Department of Mechanical Engineering

Self-Study Course			
[As per Choice Based Credit System (CBCS) & OBE Scheme]			
SEMESTER – VIII			
Course Code:	P21ME801	Credits:	02
Total Number of Teaching Hours:	-	CIE Marks:	100
		SEE Marks:	-
The student has to choose and study the course related to the program discipline with her / his own efforts under the guidance of Course Instructor / Project guide, using study materials available in Open Sources i.e., Massive Open Online Courses (MOOCs) – NPTEL Courses. The intention of the course is to encourage the habit of self-learning. In this regard, the department has to release the pool of courses from the list of available 8 weeks NPTEL online courses according to NPTEL calendar of events. The student has to register for the course from the available pool during VII / VIII Semester and the same will be reflected in the Grade Card of VIII Semester. The 100 marks CIE assessment is based on the final NPTEL score (i.e. Online assignments: 25% + Proctored exam: 75%). The NPTEL score will be mapped directly to the CIE marks as per the calculation below only if he /she has completed the NPTEL course (i.e. Certification). CIE = (NPTEL Score X 1.5) = [Maximum CIE should be 100 Marks] [Ex. – 1: If NPTEL Score is 52 then the CIE will be = 52 X 1.5 = 78] Ex. – 2: If NPTEL Score is 80 then the CIE will be = 80 X 1.5 = 100 (Subjected to a Maximum CIE Marks of 100)] If the student fails to complete the NPTEL course at the end of the VIII Semester, then the department has to constitute a committee consisting of the Head of the department, two senior faculty members of the department, one of them may be the internal guide. The evaluation is based on a Report, Presentation, and Viva-Voce of the NPTEL chosen topic and the assessment is a relative evaluation in context to the student's completed NPTEL course Certification (i.e. the CIE Score should be less than the score of the student who cleared the NPTEL Course). Note: The student who fails to enroll and appear for the proctored exam in NPTEL is considered to have failed.			



P.E.S. College of Engineering, Mandya

Department of Mechanical Engineering

Research / Industry Internship - III [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VIII			
Course Code:	P21INT802	Credits:	06
Teaching Hours/Week (L:T:P):	0:0:0	CIE Marks:	-
Total Number of Teaching Hours:	-	SEE Marks:	100
Guidelines for Internship:			
I. Internship is of minimum Fifteen weeks duration and to be completed between the vacation period of VI & VII semester and VII & VIII semester. II. The internship can be carried out in any industry/ R & D Organization/ Research/ Institute/ Educational institute of repute/ Internshala (ACITE MoU Internship). III. The Department/college shall nominate staff member/s to facilitate, guide and supervise students under internship. IV. The Internal Guide has to visit place of internship at least once during the student's internship. V. The students shall report the progress of the internship to the guide in regular intervals and seek his/her advice. VI. After the completion of Internship, students shall submit a report with completion and attendance certificates to the Head of the Department with the approval of both internal and external guides. VII. There will be 100 marks for Viva Voce conducted during Semester End Examination (SEE) of VIII Semester. For the conduction of Internship Semester End Examination following instructions are issued: a. The Semester End Examination (SEE) for 100 marks shall be conducted similar to final semester project work / lab examination. b. Internal & External Examiners shall be appointed by the BoE – Chairperson in consultation with HoD and approval of the same by the Principal & Controller of Examination. c. External Examiner may be from the Industry. If the external examiner from the industry is not available, alternative arrangement shall be made by the BoE - Chairperson by appointing a faculty from out of the available faculty in the department, wherein the student is studying. VIII. The students are permitted to carry out the internship anywhere in India or abroad. The Institution will not provide any kind of financial assistance to any student for carrying out the Internship. IX. Failing to undergo Internship: Internship is one of the head for obtaining degree, therefore completion of internship is mandatory.			



Project Work Phase – II [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VIII			
Course Code:	P21ME803	Credits:	08
Teaching Hours/Week (L:T:P):	0:0:0	CIE Marks:	100
Total Number of Teaching Hours:	-	SEE Marks:	100
Project Work: The Project Work (Phase I + Phase II) carries 12 credits (4 credits+8 credits) and spreads over TWO semesters, i.e. during 7th and 8th semesters. I. Project Phase – I and Project seminar Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and seminar presentation skill. II. The Assessment marks (CIE) in the case of Project Work - Phase I, shall be based on the evaluation at the end of the 7th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department, one of them may be the internal guide. The work may be evaluated by the committee for award of Assessment marks (CIE) based on a Report [comprising of synopsis, Introduction, Literature survey, Objective and Methodology], presentation and viva voce. III. The project work shall be carried out by candidate(s) independently/in a group (maximum of four) during the seventh and eighth semester under the guidance of one of the faculty members of the Department of study. If the project work is of inter-disciplinary nature, a co-guide shall be taken from the same or any other relevant Department. If a project work has to be carried out in any industry / factory / organization, outside the campus, the permission for the same and the name of co-guide at any of these organizations shall be intimated to the authorities at the beginning of seventh semester by the Head of the Department. IV. The weekly progress of the Project work shall be monitored and reviewed by the Project Guide assigned by DUGC. The method of evaluation, including intermediate assessment shall be evolved by the pertinent DUGC. V. A candidate shall submit N+3 (No. of candidates+3) copies of the Report of the Project Work to Head, DUGC on or before the specified date. The report shall be in the format prescribed by the Institute. The candidate shall submit a report of the project work (dissertation) duly approved by the guide and co-guide. The project report shall be countersigned by the guide, co-guide (if any) and the Head of the Department VI. The last date for the submission of Report shall be Two weeks before the closure of the semester in which the project work credits have been registered for and is expected to be completed or as announced by the COE. The date of submission of the dissertation may be extended up to a maximum of eight academic years, from the date of commencement of the first semester in which the candidate has taken admission to the course. VII. The final evaluation (CIE & SEE) for Project Work - Phase II is done by a Project Work Evaluation Committee (PWEC) constituted by the pertinent DUGC. There shall be an open seminar followed by a viva – voce examination as part of the final evaluation. After the final evaluation, appropriate letter grade is awarded. VIII. If in the opinion of the PWEC, the Project Report is acceptable with minor			



modifications for the minimum passing grade 'E' (Fair) in the case of project, the PWEC shall value and instruct the candidate suitably to incorporate the necessary modifications and to resubmit it to the Chairman, PWEC. After such resubmission, the Chairman, PWEC will certify that the necessary modification has been incorporated.

- IX. The Assessment marks in case of Project Work - Phase II and seminar shall be based on the evaluation, as per the guidelines, at the end of the 8th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department (one of them may be the internal guide).
- X. The Assessment marks sheet shall bear the signature of all those concerned, along with the date and seal of the Principal.