School of Engineering and Applied Science (SEAS), Ahmedabad University

Name: _____ Roll no.: _____

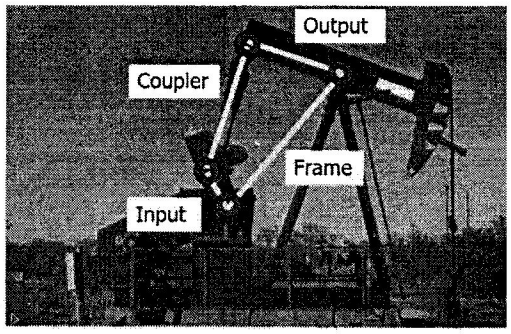
B. Tech. (Mechanical): Semester V
Dynamics of Machines and Vibrations (MEC 301): Mid Term Exam (Monsoon Sem.: 2023);
Marks: 40 M, Wt.: 25 %
September 21, 2022, Thursday: 2:00 PM – 4:00 PM

Instructions:

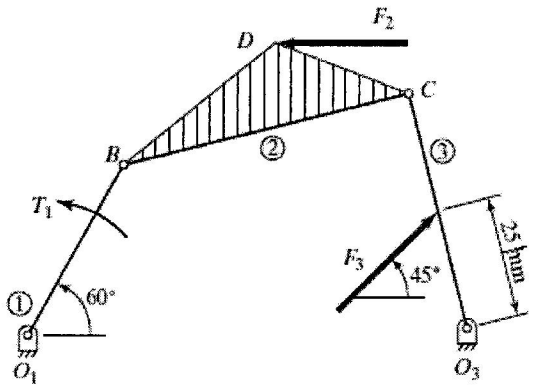
1. You are allowed to use only software and no other study materials/ppts should be opened in laptop.
2. Figures to right indicate full marks.
3. All acronyms carry their usual meaning.
4. Assume suitable data wherever necessary and specify it clearly in your answers.
5. Copying is strictly prohibited. Anyone found cheating will get zero marks.

Q1. Figure **(a)** below shows a pumpjack mechanism used in oil-well applications. For a particular configuration of the pumpjack mechanism, the distribution of forces on the various links is shown in the Figure **(b).** The dimensions of the links are provided as: $O_1O_3 = 90$ mm; $O_1B = 40$ mm; BC =60 mm; $O_3C = 50$ mm; BD = 40 mm and CD =30 mm. The forces $\mathbf{F_2}$ and $\mathbf{F_3}$ have magnitudes of 50 N and 75 N, respectively. Determine the required input torque $\mathbf{T_1}$ for static equilibrium of the mechanism.

Use graphical approach to solve the problem. You are allowed to use **FreeCAD** software for solving the problem. However, please note the following (i) sketch the final force vector diagrams in answer sheets properly (ii) mark the chosen scales, dimensions and directions in the vector diagrams suitably. **[15]**



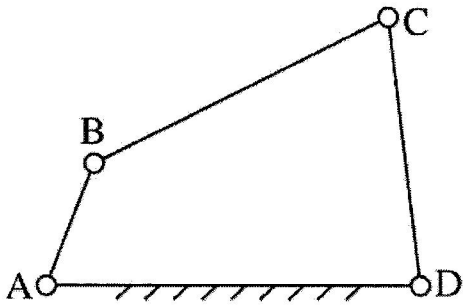
(a)



(b)

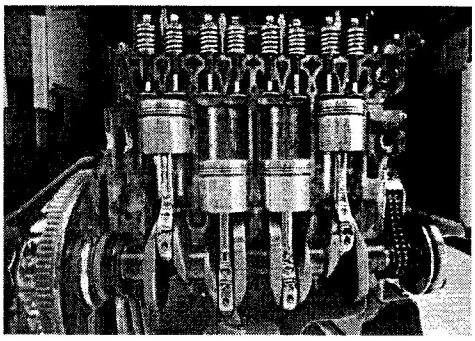
Q2. Figure below shows a four bar mechanism ABCD, where the dimensions of the links are AB = 500 mm, BC = 660 mm, CD = 560 mm and AD =1000 mm. At a particular instant, the links AB and CD make an angle of 60° and 100°, respectively, with the horizontal. The links AB and BC are assumed to be massless and the mass of the link CD is 5 kg/m of the link length. The angular acceleration of the link CD is 75 rad/s^2 and the linear acceleration of its centre of mass is 25 m/s^2 acting at an angle of 225° with the horizontal. Neglecting gravity and friction effects, determine the instantaneous drive torque required to be applied on AB to overcome the inertia forces and keep the mechanism in equilibrium.

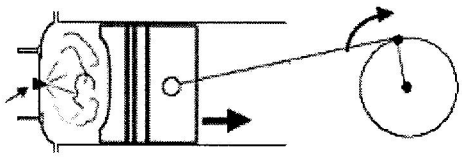
Use analytical approach to solve the problem. You are allowed to use **Python** software for solving the problem. However, please note the following (i) write the steps accurately in your answer sheets (ii) write the vector equations and numerical data appropriately. **[5]**



Q3 (a). In a horizontal four-stroke engine, the mass of the piston is 250 kg. The crank radius is 300 mm, the connecting rod length is 1200 m and the cylinder bore is 500 m. When the crank has travelled 60° from T.D.C., the driving and the back side pressures differ by 0.35 N/mm^2. If the engine runs at 250 R.P.M. and if the effect of piston rod diameter is neglected, determine: **a.** turning moment on the crank shaft, **b.** crank speed at which the net force on piston is reversed in direction. **[10]**

(b). The turning moment curve for an engine is defined by the equation, $\mathbf{T} = (20\,000 + 9500 \sin 2\theta - 5700 \cos 2\theta)$ N-m, where θ is the angle turned by the crank from inner dead centre. If the mean speed of the engine is 180 R.P.M. and the resisting torque is constant, determine: **1.** Power developed by the engine; **2.** Moment of inertia of flywheel in kg-m^2, if the total fluctuation of speed is not to exceed 1% of mean speed. **[10]**





----------All the best ----------