THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
DIPLOMA IN TECHNOLOGY – LEVEL 3
FINAL EXAMINATION 2006

MEX3271 – APPLIED MECHANICS

DATE : 27TH MARCH 2007
TIME : 0930 – 1230 HRS.
DURATION : THREE HOURS

ANSWER ANY FIVE (05) QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS.

QUESTION 01

A power transmission shaft of hollow circular section, 180 mm outer diameter and 120 mm inner diameter, is subjected simultaneously to an axial thrust of 300 kN and an axial torque of 45 kNm. Determine the following.

(i) Magnitude of the axial compressive stress in the shaft due to the thrust alone.

(ii) Magnitude of the maximum shear stress in the shaft due to the torque alone.

(iii) Magnitudes of principal stresses due to the combined loading.

(iv) Maximum shear stress due to combined loading.

QUESTION 02

A phosper- bronze shaft of 50 mm diameter and 600 mm long is bored axially for a part of its length to a diameter of 25 mm. The shaft is subjected to a twisting moment (axial torque). If the angle of twist in the section of the shaft with the 25 mm bore is the same as that in the solid section of the shaft, determine the length to which the hole has been bored.

What is the total angle of twist of the shaft when it transmits a power of 18 kW at an angular speed of 420 rev/min.?

Also find the ratio of the maximum shear stresses produced in the two sections of the shaft.

Take the rigidity modulus of phosper- bronze as 42 GN/m^2.

QUESTION 03

A beam of length 8 m is simply supported at its ends and carries a uniformly distributed load of 40 kN/m as shown in Fig. Q3. Determine the deflection of the beam at the mid point of the beam.

Also show that the maximum deflection of the beam occurs at a point at a distance of approximately 3.83 m from the left support. Calculate the maximum deflection.

Second moment of area of the cross section of the beam is 4.3×10^8 mm^4 and the modulus of elasticity of the material of the beam is 200 GN/m^2.

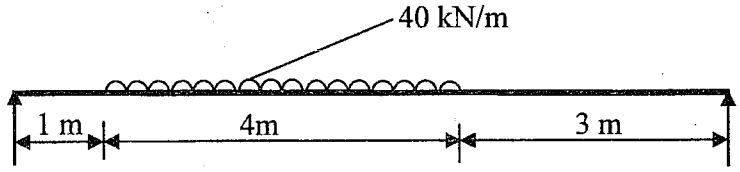


Fig. Q3

QUESTION 04

Show that the buckling load (P) for a column with both ends pinned is given, in usual notations, by

$$P = \frac{\pi^2 EI}{L^2}$$

A hollow mild steel tube 6 m long, 40 mm internal diameter and 5 mm thick is used as a strut with both ends pinned. Calculate the buckling load.
Modulus of elasticity of mild steel is 200 GN/m^2.

What would be the safe load if the factor of safety is 3?

QUESTION 05

A machine is driven by a constant torque motor at a mean speed of 80 rad/s. The load on the shaft increases uniformly with time from 50 Nm to 200 Nm over one revolution, remains constant for the following three revolutions, decreases suddenly to 50 Nm and remains constant for further two revolutions. This operation cycle, lasting a total of six revolutions, is repeated. Determine,

(i) the power of the motor, and

(ii) the moment of inertia of the flywheel required to keep the fluctuation of speed of the shaft within ± 1 rad/s of the mean speed.

QUESTION 06

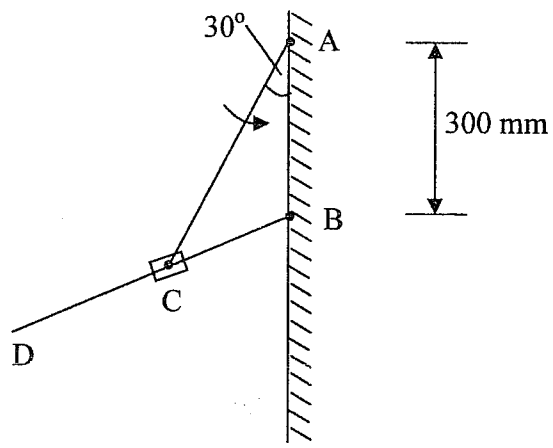


Fig. Q6

Fig. Q6 shows two links AC and BD, pivoted at A and B respectively. The link AC is 550 mm long and it carries a slider C through which the link BD is passed. Link AC rotates at a uniform angular velocity of 10 rad/s in the anticlockwise direction. For the position shown draw,

(a) the configuration diagram to a suitable scale.

(b) the velocity diagram and determine velocity of sliding of C along link BD.

(c) the acceleration diagram, and determine the acceleration of sliding of C along link BD and the angular acceleration of link BD.

QUESTION 07

Show that the belt friction formula for a belt drive system can be expressed, in usual notation, as

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

Two pulleys having diameters 500 mm and 200 mm are on parallel shafts 2 m apart. They are connected by a cross belt with negligible mass. Find the length of the belt required and the angle of lap between the belt and each pulley.

What power could be transmitted by the belt when the larger pulley rotates at 240 rev/min, if the maximum permissible tension in the belt is 1 kN and the coefficient of friction between the belt and pulley is 0.3?

QUESTION 08

What is the condition for stability of governors?

A Porter governor has four arms each 250 mm long and lying in the same vertical plane. The upper arms are pivoted on the axis of rotation and the lower arms are attached to the sleeve at a distance 25 mm form the axis. The mass of each ball is 4 kg and the load on the sleeve is 40 kg. The extreme radii of rotation are 160 mm and 200 mm. Starting from fundamentals determine the maximum and minimum equilibrium speeds.

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