Engineering Mechanics Lecture wise Content of Video Lectures of Prof. K. Ramesh

Lecture	Concepts Covered
Module 1 Lecture 1 Lecture 1 Introduction to Engineering Mechanics I	Evolution of Structural Engineering, Tacoma Narrows Bridge Collapse, History of Strength of Materials, Contributions of Archimedes and Leonardo da Vinci, Indian achievements in structural Engineering, Scientific Questions that puzzled generations, Notions on Space and Time by Aristotle, Galileo and Newton, Idea of Relativity in Sanskrit Literature, Newton's Laws of Mechanics, Kepler's prediction on motion of planets, Geocentric Theory, Timeline on Western contribution to Engineering Mechanics, Sanskrit Literature has layers of information, Law of Gravitation in Upanishads.
Module 1 Lecture 2 Lecture 2 Introduction to Engineering Mechanics II	Geocentric theory to Heliocentric theory, Circular orbits to elliptical orbits, Western developments, Gravitation – subtle to understand, Vedic view has always been Heliocentric, Spinning of Moon, Earth, Sun, Plotting of ellipse, Classification of Engineering Mechanics, Frame of reference, Spinning of storms in different hemispheres, Limitations of Newtonian mechanics, Maxwell's contribution, Michelson-Morley experiment, Speed of light in the Vedas, Einstein's relativity postulates.
Module 1 Lecture 3 Lecture 3 Force Systems I	Idealizations in engineering, Concept of a Rigid Body, Effect of a Force, Newton's third law, Force interactions, Transmissibility of a Force, Classification of Force Systems (Concurrent, Coplanar, Non-concurrent, Non-coplanar, Collinear, Parallel), Composition and Resolution of Forces, Body and Surface Forces, Distributed and Concentrated Forces, Rate of Application of Force.
Module 1 Lecture 4 Lecture 4 Force Systems II	Force Systems, Moment of a force, Varignon's theorem, Exercise problem, Moment of a couple, Resolution of a force into a force and a couple, Examples, Resultants of force systems, Distinction between statics and dynamics.
Module 1 Lecture 5 Lecture 5 Equilibrium of Rigid bodies I	Necessary and sufficient conditions for equilibrium of – a particle, system of particles, single rigid body and interconnected rigid bodies. Equilibrium conditions for two force member, three force member and coplanar force system. Free-Body Diagram, Reactions at supports for a 2D structure - class I, class II and class III supports.

Module 1 Lecture 6 Lecture 6 Equilibrium of Rigid bodies II	Supports restraining both Translation and Rotation, Commonly used supports, Universal joint example – emphasizing the need for analyzing subsystems, Importance of stating idealizations, Free Body Diagram, Example problems, Step by step solution, Checking of sufficient and necessary conditions, Analysis of a Crimping tool.
Module 1 Lecture 7 Lecture 7 Trusses I	Trusses found in real world structures, Construction of a typical joint in a Truss, Common Types of Trusses, Idealization of Joints, Construction of a Stable Truss, Deformation of a Truss, Classification of statically determinate and indeterminate trusses – Illustrative examples, Simple demonstrations.
Module 1 Lecture 8 Lecture 8 Trusses II	Analysis of statically determinate trusses, How to accommodate the weight of the individual member or snow in roof tops in analysis, Method of joints, Isolation of a joint, Representation of joint as a circle, Identification of tension or compression in the members and its representation in the sketch, Solution for a simple truss.
Module 1 Lecture 9 Lecture 9 Trusses III	Method of Sections, Solution of the same truss for selected members by method of sections, Effective way to minimize computations, Identification of zero force members, Analysis of simple statically indeterminate trusses: external and internal redundancy, Analysis of a cross braced truss, Role of computers - current trends.
Module 1 Lecture 10 Lecture 10 Beams I	Definition of beam, Slender members, Forces transmitted in a slender member, Forces transmitted by a beam, Classification of beams, Statically determinate and indeterminate beams, Some practical examples, Need for drawing forces transmitted by a beam along its length.
Module 1 Lecture 11 Lecture 11 Beams II	Recapitulation of force transmitted by a slender member, Shear force and Bending moment diagram, Subtleties' in drawing FBD and writing the equilibrium conditions, Need for a sign convention, Various sign conventions and the one that will be adopted in the course, Influence of sign convention on drawing SFD and BMD, Understanding sign convention, Need for drawing loading diagram, SFD and BMD one below the other and showing the relevant sign conventions appropriately.
Module 1 Lecture 12 Lecture 12 Beams III	Revisiting Sign Conventions for SFD and BMD, Drawing SFD and BMD- method of calculation in finding reactions and writing FBD for desired sections, SFD and BMD for simple loading situations, Principle of Superposition, Inter-relationship between Loading, SFD and BMD- Differential equilibrium relationships.

