B.E. MECH ENGG SECOND YEAR SECOND SEMESTER EXAM 2018

Time 3.0 Hrs. **ENGINEERING MECHANICS – IV** **Full Marks:100**

[**Answer All Questions**. Assume any missing data with suitable justifications.]

Group - 1

1. (a) Deduce the equation (refer to **Fig 1**)–

$$\vec{a}_{XYZ} = \vec{a}_{xyz} + \ddot{\vec{R}} + \vec{\omega}\times\left(\vec{\omega}\times\vec{\rho}\right) + \vec{\alpha}\times\vec{\rho} + 2\vec{\omega}\times\vec{V}_{xyz} \qquad 12$$

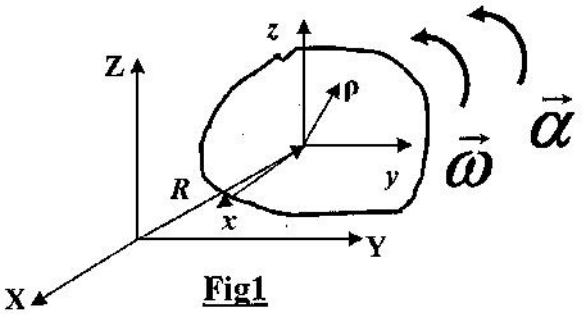

Fig1

(b) Refer **Fig 2**. The vertical shaft and attached clevis rotate about the **z**-axis at the constant rate Ω**=4 rad/s**. Simultaneously, the angle γ decreases at the constant rate of π**/4 rad/s**. Find the angular velocity, angular acceleration of the shaft **B**. Find also the velocity, acceleration of point **P** on the axis of the shaft and at its tip. Take $\gamma = 30^0$ and the length of shaft B equal to L. **13**

OR [for Q 1(b)]

Refer **Fig 3**. The circular disc is spinning about its own axis (**y**-axis) at the constant rate p**= 10**π **rad/s**. Simultaneously the frame is rotating about the **Z**-axis at the constant rate Ω **=4**π **rad/s**. Calculate the angular acceleration of the disc. Calculate also the velocity and acceleration of point **A** at the top of the disc. For calculation, use axes **xyz** which may be taken to be attached with the frame (not rotating with the disc) and has momentary orientation shown with respect to **XYZ**. **13**

