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

*Instructions:*

i. **Question No.1 is compulsory**
ii. **Attempt any 3 out of the remaining questions**
iii. **Use your judgement for unspecified data, if any but justify the assumption.**
iv. **Numbers to the right indicate marks.**

---

**Q1.** Attempt **any four** of the following sub questions: **(20)**

**a.** What do you mean by critical speed of a shaft, derive an expression for critical frequency for an undamped shaft. **(5)**

**b.** A vertical spring mass system has a mass of 0.5 kg and an initial deflection of 0.2 cm. find the spring stiffness and natural frequency of the system. **(5)**

**c.** Compare viscous and coulomb damping. Mention at least five points of difference. **(5)**

**d.** Explain the meaning of vibration isolation and transmissibility. List at least four vibration isolation materials. **(5)**

**e.** Why does gyroscopic couple occurs. Derrive an expression for Gyroscopic couple from first principle. **(5)**

**Q2.a** A machine part weighing 20 N vibrates in a viscous medium. Determine the damping coefficient when a harmonic exciting force of 25 N results in resonant amplitude of 0.01 m with a period of 0.2 sec. if the same system is excited by a harmonic force of frequency 4 Hz. What will be the percentage increase in the amplitude of forced vibration when the dash pot is removed? **(10)**

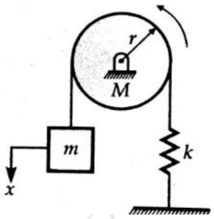
**Q2.b** The turbine rotor of a ship has a mass of 2000 kg and rotates at a speed of 3000 r.p.m. clockwise when looking from a stern. The radius of gyration of the rotor is 0.5 m. Determine the gyroscopic couple and its effects upon the ship when the ship is steering to the right in a curve of 100 m radius at a speed of 16.1 knots (1 knot = 1855 m/hr). Calculate also the torque and its effects when the ship is pitching in simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 50 seconds and the total angular displacement between the two extreme positions of pitching is 12°. Find the maximum acceleration during pitching motion. **(10)**

**Q3.a** The crank-pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from I.D.C., the difference between the driving and the back pressures is 0.35 N/mm2. The connecting rod length between centres is 1.2 m and the cylinder bore is 0.5 m. If the engine runs at 250 r.p.m. and if the effect of piston rod diameter is neglected, calculate : 1. pressure on slide bars, 2. thrust in the connecting rod, 3. tangential force on the crank-pin, and 4. turning moment on the crank shaft. **(10)**

**Q3.b** A gun barrel having mass 560kg is designed for following data : Initial recoil velocity 36m/sec. Recoil distance on firing 1.5m Determine :i) Spring constant ii)Damping coefficient iii.) time required by barrel to return to a position of 0.12m from its initial position. **(10)**

**Q4.a** A Porter governor has all four arms 250 mm long. The upper arms are attached on the axis of rotation and the lower arms are attached to the sleeve at a distance of 30 mm from the axis. The mass of each ball is 5 kg and the sleeve has a mass of 50 kg. The extreme radii of rotation are 150 mm and 200 mm. Determine the range of speed of the governor. **(10)**

**Q4.b** Find the natural frequency of the system shown in figure by no slip. **(10)**




**Q5.a.** A five cylinder in-line engine running at 750 r.p.m. has successive cranks 144° apart, the distance between the cylinder centre lines being 375 mm. The piston stroke is 225 mm and the ratio of the connecting rod to the crank is 4. Examine the engine for balance of primary and secondary forces and couples. Find the maximum values of these and the position of the central crank at which these maximum values occur. The reciprocating mass for each cylinder is 15 kg. **(10)**

**Q5.b** A vehicle has a mass of 1200 kg. The suspension system has a spring constant of 400 kN/m and damping ratio 0.5. If the vehicle speed is 100 km/hr. determine the displacement amplitude of vehicle. The road surface varies sinusoidal with an amplitude of 0.05 m and wavelength of 6 m. **(10)**

**Q6.a** A connecting rod of an I.C. engine has a mass of 2 kg and the distance between the centre of gudgeon pin and centre of crank pin is 250 mm. The C.G. falls at a point 100 mm from the gudgeon pin along the line of centres. The radius of gyration about an axis through the C.G. perpendicular to the plane of rotation is 110 mm. Find the equivalent dynamical system if only one of the masses is located at gudgeon pin. **(5)**

**Q6.b** Explain vibration based condition monitoring and fault diagnosis in rotating machine. **(5)**

**Q6.c** A vibrometer having a natural frequency of 4 rad/sec and $\xi$ = 0.2 is attached to a structure that performs a harmonic motion. If the difference between the maximum and the minimum recorded values is 8 mm, find the amplitude of motion of the vibrating structure with its frequency is 40 rad/s. **(10)**

*************