Module 1 Lecture 13 Lecture 13 Beams IV	Use of differential relations in identifying the slope of BMD and SFD, Finding the optimal position of supports – book shelf problem, Cantilever beam with triangularly varying loads, SFD and BMD for a simply supported beam, SFD and BMD for combination of loads, concentrated couple etc.
Module 1 Lecture 14 Lecture 14 Virtual Work I	Work, Principle of virtual work, Active force diagram, Determination of position of equilibrium, Degrees of freedom, Demonstrations on position of equilibrium and degrees of freedom.
Module 1 Lecture 15 Lecture 15 Virtual Work II	Methods of virtual work, Selection of independent variable, Mathematics involved in virtual work problem, Physics of virtual work problem, Sign convention for solving Problem in virtual work, Sample problems.
Module 1 Lecture 16 Lecture 16 Energy Relations	Elastic potential energy, Gravitational potential energy, Stability of equilibrium, Equilibrium in terms of potential energy, Condition for equilibrium, Solution of problems involving springs.
Module 1 Lecture 17 Lecture 17 Review Before Quiz I	Review of Force Systems, Discussion on how to employ resolution of a force into a force and a couple for determining the external load on a beam with protrusions, Solving a 3D force system, Review of Equilibrium of Rigid Bodies, How proper use of mathematics can identify improper idealisation of supports, Review of Trusses, Solving a Space Truss, Review of Beams, Drawing SFD and BMD in the case of multiple loads in a beam, Review of Virtual Work, Determination of reactive force by Virtual work, Comparison with the Force Method.
Module 1 Lecture 18 Lecture 18 Friction I	Friction a bane or a boon? Classifications of friction, External friction, Internal friction – fluid friction, solid friction (material damping), The laws of dry friction, Importance of impending motion in friction problems, Co-efficient of friction, Angle of repose – Experimental determination, Phenomenon of stick slip, Selection of friction laws.
Module 1 Lecture 19 Lecture 19 Friction II	Solution to the problem of a block with varying loads, Correct procedure for drawing FBD for friction problems, Guidelines for solving friction problems, Mechanism of static and dynamic friction, Rolling resistance – ball, roller and tapered roller bearings, Sliding or Tipping, Investigation of sliding or tipping by solving an example, Wedge problem, Self-locking.

Module 1 Lecture 20 Lecture 20 Friction III	Concept of Self-locking, Illustration with a wedge, Archimedes system of pulleys – Mechanical advantage, Demonstration of holding a liter of water by a key chain with a string wound over a peg, Belt friction, Discussion on identifying correct frictional direction in brakes and belt drives, Labeling of tensions as T_1 and T_2, Influence of the mass of the belt, Example problems.
Module 2 Lecture 1 Lecture 21 Particle Dynamics	When to idealise a problem on hand as a particle or a rigid body for analysis, Review of particle dynamics, Plane motion at constant acceleration, Projectile motion, Solving projectile motion when monkey is in free fall, Swirling of a stone, Terminal velocity, Relative motion, Apparent weight, Inertial frame of reference, Stopping distance of a car.
Module 2 Lecture 2 Lecture 22 Circular Motion	Derivative of unit vectors in Cartesian and Polar co-ordinates, Engineering examples of fixed-axis rotation, Analogy between rectilinear and angular motions, Detailed discussion on concept of rotation – a relook, Definition of angular velocity, Example problems.
Module 2 Lecture 3 Lecture 23 Absolute Motion	Plane kinematics of rigid bodies, Translation, Curvilinear translation, General Plane motion, Absolut motion analysis, What constitutes rolling, Kinematics relations of a rolling wheel without slipping, Example problems.
Module 2 Lecture 4 Lecture 24 Relative Motion I	General plane motion, Animations to demonstrate that general plane motion is a combination of translation as well as rotation, Derivation of expressions for velocity and acceleration, Animations to visualise motion of a rigid body from a non-rotating translating axes, Discussion of solution approach by graphical and vector algebra approach, Solution to problem on rolling using relative motion concept.
Module 2 Lecture 5 Lecture 25 Relative Motion II	Appreciation of General plane motion as a combination of translation as well as rotation, Relative motion analysis using non-rotating translating axes, Solution to Slider crank mechanism to determine velocity and acceleration by - velocity and acceleration polygon and vector analysis approaches.
Module 2 Lecture 6 Lecture 26 Relative Motion III and Instantaneous Center	Coincident points, Method of analysis using velocity polygon and vectorial analysis, Velocity analysis of Quick return mechanism – a practical application in Shaper, Instantaneous center of zero velocity, Example problems on rolling without slipping and analysis of Gear trains.

