ME 46051 : Vibration & Noise Control

Pre-requisites: Mechanics of Solids, Kinematics of Machine, Dynamics of Machine.

Course Assessment:

The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO 1	Mathematical Modeling of SDOF Systems and estimation of natural frequencies, damping factors.
CO 2	Forced Vibration Analysis of SDOF Systems, Vibration isolation and vibration measuring instruments
CO 3	Mathematical modeling of 2DOF systems, design of undamped dynamic vibration absorber, fundamentals of modal analysis.
CO 4	Learning techniques of vibration monitoring and fundamentals of sound/noise
CO 5	Learning techniques of noise control for welfare of human being.

COURSE CONTENTS

UNIT I

Introduction: Periodical motion, harmonic motion, the vector method of representing vibrations, displacement, velocity and acceleration in harmonic motion, work done in harmonic motion, superposition of simple harmonic motion, beat phenomenon, non harmonic periodic motions. Harmonic analysis

System having single degree of freedom, free vibration of systems without damping, Equilibrium and Energy Method for determining natural frequency. Reyleigh's Method, Equivalent Systems (systems with compound springs, shafts of different diameter Equivalent length, effects of mass of spring and shaft).

Free vibration of systems with Viscous, Coulomb and Structural damping. Equations of motion – Discussion of its solutions.

UNIT II

Forced vibrations of systems with and without damping, Method of complex algebra, equivalent viscous damping, impressed force due to unbalance, transmissibility, support motion, Vibration isolation, commercial isolators.

Whirling of shafts: Whirling of light flexible shaft with an unbalance disk at the centre of its length with and without damping, discussion of the speeds above and below the critical speed, uniform shaft with and without unbalanced masses attached along its length (by Reyleigh Method) for simply supported and fixed ends.

Vibration & Noise Measurement: Principle of frequency, amplitude, velocity and acceleration measuring instruments

UNIT III

System with two-degree of freedom: Torsional systems, Degenerate Systems, Coupled vibrations, vehicle suspension, Undamped dynamic vibration absorber, Centrifugal absorber, friction damper.

Modal Analysis, Orthogonality of Eigenvectors, Decoupling of Equations of Motion, Modal Mass, Modal Stiffness and Modal Damping, General solution in terms of normal mode (Normal Mode Summation)

Introduction to Experimental Modal Analysis

UNIT IV

Machine vibration data acquisition, Vibration Severity and Standards, analysis of vibration records, Vibration Monitoring

Noise and its causes, Subjective response to sound, sound pressure/ intensity/ power level and their inter-relation, Inverse Square Law, Decibel scale, Threshold of hearing, Audible Frequency Range, Sound wave propagation, Radiation Fields of Sound Source, Near field, Far field, Free field, Direct field, Reverberant field, Diffuse field, Loudness and equal loudness contours

UNIT V

Noise Control: Effect of machine / process noise on operators, employees and local residents. Standards of noise level and exposure limits. Frequencies of interest and Frequency Weighting networks, Sound spectra and octave band analysis, 1/1 and 1/3 Octave filters. Background noise, Measurement of noise, Acoustic Chambers, Anechoic Chamber, Reverberation chamber,

Sound absorbing materials, Sound Absorption and Reflection Coefficients, Noise reduction coefficient, Methods of industrial noise control.

Text Books:

1. J S Rao and K Gupta, Theory and Practice of Mechanical Vibrations, New Age international
2. Ambekar A.G., Mechanical Vibrations & Noise Engineering, Prentice Hall of India, 2006
3. C. Sujatha, Vibration & Acoustics, Mc Graw Hill Education
4. Thomson, Theory of Mechanical Vibration, 5th Ed., Prentice Hall, 1998

References Books:

1. TseMorse & Hinkle, Mechanical Vibrations, CBS Publication, 2002
2. S. S. Rao, Mechanical Vibrations, Pearson

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
XX 46xxx	Artificial Intelligence	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

After undergoing this course, the students will be able to:

CO1	Build intelligent agents for search and games
CO2	Solve AI problems through programming with Python
CO3	Learning optimization and inference algorithms for model learning
CO4	Design and develop programs for an agent to learn and act in a structured environment

COURSE CONTENTS

Unit 1

Introduction: Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree.

