Department of ...

AML150. Mechanics of Solids and Fluids

Dated: 28.11.2006.

MAJOR TEST

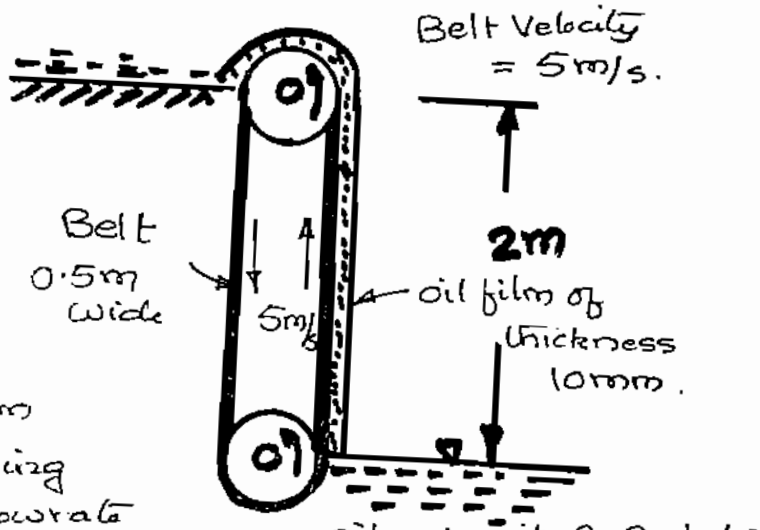
Max. Marks: 70.

I Sem, 2006-07.

Time: 1-3.00pm

NOTE: Answer ALL Questions.

(1) The Belt pump shown in the figure is moving at 5m/s and has a width of 0.5m. It is used to lift the oil Vertically by 2m. $\rho_{oil} = 900 kg/m^3$, $\mu_{oil} = 5$ Poise. The oil film sticking to belt surface is 10mm thick and shear stress at the free surface of the oil film is zero. Starting from basic governing equations, derive the expression for flowrate and calculate its Value. If the work done by the pump is only due to overcoming shear stress at the oil film, (area = 2m × 0.5m), calculate the efficiency of the pump. (13)



Make suitable assumptions and state them.

(2) The Power (P) required to drive a water pump depends on water density (ρ), pump speed (ω), flowrate (Q) and pump size (d). Using dimensional analysis and choosing ρ, ω and d as repeat Variables, derive the expressions for the dimensionless groups. A 1:10 scale model of the pump was tested with water with the following data.

$\rho_w = 1000 kg/m^3$, $\omega_m = 2000$ rpm, $Q_m = 10 m^3/hr$, $P_m = 100 W$.

Calculate the corresponding Power and Flowrate of the prototype if the prototype pump speed is 1200rpm. (10).

(3) Briefly describe the following.

(a) Bernoulli Equation for Adiabatic flow of a Perfect gas

(b) Vorticity and circulation in a Fluid Flow.

(c) Stability of a Floating Body. (12)

(Continued at the back)

Q4 In an experiment on a piece of aluminium, the following stresses were applied:
$\sigma_{xx} = 36.0$ MPa, $\sigma_{yy} = -32.8$ MPa & $\sigma_{zz} = -21.3$ MPa
Also, the following strains were measured:
$\varepsilon_{xx} = 713.8 \times 10^{-6}$, $\varepsilon_{yy} = -502.3 \times 10^{-6}$
Using this data, determine E, ν and K (bulk modulus) of aluminium. Clearly state the relationships used by you and the corresponding restrictions. (10)

Q5 What are the basic assumptions involved in the Bernoulli-Euler beam theory. Derive the relationship between the bending moment, bending stress and curvature of the beam. Why is it necessary to restrict plane of bending to the symmetry plane? Also,
(i) Show the variation of bending stress through beam depth.
(ii) How is the neutral axis determined? (12)

Q6 A beam AB of constant flexural rigidity (EI) is loaded as shown below. Find the end slope θ_A and end deflection δ_A of the beam. State the relevant equations/theorems involved in the method adopted by you. (13)