Module 2 Lecture 7 Lecture 27 Rotating frame of reference I- Velocity	Choice of Polar/Intrinsic co-ordinates or Rotating Frame of Reference, Usual forms of rotating frames, Motion relative to rotating axes, Component of velocity measured from rotating frame, Understanding the terms in velocity, Relative velocity, Recap on non-rotating translating axes to identify the missing component in rotating frame, Recap on coincident point to understand v_{rel}, Time derivative of a vector in fixed and rotating frames.
Module 2 Lecture 8 Lecture 28 Rotating frame of reference II- Acceleration	Time derivative of a vector in fixed and rotating frame of reference, Derivation of acceleration in rotating co-ordinates, Understanding terms in acceleration, Various ways of interpreting the terms in acceleration, Coriolis acceleration term, Solving two example problems.
Module 2 Lecture 9 Lecture 29 Rotating frame of reference III- Choice of rotating frame of reference	Recapitulation of expressions for velocity and acceleration in rotating frame, Discussion on what a person views from a fixed frame and rotating frame for the problems discussed in Lecture 8, Solving advanced problems involving Rotating Frames – Problem of a multi utility truck and Quick return mechanism of a shaper.
Module 2 Lecture 10 Lecture 30 RFR- IV Crank and slotted bar	Guidelines on how to identify a suitable choice of rotating frame of reference, Detailed discussions on solving crank and slotted bar problem, Evaluation of velocity using velocity polygon method, Using rotating frame of reference. Acceleration by rotating frame of reference, Visualisation of the mechanism from various standpoints through detailed animations, Relevance of using polar co-ordinates for solving the problem based on particle dynamics, Guideline to select the origin of rotating frame of reference.
Module 2 Lecture 11 Lecture 31 RFR-V Understanding Coriolis Acceleration	Understanding Coriolis acceleration, Deviation of the path due to Coriolis effect, Direction of Coriolis acceleration, A relook at frames attached to Earth, Coriolis effect due to Earth's rotation, How Coriolis effect determines the motion of cyclones in Northern and Southern hemispheres, Role of Coriolis effect in Geocentric vs. Heliocentric debate, Work of Coriolis, Multiple uses of Coriolis effect, Nature is far advanced!
Module 2 Lecture 12 Lecture 32 Kinetics I	Plane kinetics, Kinetics of a particle, System of particles, Expressions for angular momentum and rate of change of angular momentum with respect to mass point, fixed point and an arbitrary point, Kinetics of rigid bodies, General plane motion, Derivation of moment equation about mass point from angular momentum and from first principle, Moment equation about an arbitrary point and fixed point, Interconnected rigid bodies.

Module 2 Lecture 13 Lecture 33 Kinetics II	Kinetics of rigid bodies, Kinetic diagram, Governing equations in translation, curvilinear translation, fixed-axis rotation, Centre of percussion, Example problems in translation and curvilinear translation. Problem of a truck lifted along a slope by a pulley mass system, problem of lifting a rectangular block in vertical plane by parallel links.
Module 2 Lecture 14 Lecture 34 Kinetics III	Application of kinetics to solve problems in translation, Mass point rotation, and General plane motion. Problems such as tipping of bottles, rolling without slipping, general plane motion of satellites, general plane motion of a car door opening in motion.
Module 2 Lecture 15 Lecture 35 3D Kinematics I	Finite rotations are not vectors, Proof of infinitesimal rotations as vectors, 3D Kinematics, Fixed-axis rotation, Plane parallel motion, Fixed-point rotation, Body and space cones, Instantaneous axis of rotation, Precession of Earth, Shifting of equinoxes due to precession, Error in the calendar, Indians calculated precession in 550 AD, Angular acceleration – Generic and simple cases.
Module 2 Lecture 16 Lecture 36 3D Kinematics II	Calculation of angular acceleration through analogy when precession axis is rotating with constant ω, Determination of acceleration in a generic case, Discussion and comparison of fixed-axis rotation and fixed-point rotation, Example problems on fixed-axis rotation and fixed-point rotation, Determination of angular acceleration reflecting the directional change and the magnitude change in ω.
Module 2 Lecture 17 Lecture 37 3D Kinematics III	General motion of 3D bodies, Relative motion analysis, Non-rotating translating axes, Motion relative to rotating axes, Example problems illustrating the use of rotating axes, Rotating axes having fixed axis rotation, Interrelationships between co-ordinates, Rotating axes having fixed-point rotation.