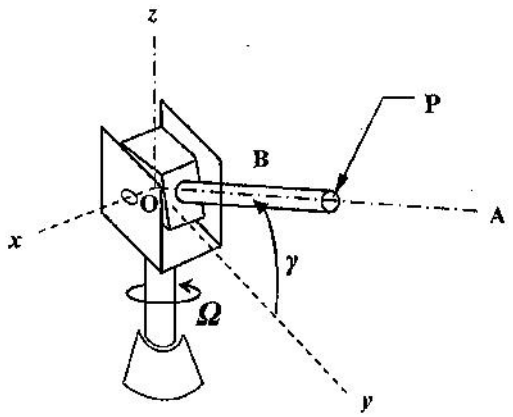

Fig2

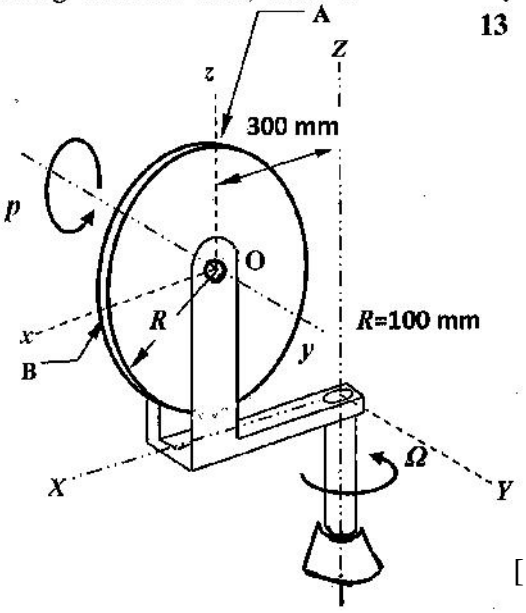

Fig3

Group - 2

2. (a) Deduce Euler's equations stating all the assumptions. **13**

(b) Refer **Fig 4**. A thin disc weighing **20 kg** rotates on rod **AB** at a speed ω_2= **100 rad/s**. The radius of the disc is **0.5m** and the disc is located **5m** from the centerline of the shaft **CD**, to which rod **AB** is fixed. Shaft **CD** rotates at ω_1= **50 rad/s**. Find the axial force, shear force and bending moment on rod **AB** at the end **A** due to the disc. **12**

OR [for Q 2(b)]

Refer **Fig 5**. The rectangular bar is spinning in space about its longitudinal axis at a rate of **200 rpm**. If its axis wobbles through an angle of **20 degrees**, calculate the time period (τ) of the wobble (about **O**). **12**

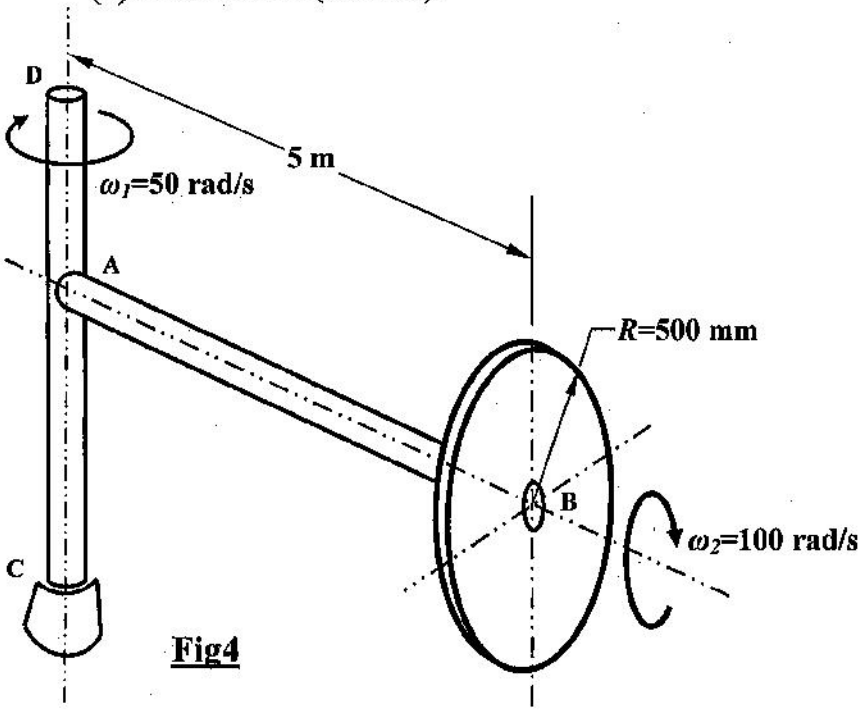

Fig4

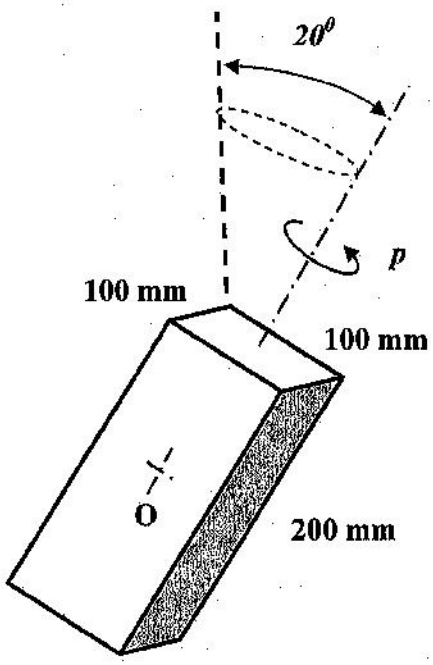

Fig5

Group – 3

3. (a) Deduce the expressions of octahedral normal and octahedral shear stresses for a three-dimensional stress state. **13**

