Strength of materials-II
(ME-204, MAY 2007)

Time: 3 Hrs
Max Marks: 60

Note: Section A is compulsory. Attempt any four questions from Section B and any two from Section-C.

Section-A

1. a) What is strain energy? How does it related between the suddenly applied loading and gradual applied loading?
   b) Differentiate between the distortional and dilatational stresses.
   c) List the applications of closed coiled helical spring.
   d) Write the general equation for shear stress distribution for a beam subjected to lateral loading.
   e) What is Maxwell's theorem of reciprocal deflection?
   f) What is "Unit-moment' method?
   g) What are Lame's equations?
   h) What is critical cross-section in case of curved beams?
   i) What is Castigliano's theorem and its significance?
   j) What are the various theories of failure?

Section-B

2. Derive the equation for the slope at the free end of a cantilever carrying UDL over its full length Using Castigliano's theorem.
3. A flat spiral spring is 18 mm wide, 0.5 mm thick and 3 m long. Assuming the maximum stress of 800 MN/m^2 to occur at the greatest bending moment, calculate the torque, the work stored and the number of turns to wind up the spring.
4. A closed coil helical spring whose free length when not compressed is 15 cm is required to absorb strain energy equal to 50 N-m when fully compressed with the coils in contact. The maximum shearing stress is limited to 140 MPa. Assuming a mean coil diameter of 10 cm, find the diameter of the steel wire required and number of coils. G = 80 GPa.
5. A thick cylinder of 100 mm internal radius and 150 mm external radius is subjected to an internal pressure of 69 MN/m^2 and external pressure of 30 MN/m^2. Determine the hoop and radial stresses at the inside and outside of the cylinder together with the longitudinal stress if the cylinder is assumed to have closed ends.
6. The cross-section of the turbine rotor disc is designed for uniform strength under rotation conditions. The disc is keyed to a 60 mm diameter shaft at which point its thickness is a maximum. It then tapers to a minimum thickness of 10 mm at the outer radius of 250 mm where the blades are attached. If the design of the shaft is 250 MN/m^2 at the design speed of 12,000 r.p.m. What is the required maximum thickness? For steel ρ = 7470 kg/m^3.

Section-C

7. a) Derive the relation for the strain energy resulting from the bending of a beam (neglecting shear).
   b) A beam, simply supported at its ends, is of 4 m span and carries, at 3 m from the left hand support, a load of 20 KN. If I is 120 x 10^{-6} m^4 and E = 200 GN/m^2, find the deflection under the load using the relation in part (a).
8. a) Derive the general relation for the shear stress distribution due to bending.
   b) At a certain section a beam has a rectangular cross-section, 100 x 200 mm. The beam is simply supported at its ends and carries a central concentrated load of 500 KN together with uniformly distributed load of 300 KN/m across. Draw the shear stress distribution diagram for a section 1 m from the left hand support.
9. a) State the Lame equation for hoop and radial stresses in a thick cylinder to an internal pressure and show how these may be expressed in graphical form.
   b) A steel tube is shrunk on to another steel tube to form a compound cylinder 60 mm internal diameter, 180 mm external diameter. The initial radial compressive stress at the 120 mm common diameter is 30 MN/m^2. Calculate the shrinkage allowance. E = 200 GN/m^2.