Bachelor of Technology – Mechanical & Automation Engineering

FLEXILEARN

-Freedom to design your degree

Programme Structure

Curriculum & Scheme of Examination

2014

AMITY UNIVERSITY CHHATTISGARH

RAIPUR

B.Tech-Mechanical & Automation Engineering

Programme Structure

FIFTH SEMESTER

Course Code	Course Title	Lecture (L) Hours Per week	Tutorial (T) Hours Per week	Practical (P) Hours Per week	Total Credits
MAE2501	Machine Design – I	3	-	-	3
MAE2502	Heat Transfer	2	1	-	3
MAE2551	Metrology	3	-	-	3
MAE2503	Measurements & Controls	3	-	-	3
MAE2504	Machine Design Lab – I	-	-	2	1
MAE2505	Metrology Lab	-	-	2	1
MAE2506	Measurements & Controls and MAT Lab Programming Lab	-	-	2	1
MAE2507	Heat & Mass Transfer Lab	-	-	2	1
MAE2535	Summer Internship - I (Evaluation)	-	-	-	3
Concentration Electives					**3**
MAE2508	Optimization Techniques	3	-	-	3
MAE2509	Microprocessor System	3	-	-	3
MAE2510	Vibration Engineering	3	-	-	3
Open Electives					**4*+3**
CSS2351	Reading & Comprehension*	1	-	-	1
BEH2551	Personality, Nationalism and Human Values*	1	-	-	1
	Foreign Language – V*	2	-	-	2
LAN2551	French-V				
LAN2552	German-V				
LAN2553	Spanish-V				
LAN2554	Russian-V				
LAN2555	Chinese-V				
LAN2556	Portuguese-V				
LAN2557	Korean-V				
LAN2558	Japanese-V				
	TOTAL				**29**

*** Compulsory**

Syllabus – Fifth Semester

MACHINE DESIGN - I

Course Code: MAE2501 **Credit Units: 03**

Course Objective:
The objective of this course is to help students apply concepts learned in the mechanics, structure, material and manufacturing courses. This course offers working knowledge in the use of proper failure theories under steady and variable loading, design of mechanical elements, such as shaft, coupling, power screws, and detachable, permanent and welded connections.

Course Contents:

Module I: Variable stresses in Machine Parts
Fatigue and Endurance Limit, Factor of Safety for Fatigue Loading, Stress concentration, Notch sensitivity, Gerber Method, Goodman Method and Soderberg Method for combination of stresses.

Module II: Power Screws
Types of screw threads, Torque required to raise and lower the load, Efficiency of square threaded screw, overhauling and self locking screw, stresses in power screw, design of screw jeck.

Module III: Cotter and Knuckle Joints
Types of cotter joints, design of socket and spigot joint, design of sleeve and cotter joint, design of jib and cotter joint, Design procedure of Knuckle joint.

Module IV: Riveted and Welded Joint
Types of Riveted joint, Lap joint , Butt Joint, Caulking and Fullering, Failure of Riveted joint, Strength of Riveted joint, Efficiency of Riveted joint. Advantages and Disadvantages of welded joint over Riveted joint, Strength of Fillet joint, strength of Butt joints.

Module V: Keys and Couplings
Types of Keys, Splines, Strength of Sunk Key, types of shaft coupling, Sleeve and muff coupling, Flange coupling, Flexible coupling, Oldham coupling, Universal coupling.

Module VI: Drives
Types of Belt drives, Flat Belt drives, Velocity ratio, Sleep, Creep of Belt, Length of open Belt, length of cross belt, power transmission by belt, Maximum tesion in the belt. Types of V belt and Pulleys, advantages and disadvantages of V belt over Flat Belt, Ratio of Driving tensions for V belt, Rope drives. Chain drives, advantages and disadvantages of Chain drives.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:

- J.E. Shigley, Mechanical Engineering Design.
- Sadhu Singh, Machine Design
- R.S. Khurmi & J.K. Gupta, Machine design
- D.K. Aggarwal & P.C. Sharma, Machine Design

HEAT TRANSFER

Course Code: MAE2502 **Credit Units: 03**

Course Objective:
The main objective of the course to understand the behaviour of thermal systems. To illustrate the development of the governing differential, algebraic and finite difference equations associated with thermal systems. To introduce the possible methods of solution to the governing equation. To investigate the influences of boundary and initial conditions and system parameters on the resulting steady or transient response of the system. To provide the basic tools those are used in thermal system design. To expose students to heat transfer applications in industry.