Unit 2

Search Algorithms: Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search.

Unit 3

Probabilistic Reasoning: Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, temporal model, hidden Markov model.

Unit 4

Markov Decision process: MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.

Unit 5

Reinforcement Learning: Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning.

Books:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill
3. Trivedi, M.C., “A Classical Approach to Artificial Intelligence”, Khanna Publishing House, Delhi.
4. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, 2011
5. David Poole and Alan Mackworth, “Artificial Intelligence: Foundations for Computational Agents”, Cambridge University Press 2010.

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46xxx	Robotics	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

After undergoing this course, the students will be able to:

CO1	Understand basic terminologies and concepts associated with Robotics and Automation.
CO2	Understand robot kinematics and dynamics to explain motion and force analysis in robotics.
CO3	Application of different types of sensors and actuating system in robotics.
CO4	Concept of control system in robotics
CO5	Application of AI and Embedded systems in Robotics

COURSE CONTENTS

Unit 1

Introduction to Robotics

Introduction to Robotics, Types and components of a robot, Classification of robots, Kinematics systems; Definition of mechanisms and manipulators, Degrees of Freedom. Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Robotics and Automation for Industry 4.0.

Unit 2

Robot Kinematics and Dynamics

Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Singularity, and Statics.

Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation.

Unit 3

Robot Sensors and Actuating systems

Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations Vision applications in robotics.

Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

Unit 4

Control Systems

Basics of control: open loop- closed loop, Transfer functions, block diagram, Laplace Transformation, Mathematical modelling of mechanical and electrical system and Control laws: P, PD, PID Linear and Non-linear controls.

Unit 5

AI and Embedded systems in Robotics

Applications in unmanned systems, defense, medical, industries, etc. Microcontroller Architecture and integration with sensors, actuators, components, Programming Applications for Industrial robot - programming in – VAL II

Books:

1. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Industrial Robotics: M. P. Groover, Ashish Dutta, McGraw Hill
3. Craig, J.J., "Introduction to Robotics: Mechanics and Control", Pearson, New Delhi.
4. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modelling and Control", John Wiley
5. Robotics Engineering: R. Klafter, PHI

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
XX 46xxx	3D Printing And Design	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

After undergoing this course, the students will be able to:

CO1	Develop CAD models for 3D printing
CO2	Import and Export CAD data and generate .stl file.
CO3	Select a specific material for the given application
CO4	Select a 3D printing process for an application.
CO5	Build a product using 3D Printing or Additive Manufacturing (AM).

COURSE CONTENTS

Unit 1

CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL file format & its importance

3D Printing (Additive Manufacturing): Introduction, Process, Classification, Advantages, Additive v/s Conventional Manufacturing processes, Applications.

Unit 2

Additive Manufacturing Techniques:

- Process, Process parameter, Process Selection for various applications.
- Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools
- Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

Unit 3

Materials

- Polymers, Metals, Non-Metals, Ceramics
- Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.
- Support Materials

Unit 4

Additive Manufacturing Equipment

- Process Equipment- Design and process parameters, Laser in additive manufacturing.
- Governing Bonding Mechanism
- Common faults and troubleshooting
- Process Design

Unit 5

Post Processing: Requirement and Techniques

Product Quality

- Inspection and testing
- Defects and their causes

Books:

1. Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.
3. Khanna Editorial, “3D Printing and Design”, Khanna Publishing House, Delhi.
4. CK Chua, Kai Fai Leong, “3D Printing and Rapid Prototyping- Principles and Applications”, World Scientific, 2017.
5. J.D. Majumdar and I. Manna, “Laser-Assisted Fabrication of Materials”, Springer Series in Material Science, 2013.
6. L. Lu, J. Fuh and Y.S. Wong, “Laser-Induced Materials and Processes for Rapid Prototyping”, Kulwer Academic Press, 2001.

