Ex/FTBE/ME/T/215/2017(S)

B. FTBE 2nd Year, 1st Semester SUPPLEMENTARY EXAMINATION, 2017

MECHANICS OF SOLIDS

Time : Three hours | Full Marks : 100

Answer any *five* questions

1. a) For a vector with direction cosines l, m, n prove that $l^2 + m^2 + n^2 = 1$. (10)

   b) The force $\vec{F}$ is expressed as a function of position as

   $\vec{F} = (10x - 6)i + (x^2z)j + (xy)k$.

   What are the direction cosines of the force at position (1, 2, 2) ? What is the position along the x coordinate where $F_x = 0$? F_x is the scalar component of F along x-axis. (10)

2. a) Given a force $\vec{F} = (20i + 10j + Pk)$ N. If this force is to have a component 16 N along a line having a unit vector $\vec{r} = 0.6i + 0.8k$, what should be the value of P? What is the angle between between F and r ? (10)

   b) What is the component of the cross product $(\vec{A} \times \vec{B})$ along the direction n where $\vec{A} = 10i + 16j + 3k$, $\vec{B} = 5i - 2j + 2k$, and $\vec{n} = 0.8i + 0.6k$. (10)

3. Write down the equations of equilibrium for a rigid body subjected to parallel and concurrent system of forces. Define statically determinate and statically indeterminate problems. A weight Q is suspended from point B of an inextensible cord ABC, the ends of which are pulled by equal weights P over-hanging small pulleys A and C which are on the same level (Figure Q3). Neglecting the radii of the pulleys determine the sag BD if AC = 4 m, P = 20 N and Q = 10 N. (20)

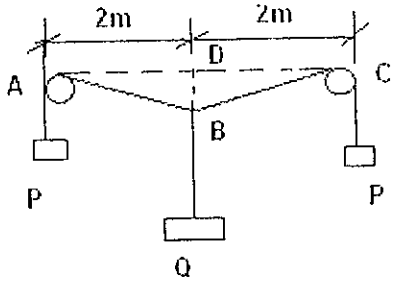

Figure Q3

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4. a) A mild steel tensile test specimen, having a circular cross-section of diameter, d = 1.5 cm shows an elongation reading of 0.01 cm over a gauge length of 10.0 cm. Calculate the tensile stress in the material, assuming that Young's Modulus of Elasticity, $E = 0.8 \times 10^6$ kgf/cm^2. (10)

   b) Derive the equation defining the deflection curve of a uniformly loaded cantilever beam. Also determine the expression for the maximum deflection of the beam. (10)

5. a) For torsion of a circular shaft with usual notations show that

$$\tau_{max}/R = \tau/r = (G\theta)/L \quad (10)$$

   b) Determine the proper diameter of a solid steel shaft to transmit 300 hp at 3600 rpm, if the working stress in shear is 400 kgf/cm^2. (10)

6. a) A simply supported beam of length 1 m is subjected to uniformly distributed load of intensity, w = 2000 kgf/m. Draw the shear force and bending moment diagrams for the beam showing the important coordinates therein. (10)

   b) A 2 m long beam with rectangular section of 10 cm width and 20 cm height is simply supported at the ends. If the beam is loaded with a uniformly distributed load of 100 kgf/m throughout the span, determine at mid-span the bending stress at a point 2 cm above the bottom of the beam. (10)