Course Contents:

Module I
One-dimensional steady-state conduction through homogeneous and composite plane walls, cylinders and spheres, critical thickness of insulation; heat transfer from fins of uniform cross section.

Module II
Concept of hydrodynamic and thermal boundary layers, momentum and energy equation for boundary layers on a flat plate application of dimensional analysis to free and force convection; important dimensionless number.

Module III
Thermal radiation; Kirchoff‟s law; Planck‟s distribution law, Wien‟s displacement law; Stefan-Boltzmann‟s relation, Configuration factors; radiant interchange between black and grey surfaces; radiation shielding solar radiation.

Module IV
Combined heat transfer analysis; overall heat transfer co-efficient; types of heat exchangers; LMTD methods of heat exchanger design; simple heat exchanger calculations.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:

- Incropera, F.P. and DeWitt, D.P. (2002). Fundamentals of Heat and Mass Transfer, John Willy & Sons, New York, NY.
- Nag, P.K. (2002). Heat and Mass Transfer, TMH.
- John R.Howell & Richrd O Buckius, Fundamentals of Engg. Thermodynamics, McGraw Hill International.
- Holman, J.P. (1997). Heat Transfer, 9th edition, McGraw-Hill.
- Mills, A.F. (1999). Basic Heat and Mass Transfer. Prentice-Hall.
- Thirumaleshwar, M. (2006). Fundamentals of Heat and Mass Transfer, Pearson education.
- Ghoshdastidar, P.S. (2004). Heat Transfer. Oxford University Press.
- Arora, Domkundwar, S. and Domkundwar, A. (1988). A Course in Heat & Mass Transfer, Dhanpat Rai & Co.

METROLOGY

Course Code: MAE2551 **Credit Units: 03**

Course Objective:
The main objective of this course is to give the student: a basic understanding of the physical loss governing metrology and tolerance design. Gain and appreciation for the capabilities and applications of metrology through hands own experiences.

Course Contents:

Module I: Principles of measurement
Definition of Metrology, difference between precision and accuracy. Sources of errors: Controllable and Random Errors, Effects of Environment and Temperature, Effects of support, alignment errors.
Length Standards: Line standards, end standards and wavelength standards, transfer from line standards to end standards. Numerical based on line standards. Slip gauges – its use and care, methods of building different heights using different sets of slip gauges.
Limits, fits and tolerances: Various definitions, different types of fits and methods to provide these fits. Numerical to calculate the limits, fits and tolerances, ISO system of limits and fits; Gauges and its types, limit gauges – plug and ring gauges. Gauge Design – Taylor‟s Principle, wear allowance on gauges.

Module II: Comparators
Principles and working of Mechanical, Electrical, Optical and Pneumatic Comparators.
Angular Measurement: Sine Bar – different types of sine bars, use of sine bars in conjunction with slip gauges, Use of angle gauges, spirit level, errors in use of sine bars. Numericals. Principle and working of autocollimator.

Module III: Straightness and flatness
Definition of Straightness and Flatness error. Numericals based on determination of straightness error of straight edge with the help of spirit level and auto collimator
Screw Thread Measurement: Errors in threads, Measurement of elements of screw threads –major diameter, minor diameter, pitch, flank angle and effective diameter (Two and three wire methods). Effect of errors in pitch and flank angles
Gear Measurement: Measurement of tooth thickness – Gear tooth vernier caliper, Constant chord method, base tangent method and derivation of mathematical formulae for each method. Parkinson Gear Tester.

