ME 613 Nonlinear Vibrations (3-0-0-6)

Mechanical Vibrations Dynamics of conservative and non-conservative systems; Phase planes, fixed points; Local and global stability, Lyapunov theory; Analytical solution methods: Harmonic balance, equivalent linearization, perturbation techniques (Linstedt-Poincare, Multiple Scales, Averaging – Krylov-Bogoliubov-Mitropolsky); Damping mechanisms; self-excited systems, Van der Pol's oscillator. Forced oscillations of SDOF systems, Duffing's oscillator; primary-, secondary-, and multiple- resonances; period-multiplying bifurcations; Poincare' maps, point attractors, limit cycles and their numerical computation, strange attractors and chaos; Types of bifurcations, Lyapunov exponents and their determination, fractal dimension. Parametric excitations, Floquet theory, Mathieu's and Hill's equations; effects of damping and nonlinearity; MDOF systems, solvability conditions, internal (autoparametric) resonances; Hopf bifurcation and panel flutter example. Application to continuous systems.

Textsbooks:

[1] Nayfeh, A. H., and Mook, D. T., *Nonlinear Oscillations*, Wiley-Interscience, 1979..

[2] Hayashi, C. *Nonlinear Oscillations in Physical Systems*, McGraw-Hill, 1964.

[3] Evan-Ivanowski, R. M., *Resonance Oscillations in Mechanical Systems*, Elsevier, 1976.

[4] Nayfeh, A. H., and Balachandran, B., *Applied Nonlinear Dynamics*, Wiley, 1995.

[5] Seydel, R., *From Equilibrium to Chaos: Practical Bifurcation and Stability Analysis*, Elsevier, 1988.

[6] Moon, F. C., *Chaotic & Fractal Dynamics: An Introduction for Applied Scientists and Engineers*, Wiley, 1992.

[7] Srinivasan, P. *Nonlinear Mechanical Vibrations*, New Age International, 1995.

[8] Rao, J. S., *Advanced Theory of Vibration: Nonlinear Vibration and One-dimensional Structures*, New Age International, 1992.