

ME 818 Flow Induced Vibration (Credits 3)

COURSE OUTCOME

- Handle qualitative and quantitative knowledge regarding flow induced vibration sources, physical phenomena of structures and technical aspects.
- Concretize and apply some specific methods to identify, analyze and formulate complex problems.
- Suggest methods and solutions in order to correlate flow velocities, pressure and structural phenomena, boundary conditions with flow
- Ability to perform decision analysis and evaluations in research considering scientific, social and ethical aspects.

SYLLABUS Description

Unit I

Waves in Fluids and Solid structures

Frequency and Wave number - sound wave in fluids - Longitudinal, Quasi - longitudinal and transverse waves in solids - Bending waves in bars and thin plates - Flexural waves in thin walled cylindrical shells

Unit II

Body and fluid oscillators and fluid loading

Body oscillators: Free vibration - Forced vibration - Self excited vibration - Parametrically excited vibration

Fluid oscillators: Over view - Discrete mass fluid oscillators - Distributed mass fluid oscillators

Fluid loading: Type of fluid loading - Added mass and fluid damping, effect of geometry, effect of wave radiation, effect of viscosity and amplitude, effect of mean flow.

Unit III

Vortex induced vibration and instabilities

Vortex induced vibration: Vortex-Shedding frequency and Strouhal Number- 'Lock-in' phenomena - Vortex induced vibration amplitude - Vortex shedding inside a tube bundle - Strouhal numbers for tube arrays.

Instabilities of tube arrays: Equation of motion for whirling - Stability analysis of tube rows and tube rows bounded by wall - Fluid force coefficient for tube arrays - Wake induced vibration.

Unit IV

Vibrations of pipe conveying fluid

Straight pipe conveying fluid - Equation of motion, Free vibration and stability analysis, stability boundaries, effect of fluid pressure, gravity and damping forces. Curved pipe conveying fluid - Equation of motion, out of plane vibration and stability analysis, in plane vibration and stability.

Unit V

Turbulence induced vibration

Elements of theory of random vibration - Static principles, turbulence spectra, response spectra. Flexible rod parallel to turbulence flow - cross spectral density and joint acceptance, mean square response. Vibration induced by wind - spectra and correlation of wind, response of structure to wind, wind tunnel simulation

Reference

- 1) Frank Fahy, Paolo Gardonio, "Sound and structural vibration, Radiation Transmission and response", Academic press, ELSEVIER, Second edition 2007.
- 2) Eduard Naudascher, Donald Rockwell, "Flow - Induced Vibrations, An engineering guide - Hydraulic Structures Design Manual - 7", International Association for Hydraulic Research, published by A.A. Balkema Publishers, USA 1994.
- 3) M.K. Au-Yang, "Flow - Induced vibration of power and process plant components" Professional Engineering Publishing Limited, 2001.
- 4) Robert D. Blevins, "Flow - Induced vibration", Robert E. Krieger Publishing company, 1986.
- 5) Shoen-Sheng Chen, "Flow induced vibration of circular cylindrical structures", Hemisphere publishing corporation, 1987.