Module IV
Machine Tool Alignment: Machine tool tests and alignment tests on lathe. Alignment tests on milling machine. Alignment tests on a radial drilling machine, Interferometry.
Surface texture: Introduction, types of irregularities, Elements of surface
Texture, Measurement of surface finish, Examination of surface Roughness.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:
Text:
- R.K. Jain, “Engineering Metrology”, Khanna Publishers, Delhi
- I.C. Gupta, “Engineering Metrology”, Dhanpat Rai Publications, Delhi

References:
- F.W. Galyer & C.R. Shotbolt, “Metrology for Engineers”, ELBS edition.

MEASUREMENTS AND CONTROLS

Course Code: MAE2503 **Credit Units: 03**

Course Objective:
Knowledge of Measurement & Control in any engineering branch is vital in designing and industrial production/application. The course covers the characteristics and classifications of measurement related to mechanical & automation as well as recent development in measurement & control engineering applications. Successful completion of this course will be very helpful for the students who wish to join challenging industry.

Course Contents:

Module I
Introduction to generalized measurement system and their functional elements. Basic characteristics of measuring devices, Standards & Calibration. Accuracy, Precision, Sensitivity, Resolution, Linearity & Errors in measurement.

Module II
Transducers, Stages & their classification, Resistive transducers, Strain gauges, Rosettes, Inductive transducers, Displacement measurement, LVDT.

Module III: Applications
Miscellaneous instruments in Industrial & Environmental Applications, Measurement of viscosity & flow, Transient Time & Doppler‟s flow meter, Measurement of liquid level, humidity, hair hygrometers.

Module IV
Control engineering applications, Introduction to type of control Systems, Open loop & close loop Control Systems; Examples & their block diagrams. Transfer function, Stability of Control System, Hurwitz Polynomial& Routh Hurwitz Criterian. Block diagram representation & reduction.

Module V: Modes of Control & Controller Mechanism
P, PI and PID Controller. Pneumatic & Hydraulic Controller, General Pr. of generating various Control Actions. Concept of Control Valves.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:

Text:
- Sawhney A. K 2000, “A course in Electrical & Electronics Measurement & Instrumentation”, Dhanpat Rai & Son‟s.
- B.C Nakra, K K Chaudhary. 2004,”Instrumentation, Measurement & Analysis”. TMH.
- M Ogata, “Modern Control Engineering” PHI.

References:
- H.S Kalsi, 1999, Electronic Instrumentation”, TMH.
- B. C Kuo, “Automatic Control System”, Prentice Hall.

MACHINE DESIGN LAB - I

Course Code: MAE2504 **Credit Units: 01**

Course Contents:

Design of:

(i) Cotter Joint
(ii) Knuckle Joint
(iii) Pipe Joint
(iv) Screw Jack
(v) Rigid and Flexible coupling
(vi) Spur Gear Train

Examination Scheme:

IA				EE	
A	**PR**	**LR**	**V**	**PR**	**V**
5	10	10	5	35	35

Note: IA –Internal Assessment, EE- External Exam, PR- Performance, LR – Lab Record, V – Viva.

METROLOGY LAB

Course Code: MAE2505 **Credit Units: 01**

Course Contents:

Name of Experiments:

1 Set up a dimension by slip gauges (example 36.936; 14.727…..) Measure this set up by micrometer (least count 0.01) several times and read dimensions. Find statistical mean and record the expected variation between the actual dimension and dimension measured by micrometer.

2 To check the roundness of a circular bar with the help of dial gauge.

3 Mill a component to dimension (23, 57.6,…). Set up a comparator by slip gauge set to this dimension. Check component deviation by the comparator and record the deviation. Measure several times and obtain the mean value.

4 Check the bore in a component by a bore-indicator. Set the bore indicator by micrometer and measure the deviation in the bore. Measure several times and obtain the mean value at three positions along the length of the bore.

5 Set – up a sine bar for measuring the angle of an inclined surface (of a bracket, milling cutter arbor with 7/24 taper, ….). Measure the angle several times and record the mean value. Use height gauge wherever necessary.