(b) The stress state at a point in a body is given by –

$$\sigma_{xx} = -5.0 \text{ MPa}; \sigma_{yy} = 1.0 \text{ MPa}; \sigma_{zz} = 1.0 \text{ MPa}$$

$$\tau_{xy} = -1.0 \text{ MPa}; \tau_{yz} = 0; \tau_{zx} = 0$$

Find the principal stresses, maximum shear stress, Octahedral normal stress, Octahedral shear stress. **12**

Group – 4

4.(a) Consider the problem of a thick cylinder as a axis symmetric and plane stress problem (i.e., open ended cylinder). From fundamental principles, prove that –

$$\sigma_r = \alpha + \frac{\beta}{r^2} \text{ and } \sigma_\theta = \alpha - \frac{\beta}{r^2}$$

Hence, obtain the expression for radial and circumferential stress of an internally pressurized cylinder and plot it over a cross section of the cylinder. **13**

(b) A cantilever beam is of rectangular cross section and is subjected to a concentrated load applied at its free end. The load is so oriented that its line of action is along a diagonal of the cross section. Show that the neutral axis is along the other diagonal. Refer to **Fig 6.** **12**

OR[for Q4(b)]

A beam has a thin walled channel section. The width of the flange is ***b*** and height of the web is ***h***. It is loaded in a vertical plane so as to produce simple bending. Locate its shear centre. Refer to **Fig 7.** **12**

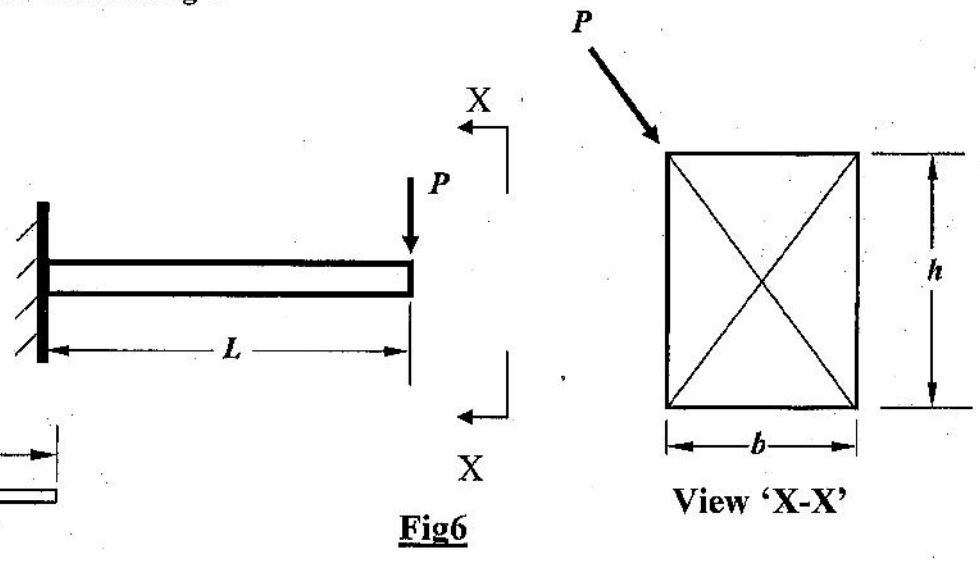

Fig6

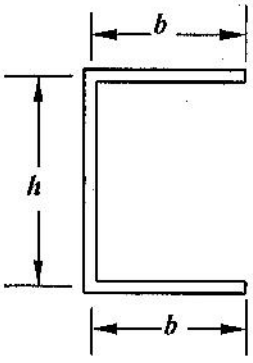

Fig7

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