Name: **Enrolment No:**	**UPES SAP ID:**

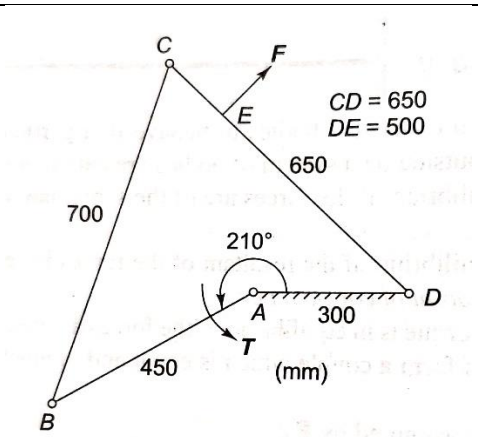
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May, 2021

Course: Advanced Theory of Machines — **Semester: V**
Program: B.Tech – Mechanical — **Time: 3 hours**
Course Code: MECH4024P — **Max. Marks: 100**
No. of Pages: 02

Note:

1. The paper consists of 3 sections A, B and C.
2. For Section A, type your answers in the browser directly
3. For Sections B and C, scan and upload your answers.
4. In Section C, Q12 has internal choice.

	Section A		
Q1.	Define centrode of a body. Mention its types.	**5**	**CO1**
Q2.	Define following terms: a. Kinematic Mechanism b. Kinematic chain c. Degree of freedom d. Lower pair e. Higher pair	**5**	**CO1**
Q3.	Explain the terms sensitiveness and hunting of a governor.	**5**	**CO1**
Q4.	Define the terms coefficient of fluctuation of energy and coefficient of fluctuation od speed as applied to flywheel.	**5**	**CO1**
Q5.	Explain Bobillier theorem as applied to acceleration analysis.	**5**	**CO1**
Q6.	Explain the principle of virtual work.	**5**	**CO1**
	Section B		
Q7.	Each arm of a Porter governor is 250 mm long and is pivoted on the axis of rotation. The mass of each ball is 5 kg and the sleeve is 25 kg. The sleeve begins to rise when the radius of rotation of the balls is 150 mm and reaches the top when it is 200 mm. If the friction at sleeve is equivalent to 10 N, determine the range of speed, lift if sleeve, governor effort and power.	**10**	**CO3**
Q8	Design a four-link mechanism to coordinate three positions of the input and the output links given by $\theta_1 = 25° \varphi_1 = 30°$ $\theta_2 = 35° \varphi_2 = 40°$ $\theta_3 = 50° \varphi_3 = 60°$	**10**	**CO2**
Q9	Determine the torque required to be applied to the link AB of the linkage shown in figure below to maintain the static equilibrium if F = 100 N. The lengths of the links are mentioned beside each link in mm.	**10**	**CO3**



Q10	A machine is coupled to a two-stroke engine which produces a torque of (800 + 180 sin 3θ) N.m, where θ is the crank angle. The mean engine speed is 400 rpm. The flywheel and the other rotating parts attached to the engine have a mass of 350 kg at a radius of gyration of 220 mm. Calculate the (i) Power of the engine (ii) Total percentage fluctuation of speed of the flywheel.	**10**	**CO3**
Q11	Derive the expressions for velocity and acceleration of a piston	**10**	**CO3**
	Section C		
Q12	While balancing a turbine rotor by the field balancing, the results obtained are shown in table below. Determine the correct balance masses to be placed in planes A and B at the same radii as for the trail masses. Also, determine the angular positions of the balance masses with respect to the trail masses to have the complete dynamic balance of the rotor.	**20**	**CO4**

		Plane A		Plane B	
No.	Trial mass (kg)	Amplitude (mm)	Phase angle (degrees)	Amplitude (mm)	Phase angle (degrees)
1.	0	3×10^{-3}	25	5×10^{-3}	70
2.	3 (in plane A)	4.5×10^{-3}	110	3.8×10^{-3}	135
3.	3 (in plane B)	4×10^{-3}	60	3.2×10^{-3}	215

OR

The following data relate to a four-link mechanism:

$a = 55\ mm$ $m_a = 0.045\ kg$ $r_a = 28\ mm$ $\varphi_a = 0°$

$b = 165\ mm$ $m_b = 0.13\ kg$ $r_b = 85\ mm$ $\varphi_b = 15°$

$c = 80\ mm$ $m_c = 0.05\ kg$ $r_c = 42\ mm$ $\varphi_c = 0°$

$d = 150\ mm$

Complete force balancing by adding countermasses to the input and the output links is desired. Determine the mass-distance values and angular position of each countermass.