6 Check angular dimension of a dovetail guide way by measuring across rollers.
Check the included angle of a V – block (90º, 60º, …) / or a machined groove by measuring over a roller using height gauge and parallel blocks/slip gauges.

7 Measure the straightness of a surface (surface plate; guide way of machine tool) by using straight edge and dial gauge and dial gauge stand. Set up straight edge on jacks such that dial reading at each end coincide. Move the dial stand along the straight edge. Record readings at 50 mm interval and draw a plot. Obtain maximum deviation which is the straightness.

8 Measure straightness using a spirit level. Place spirit level at an initial position and note level reading. Move the level on a straight line and take readings at 50 mm intervals. Plot the difference from the original reading and obtain the straightness value.

9 Draw a trapezoidal and any other profile in AutoCAD to 1:1 scale. On a steel plate make the profile by fitting and filing. Set up the drawing on profile projector. Check the component and note deviations. Correct the profile and recheck. Make the profile as close to the required one.

10 To machine a given surface and study its roughness characteristics

11 To measure the geometry of a screw using profile projector

12 To study the cutting tool geometry using tool makers microscope

Examination Scheme:

IA				EE	
A	**PR**	**LR**	**V**	**PR**	**V**
5	10	10	5	35	35

Note: IA –Internal Assessment, EE- External Exam, PR- Performance, LR – Lab Record, V – Viva.

MEASUREMENTS & CONTROLS AND MAT LAB PROGRAMMING LAB

Course Code: MAE2506 **Credit Units: 01**

List of Experiments:

1. Measurement of resolution and sensitivity of thermocouple (study of various thermocouples J, K, T, etc.) (Calibration)
2. Measurement of resolution, sensitivity and non linearity of termistor. (termistor instability)
3. Measurement of thickness of LVDT.
4. Measurement of resolution of LVDT (and displacement measurement)
5. Vibration measurement by stroboscope (natural frequency of a cantilever)
6. Angular frequency (speed of rotating objects) measurement by stroboscope.
7. Pressure transducer study and calibration.
8. Proving ring (force measurement)
9. Torque cell.
10. Closed loop study of an electric circuit.
11. Young"s modulus of a cantilever.
12. Young"s modulus and poison"s ratio of tensile test piece of M.S.

Experiments on Mat Lab:

1 To draw the time response for first order transfer function

$$H(S)=\frac{6}{S+9}$$

second order transfer function

$$H(S)=\frac{45}{S^2+6S+49}$$

third order transfer function

$$H(S)=\frac{8S}{S(S+2)(S+3)}$$

2 To realize the time response in simulink by importing the system parameters from the work window for given transfer function

$$H(S)=\frac{4S}{S(S+9)(S+5)}$$

3 To draw the bode plot for following function

$$H(S)=\frac{46S}{(S+2)(S+4)(S_2+2S+4)}$$

and draw the bode plot using input arguments that represents the continuous state space system:

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -3 & -4\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u$$

$$y = \begin{bmatrix} 10 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + [0]u$$

4 To draw the Nyquist plot for following function

$$H(S) = \frac{46S}{(S+2)(S+4)(S_2 + 2S + 4)}$$

and draw the Nyquist plot using input arguments that represents the continuous state space system:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 10 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + [0]u$$

5 To draw the root locus plot for following transfer function

$$H(S) = \frac{45}{S(S+2)(S+4)^2}$$

6 Write a program to determine the values of the DTFT of a real sequence described as a rational function in $e^{-j\omega}$

$$X(e^{-j\omega}) = \frac{0.008 - 0.033e^{-j\omega} + 0.05e^{-j2\omega} - 0.033e^{-j3\omega} + 0.033e^{-j4\omega}}{1 + 2.37e^{-j\omega} + 2.7e^{-j2\omega} + 1.6e^{-j3\omega} + 0.41e^{-j4\omega}}$$

where K= 256

7 Write a program to determine the M-point DFT $u[k]$ of the following N-points sequence

$$u[n] = \begin{cases} 1, & 0 \le n \le N-1 \\ 0, & \text{Otherwise} \end{cases}$$

here N=8 and M=16

8 Express the following Z- transform in factored form , plot its poles and zeros, and then determine its ROCs

$$G(Z) = \frac{2z^4 + 16z^3 + 44z^2 + 56z + 32}{3z^4 + 3z^3 - 15z^2 + 18z - 12}$$

