(3 hours) **Total Marks: 80**

N.B.: 1) Question No. 1 is compulsory
2) Attempt any three questions out of the remaining five questions.
3) Figures to the right indicate full marks.
4) Assume suitable data wherever required but justify the same.

Q1. Attempt any four **(20)**

A. Define the flexibility and stiffness influence coefficients. What is the relation between them?
B. Explain the sources of non-linearity
C. Explain probability distribution function for random variables.
D. What is a wave equation? What is a traveling-wave solution?
E. Explain the three types of maintenance schemes used for machinery.

Q2 A. The arrangement of the compressor, turbine, and generator in a thermal power plant is shown in Fig. 1. Find the natural frequencies and mode shapes of the system **(12)**

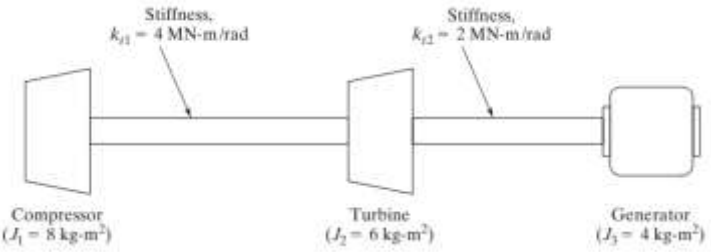

Fig 1 Free-free torsional system

B. Explain the time and frequency domain analysis in vibration measurement **(08)**

Q3 A. Explain vibration isolation considering two typical situations of vibrating systems. **(10)**

B. Derive one dimensional wave equation for transverse vibration of a string. **(10)**

Q4 A. An accelerometer has a suspended mass of 0.01 kg with a damped natural frequency of vibration of 150 Hz. When mounted on an engine undergoing an acceleration of 1g at an operating speed of 6000 rpm, the acceleration is recorded as 9.5 m/s^2 by the instrument. Find the damping constant and the spring stiffness of the accelerometer. **(12)**

B. Explain machine condition monitoring and diagnosis. **(08)**

Q5 **A.** Explain in detail the power spectral density. **(08)**

B. An industrial sewing machine has a mass of 430 kg and operates at 157 rad/s. It appears to have a rotating unbalance of magnitude 0.8 kg · m. Structural engineers suggest that the maximum repeated force transmitted to the floor is 10,000 N. The only isolator available has a stiffness of 7 x 10^6 N/m and a damping ratio of 0.1. If the isolator is placed between the machine and the floor, will the transmitted force be reduced to an acceptable level? If not, what can be done? **(12)**

Q6 **A.** Explain the perturbation method for approximate analysis of non-linear vibration. **(10)**

B. Draw the state plane for the unforced Duffing's equation with no damping for a hardening spring **(10)**

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