BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) FIRST YEAR
SECOND SEMESTER – 2019
ENGINEERING MECHANICS – IV

Time: 3 Hrs. **Full Marks: 100**

(Answer Any Five Questions)

1. (a) State the principle of conservation of Linear Momentum. (4)

(b) The 50-g bullet (**Fig. 1a**) travelling 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 v_2 of the block and embedded bullet immediately after impact. (8)

(c) A 75-g projectile (**Fig. 1b**) travelling at 600 m/s strikes and becomes embedded in the 50-kg block, which is initially stationary. Compute the energy lost during the impact. Express the answer as an absolute value and as a percentage n of the original system energy E. (8)

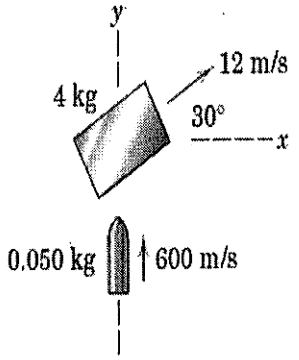

Fig. 1(a)

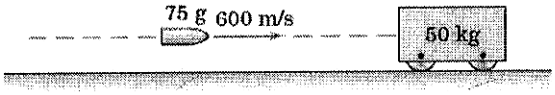

Fig. 1(b)

2. (a) State the Lame's theorem. Based on this theory, derive the expressions for the maximum Hoop stress and radial stress in thick cylinders. (4+8)

(b) Find the thickness of metal necessary for a cylindrical shell of internal diameter 160mm to withstand an internal pressure of $8N/mm^2$. The maximum Hoop's stress in the section is not to exceed $35N/mm^2$. (8)

3. (a) What is meant by shear centre of a cross-section. What will be the location of the shear centre for sections having one- and two-axes of symmetry? (8)

(b) Derive an expression for the shear centre of the channel section shown in **Fig. 3a**. (12)

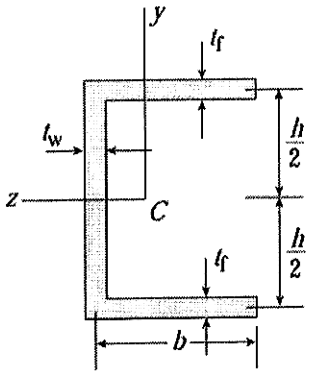

Fig. 3a

4. (a) Explain in brief ***any two*** of the following failure theories (*i*) Maximum Principal Stress theory (*ii*) maximum Shear Stress theory (*iii*) Maximum Distortion energy theory. (10)

(b) Design a steel bolt subjected to a tensile load of 20kN along with a shear stress 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 Shear Stress theory and (*ii*) Maximum Distortion Energy theory, assuming a factor of safety of 2.5. (10)

5. (a) Develop an expression for the radial and hoop stresses induced in a flat rotating solid disc of uniform thickness. (12)

(b) A steel disc of uniform thickness and diameter 900mm is rotating about its axis at 3000 rpm. Determine the radial and circumferential stresses at the centre and outer radius. The density of the material is 7800kg/m^3 and Poisson's ratio is 0.30. (8)

6. (a) Compute the final velocities v_1' and v_2' after collision of the two cylinders (**Fig. 6a**) which slide on the smooth horizontal shaft. The coefficient of restitution is e=0.6. (10)

(b) The two cars (**Fig. 6b**) collide at right angles in the intersection of two icy roads. Car *A* has a mass of 1200 kg and car *B* has a mass of 1600 kg. The cars become entangled and move off together with a common velocity in the direction indicated. If car *A* was travelling 50 km/h at the instant of impact, compute the corresponding velocity of car *B* just before impact. (10)

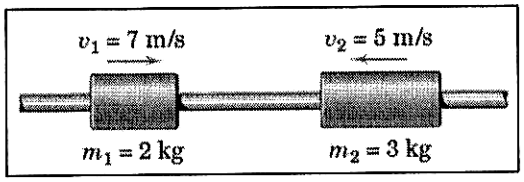

Fig. 6a

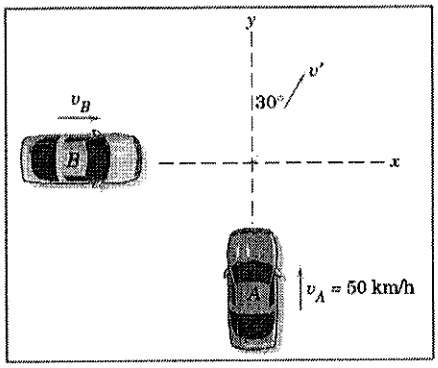

Fig. 6b

7. (a) A mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000N-m and a torque T. If the yield point of the steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft according to (*i*) The maximum principal stress. (*ii*) The maximum shear stress. (*iii*) The maximum distortion strain energy theory of yielding. (5+5+5)

(b) The 20lb block (**Fig. 7**) is moving to the right with a velocity of 2.0ft/s on a horizontal surface when a force ***P*** is applied to it at time t=0. Calculate the velocity v of the block when t=0.4sec. The coefficient of kinetic friction is μ_k=0.30. (5)

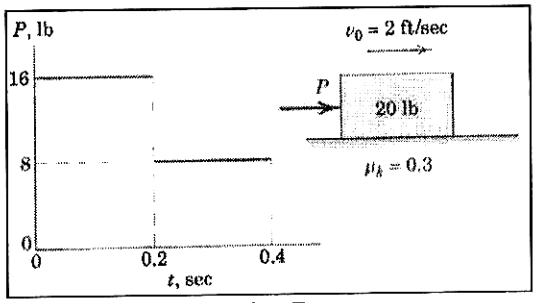

Fig. 7