**Time: 3 Hours**                                                                                                    **Total Marks: 80**

**N.B.**   1. Question **No.1** is **compulsory.**
2. Answer **any three** questions from remaining questions.
3. Assume suitable data if required.
4. Figure to the right indicates full marks.

**Q. 1**   Solve any **FIVE**                                                                                          **20**
a) State the different types of governors.
b) Explain the term critical speed of rotating shaft.
c) Explain Gyroscopic Couple
d) Discuss the effect of damping on vibratory system.
e) Why is balancing necessary for rotors of high speed engines?
f) Explain in details condition monitoring and fault diagnosis.

**Q. 2** a) The length of the arms of a Porter governor is 300mm long. The upper and lower    **10**
arms are pivoted to links at 50mm and 60mm, respectively, from the axis of the
rotation. The mass of each ball is 5kg and the sleeve is of mass 60kg. The frictional
force on the sleeve is 35N. Determine speed range for extreme radii of rotation of
120mm and 150mm.

b) The total mass of a four wheel trolley car is 1800kg. The car runs on rails of 1.6m    **10**
gauge and round a curve of 24m mean radius at 36 km/hr. The track is banked at
$10^0$. The diameter of the wheels is 600mm. Each pair of wheels with axle has a mass
of 180kg and radius of gyration of 240mm. The height of the C.G. of car above the
wheel base is 950mm. Determine the pressure on each rail.

**Q. 3** a) Explain Dynamically Equivalent System and correction Couple.                            **10**
b) In a damped vibrating system, the mass having 20kg makes 40 oscillations in 25sec.    **10**
The amplitude of natural vibrations decreases to one eighth of the initial value after
8 oscillations. Determine (i) the logarithmic decrement (ii) damping factor &
damping coefficient (iii) spring stiffness.

**Q. 4** a) How to convert multi-springs, multi dampers into a single spring and damper with    **10**
linear or rotational coordinate system?

b) A machine part having a mass of 2.5kg vibrates in a viscous medium. A harmonic    **10**
exciting force of 30N acts on the part and causes a resonant amplitude of 14mm
with a period of 0.22 sec. Find the damping coefficient. If the frequency of the
exciting force is changed to 4Hz, determine the increase in amplitude of forced
vibrations upon the removal of the damper.

**Q. 5** a) Determine the natural frequency of oscillation of a half solid cylinder of mass 'm'    **10**
and radius 'r' when it is slightly displaced from mean position and released.

b) How does the force transmitted to the base change as the speed of the machine    **10**
increases? Explain using an equation and the corresponding graph.

**Q. 6** a) Explain the principle of vibration measuring instruments and working principle of    **10**
any one amplitude measuring instrument.

b) Each crank and connecting rod of a four crank in-line engine are 200mm and 800mm    **10**
respectively. The outer cranks are set at $120^0$ to each other and each has a
reciprocating mass of 200kg. The placing between adjacent planes of cranks are
400mm, 600mm and 500mm. If the engine is in complete primary balance,
determine the reciprocating masses of the inner cranks and their relative angular
positions. Also find the secondary unbalanced force if the engine speed is 210rpm.

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