BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2022 – 2023
Comprehensive Exam
Mechanics of Solids

Course No: CE F211 **Date: 19. 12. 2022**
Time: 9 AM to 12 Noon
Instructions: **Max. Marks: 90**

(a) Part A will be Closed Book and Part B will be Open Book
(b) Assume necessary data suitably
(c) Solve Part B after submission of Part A
(d) Text book and Hand-written class notes are only allowed for Part B

Part A (Closed book)

Q1a) Draw Free body diagram for following systems **[3]**
i. A body resting on rough surface
ii. Clamped support
iii. A frictionless pinned joint

Q1b) Link BC is 6 mm thick and is made of a steel with a 150 MPa yield strength in tension. What should be its width w if the structure shown (**Fig. Q1(b)**) is being designed to support a 20 kN load P? **[7]**

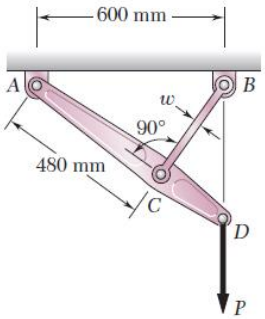

Fig. Q1(b)

Q2. The shear-force diagram for a beam is shown in the **Fig. Q2**. Assuming no couples act as loads on the beam, determine the forces acting on the beam and draw the bending moment diagram. **[8]**

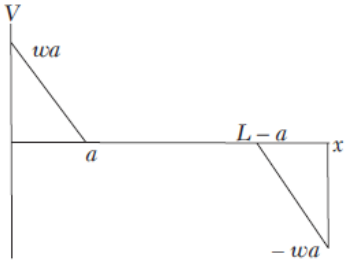

Fig. Q2

Part B (Open book)

3. A cantilever 1m long carries a concentrated load of 500 kg at its free end and a UDL of 250 kg/m over the entire length. The cantilever has a channel section with overall width 10 cm, depth 5 cm and 1.5 cm thick web and flanges as shown in **Fig. Q3**. Calculate the value of maximum compressive and tensile stress produced due to bending. **[9+9]**

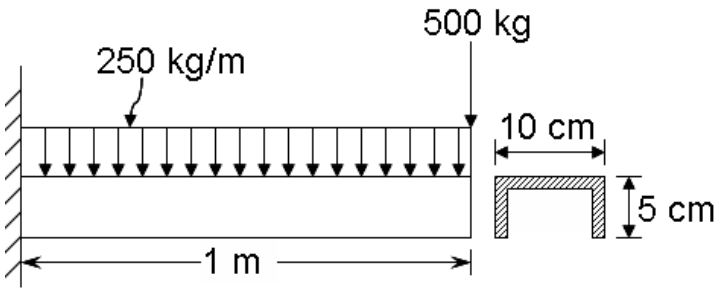

Fig. Q3

4. The torques shown (**Fig. Q4**) are exerted on pulleys *A* and *B* which are attached to solid circular shafts *AB* and *BC*. In order to reduce the total mass of the assembly, determine the smallest diameter of shaft *BC* for which the largest shearing stress in the assembly is not increased. **[7]**

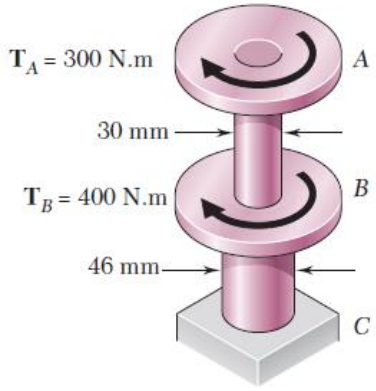

Fig. Q4

5. For the following loading conditions, write expression for [**8**]

i) Magnitude of deflection at center for simply supported beam subjected to udl over whole span.

ii) Magnitude of slope at free end of a cantilever beam subjected to point load at its free end.

iii) Magnitude of slope and deflection at free end of a cantilever beam subjected to moment at its free end.

Determine the maximum deflection and maximum slope for the given loading condition on the simply supported beam as shown in **Fig. Q5**. Further, find the locations of maximum deflection and maximum slope. Assuming Flexural Rigidity EI is constant thorught the length of the beam.

[**5+5+2+2**]

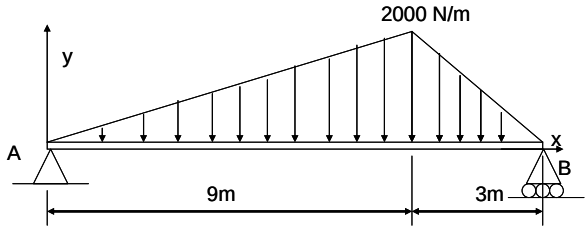

Fig. Q5

6. In a steel material in state of plane strain, it is known that the horizontal side of 10 X 10 mm square elongates by 4 μm, while its vertical side remains unchanged, and that the angle at the lower left corner increases by 0.4 x 10^{-3} radians. Determine the principal axes and principal strains. Also determine maximum shearing stress and corresponding normal stresses. Show salient features on Mohr's Circle. If temperature is increased by 10^0C, determine normal strains and shearing strains. **[4+5+5+5+3+3 = 25]**