

**Department of mechanical engineering**

**IIT Delhi**

**Subject:-** Proposed syllabus of the written comprehensive examination of Mr. Sandeep Kumar (2019MEZ8423)

**Topic:-** Dynamics and control of flexible multibody systems

1. **Linear Algebra:** Vector Spaces, Matrix Algebra, Singularity, Condition Numbers, LU,  $LL^T$ , QR, SVD,  $UDU^T$  Decompositions, Eigen Value Problems.
2. **Engineering Mathematics:** Calculus, differential equations, Laplace transforms, Fourier series and Fourier transforms.
3. **Numerical Methods:** Newton-Raphson method, Euler Method, Runge-Kutta Method.
4. **Multibody Dynamics:** Linkages, Degree-of-freedom, Constraints, Spring-damper Elements, Generalized Coordinates, Newton-Euler, Lagrange, DeNOC and other Multibody Dynamic formulations for Rigid Bodies. Introduction to Flexible Multibody Dynamics, Floating frame of reference, Equations of motion of a planar single flexible link using AMM and FEM.
5. **Finite Element Methods:** Introduction to the Finite Element Method, principles of minimization of potential energy: Rayleigh Ritz and Galerkin Methods, 1D elements and their analysis, analysis of bars, beams and trusses, 2D/3D solids, solution methods in FE.
6. **Vibration Engineering:** Basics of vibrations, Study of vibrations of single and multi degree of freedom systems under different type of excitation, Estimation of damping, Damping in dynamic model, Damping coefficients, structural damping, damping in joints, Introduction to vibration isolation: displacement/force isolation, introduction to vibration modes.
7. **Control Theories:** Necessity of control, Transfer function, observability and controllability, poles and Zeros, stability criteria, PD, PI and PID controls, State Space form, modern control theories (command shaping, sliding mode control etc. )
8. **Mechanical Design:** Concept of continuum, Stress strain properties, theory of failures.