9 Write a program to test the stability of the transfer function

$$H(Z) = \frac{1}{4z^4 + 3z^3 + 2z^2 + z + 1}$$

10 Design a DAS of given four signals with signal conditioning equipments in SIMULINK

Examination Scheme:

IA				EE	
A	**PR**	**LR**	**V**	**PR**	**V**
5	10	10	5	35	35

Note: IA –Internal Assessment, EE- External Exam, PR- Performance, LR – Lab Record, V – Viva.

HEAT & MASS TRANSFER LAB

Course Code: MAE2507 **Credit Units: 01**

Experiments to be Performed (Minimum 10 Numbers)

1. To Determine Thermal Conductivity of Insulating Powders.
2. To Determine Thermal Conductivity of a Good Conductor of Heat (Metal Rod).
3. To Measure the thermal Conductivity of Liquid.
4. To determine the transfer Rate and Temperature Distribution for a Pin Fin.
5. To Measure the Emissivity of the Test plate Surface.
6. To Determine Stefan Boltzmann Constant of Radiation Heat Transfer.
7. To Determine the Surface Heat Transfer Coefficient For Heated Vertical Cylinder in Natural Convection.
8. Determination of Heat Transfer Coefficient in Drop Wise and Film Wise condensation.
9. To Determine Critical Heat Flux in Saturated Pool Boiling.
10. To Study Performance of Simple Heat Pipes.
11. To Study and Compare LMTD and Effectiveness in Parallel and Counter Flow Heat Exchangers.
12. To Find the Heat transfer Coefficient in Forced Convection in a tube.
13. To determine the total thermal conductivity and thermal resistance of the given compound resistance in series.
14. To find out the thermal conductivity of given slab material.
15. To determine the individual thermal conductivity of different lagging in a lagged pipe.
16. To study the rates of heat transfer for different materials and geometries
17. To understand the importance and validity of engineering assumptions through the lumped heat capacity method.
18. Testing and performance of different heat insulators.

SUMMER INTERNSHIP - I (EVALUATION)

Course Code: MAE2535 **Credit Units: 03**

Methodology:
Practical training is based on the theoretical subjects studied by students. An industry visit will be planned for each student and on-site practical training will be imparted with the help of the industry guide. The students are to learn various industrial, technical and administrative processes followed in the industry. On completion of the practical training the students are to present a report covering various aspects learnt by them and give a presentation on same.

Examination Scheme:

Feedback from industry/work place	20
Training Report	40
Viva	15
Presentation	25
Total	**100**

OPTIMIZATION TECHNIQUES

Course Code: MAE2508 **Credit Units: 03**

Introduction& history of optimization, Clasification & application of optimization technique. Classical optimization techniques for unconstrained optimization. Karush-Kuhn-Tucker conditions. Sensitivity analysis for linear programming problems. Non-linear programming. Penalty function methods. Sequential linear programming. Feasible direction methods. Quadratic programming. Geometric programming. Integer programming.

Books :-

1 Engineering Optimization: Theory and Practice By Singiresu S. Rao , John Wiley Publication
2 Optimization Concepts and Applications in Engineering by Ashok D. Belegundu, Tirupathi R. Chandrupatla, Cambridge University Press, 2011
3 Theory and Techniques of Optimization for Practicing Engineers by Raymond L. Zahradnik , Barnes & Noble, 1971

MICROPROCESSOR SYSTEM

Course Code: MAE2509 **Credit Units: 03**

Course Objective:
This course deals with the systematic study of the Architecture and programming issues of 8085-microprocessor family. The aim of this course is to give the students basic knowledge of the above microprocessor needed to develop the systems using it.