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46xxx	Advanced Machine Design	4	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 36001, ME26002, Machine Design I. Machine Design II

Course Assessment:

The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO1	Design analysis of rotating ring, disk and curved machine member and their applications in designing of different machine components.
CO2	Design analysis of parts of unsymmetrical section
CO3	Demonstrate reliability based design. Design of machine tool derives for different machines such as lathe, milling and drilling
CO4	Explain optimum design analysis of simple machine members and human factors in design.
CO5	Design analysis of automotive gear box.

COURSE CONTENTS

Unit 1

Rotating ring and disks: Discs of uniform thickness and disc of uniform strength effect of drill hole and extra mass, design of flywheel and pulley, etc.

Design analysis of curved machine members: Crane hooks, chain link, open and close link, m/c frames.

Unit 2

Design of parts of unsymmetrical sections: Defining shear centre, parts subjected to unsymmetrical bending

Limit design analysis: Simple cases of deformations beyond elastic limits.

Unit 3

Reliability based design: Reliability based design of machine elements, design of elements subjected to tension, compression, bending and torsion

Design of machine tool drives: Design of machine tool drives for different machines such as lathe, milling machine, drilling machine, etc.

Unit 4

Experimental method in design: Introduction to experimental stress analysis techniques.

Human factors in design: Introduction to human – machine system, human factors, applications in system design, human physical activities, human control of systems, shapes, coding of control.

Unit 5

Design of automotive gear box-manual and automatic

Text Books:

1. Mechanical Engineering Design, Shigley and Mischke, TMH, 2001
2. Introduction to Machine Design, V. Bhandari, TMH, 2004
3. Strength of Materials, S.S. Ratan, TMH.

Reference Books:

1. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M. Marshek, John Wiley, 2006
2. Engineering Optimization, Rao S.S., John Wiley, 1996

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46218	Mechatronics and Automation	4	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 3606, ME3601, ME3603, ME3607, PE3662 and IM3661

Course Assessment:

The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO 1	List various control actions and apply the concepts of transfer functions for mathematical modelling mechanical and electrical system
CO 2	Explain system stability criteria, method and application of PID controller
CO 3	Discuss various types of solenoids, relays and electromechanical actuators and Demonstrate various hydraulic and pneumatic systems and their applications
CO 4	Apply different motion control techniques in various engineering applications.
CO 5	Explain signal conditioning and data acquisition process.

COURSE CONTENTS

Unit 1:

Control system and types: Open loop and closed loop control systems. Block Diagrams representation of control system. Laplace Transform and Transfer Function. Mathematical modeling of mechanical and electrical system. Poles and zeros. Zero order, first order and second order systems and their dynamic response.

Unit 2:

Routh Hurwitz stability criteria, Introduction to bode plot and root locus method. Basic control actions. Proportional, integral and derivative control. Op Amp based PID controller, PID control using MATLAB. Combinatorial and sequential logic. Simple logic networks.

Unit 3:

Electro-Mechanical Actuators: Electro-mechanical actuators, solenoids and relays, types of electric motors and their characteristics, electrical drives and control of electric motor.

Hydraulic &Pneumatic Systems: Hydraulic & Pneumatic cylinders and Actuators, Pressure and Flow Control Valves, Direction Control Valves, Basic circuit, Reference circuit, Meter-in, Meter-out and Bleed off circuit, Accumulator circuit, Circuit Diagram representation,

Unit 4:

Motion Control: Trajectory planning, motion controllers, point to point motion, co-ordinated multi-axis motion, electronic gearing,

Feedback devices: linear and rotary encoders, resolvers, tachometers and tacho-generators.

Unit 5:

Signal Conditioning & Data Acquisition: Amplification. Filters. Operational amplifier and its applications. Analog to digital conversion. Data acquisition. Introduction of microcontrollers interfacing with micro-controller and micro-processor.

References:

1. K. Ogata, Modern Control Theory, PHI, 2004
2. Nakra & Choudhary, Instrumentation, Measurement and Analysis, TMH, 2004
3. Bolton, Mechatronics, Pearson Education India, 2004
4. Norman S. Nice, Control System engineering, John Wiley & Sons, Inc.