B.E. MECHANICAL ENGINEERING (PART TIME) FIRST YEAR SECOND SEMESTER - 2018

ENGINEERING MECHANICS- IV

Time: 3 hours **Full Marks: 100**

(Answer any *five* questions)

1. (a) Derive the mathematical relationships for the oblique central impact between two spherical masses m_1 and m_2 having initial velocities of v_1 and v_2 respectively. (8)

(b) What is the difference between elastic and inelastic impact. (2)

(c) Car B is initially stationary and is struck by a car A, which is moving at a speed of v. The mass of the car B is pm where m is the mass of the car A and p is a positive constant. If the coefficient of restitution is e=0.1, express the speeds v_A' and v_B' of the two cars at the end of the impact in terms of p and v. (10)

2. (a) State the assumptions of Lame's Theorem. Based on this theory, deduce the general expressions for the maximum Hoop stress and radial stresses in thick cylinders. (4+8)

(b) A thick cylinder has inner and outer diameters of 120mm and 180mm respectively. It is subjected to an external pressure of 9MPa. Find the value of the internal pressure which can be applied if the maximum stress is not to exceed 30MPa. (8)

3. (a) What is meant by shear center. What is the location of the shear center for sections having one and two-axes of symmetry? (5)

(b) Explain the term *unsymmetric bending*. (5)

(c) Determine the position of the shear center for a channel section of 60mm by 60mm outside and of 5mm thickness, with its web vertical. (10)

4. (a) Explain in brief ***any two*** of the following failure theories along with the associated region of safety (*i*) Maximum Principal stress theory (ii) Maximum Shear Stress Theory (iii) Maximum Distortion energy theory. (5+5=10)

(b) Design a steel bolt subjected to a tensile load of 20kN along with a shear force of 10kN. The yield point of the material is 300MPa and Poisson's ratio is 0.30. Calculate the safe diameter of the bolt according to (i) Maximum Principal stress theory; (ii) Maximum Distortion energy theory, assuming a factor of safety of 2.5. (5+5=10)

5.(a) The 50-g bullet (**Fig. 1**) traveling at 600 m/s strikes the 4-kg block centrally and is embedded within it. If the block slides on a smooth horizontal plane with a velocity of 12 m/s in the direction shown prior to impact, determine the velocity $\mathbf{v}_2$ of the block and embedded bullet immediately after impact. (10)

(b) Spherical particle 1 has a velocity v_1=6 m/s in the direction shown (**Fig. 2**) and collides with spherical particle 2 of equal mass and diameter and initially at rest. If the coefficient of restitution for these conditions is e=0.6, determine the resulting motion of each particle following impact. (10)

[Turn over

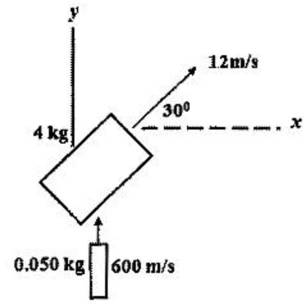

Fig. 1

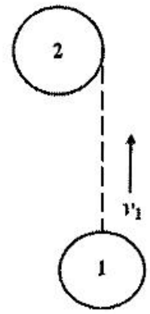

Fig. 2

6.(a) Develop the expressions for the radial and hoop stresses induced in a flat rotating solid disc of uniform thickness. What are the maximum values of the same and at what radii. (10)

(b) A disc of uniform thickness and 600m diameter rotates at 1800rpm. Find the maximum stress developed in the disc. If a hole of 100mm diameter is made at the center of the disc, find the maximum values of the radial and hoop stresses. Density of the material of the disc= $7700 kg/m^3$ and Poisson's ratio=0.30. (10)

7. (a) What is the difference between static friction and dynamic friction? (5)

(b) The 50kg crate (**Fig. 3**) is stationary when a force *P* is applied. Determine the resulting acceleration of the crate if (*i*) *P*=150N and (*ii*) *P*=300N. (8)

(c) A body of weight 400N slides along an inclined plane making an angle of 30^0 with the horizontal having an initial velocity of 2m/s. The distance travelled by the body along the plane is 2 meters and after that it strikes a spring whose stiffness is 100N/mm. Taking coefficient of friction μ=0.20, determine the compression of the spring. (7)

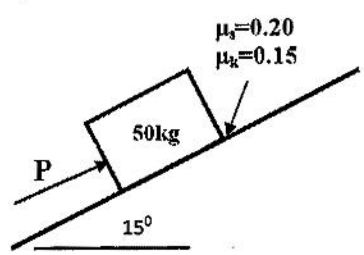

Fig. 3