Course Contents:

Module I: Introduction to Microcomputer Systems
Introduction to Microprocessors and microcomputers, Study of 8 bit Microprocessor, 8085 pin configuration, Internal Architecture and operations, interrupts, Stacks and subroutines, various data transfer schemes.

Module II: ALP and timing diagrams
Introduction to 8085 instruction set, advance 8085 programming, Addressing modes, Counters and time Delays, Instruction cycle, machine cycle, T-states, timing diagram for 8085 instruction.

Module III: Memory System Design & I/O Interfacing
Interfacing with 8085.Interfacing with input/output devices (memory mapped, peripheral I/O), Cache memory system. Study of following peripheral devices 8255, 8253, 8257, 8255, 8251.

Module IV: Architecture of 16-Bit Microprocessor
Difference between 8085 and 8086, Block diagram and architecture of 8086 family, pin configuration of 8086, Minimum mode & Maximum mode Operation. Internal architecture of 8086, Bus Interface Unit, Register Organization, Instruction Pointer, Stack & Stack pointer, merits of memory segmentation, Execution Unit, Register Organization.

Module V: Pentium Processors
Internal architecture of 8087, Operational overview of 8087, Introduction to 80186, 80286, 80386 & 80486 processors, Pentium processor.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:

Text:
- Ramesh. S. Gaonkar, "Microprocessor architecture Programming and Application with 8085" Penram International Publishing, 4th Edition
- B.Ram, "Fundamentals of microprocessors and microcomputer" Dhanpat Rai, 5th Edition.
- Douglas V Hall.

References:
- M. Rafiquzzaman, "Microprocessor Theory and Application" PHI – 10th Indian Reprint.
- Naresh Grover, "Microprocessor comprehensive studies Architecture, Programming and Interfacing" Dhanpat Rai, 2003.
- Gosh," 0000 to 8085" PHI.

VIBRATION ENGINEERING

Course Code: MAE2510 **Credit Units: 03**

Module 1

Scope of Vibration: Important terminology and classification, Degrees of freedom, Harmonic motion, vectorial representation, complex number representation, addition, Derivation of equation of motion for one dimensional longitudinal, transverse and torsional vibrations without damping using Newton‟s second law, D‟ Alembert‟s principle and Principle of conservation of energy, Compound pendulum and centre of percussion, Damped vibrations of single degree of freedom systems, Viscous damping, underdamped, critically damped and overdamped systems, Logarithmic decrement, Vibration characteristics of Coulomb damped and Hysteretic damped systems.

Module 2

Forced Vibrations of Single Degree of Freedom Systems: Forced vibration with constant harmonic excitation, Steady state and transient parts, Frequency response curves and phase angle plot, Forced vibration due to excitation of support.

Module 3

Vibration Isolation and Transmissibility: Force transmissibility, Motion transmissibility, Forced vibration with rotating and reciprocating unbalance, Materials used in vibration isolation.

Module 4

System with Two Degrees of Freedom: principle mode of vibration, Mode shapes, Undamped forced vibrations of two degrees of freedom system with harmonic excitation, Vibration Absorber, Undamped dynamic vibration absorber and centrifugal pendulum absorber

Module 5

Many Degrees of Freedom Systems: exact analysis.

Many Degrees of Freedom Systems: approximate methods, Rayleigh‟s, Dunkerley‟s, Stodola‟s and Holzer‟s methods, Vibrations of continuous systems, Transverse vibration of a string, Longitudinal vibration of a bar, Torsional vibration of a shaft.

List of Recommended Books

1. Mechanical Vibrations, Rao S.S., Pearson Education.
2. Mechanical Vibrations and Noise Engineering, Ambekar A.G., Prentice Hall India.
3. Mechanical Vibrations, Grover G.K., Nem Chand and Brothers.
4. Theory of Vibrations with Applicaion, Thomson and Dahleh, Pearson Education.
5. Elements of Vibration Analysis, Leonard Meirovitch, Tata McGraw-Hill, New Delhi.
6. Principles of Vibration, Benson H.Tongue, Oxford Publcation.