Name: **Enrolment No:**	

UPES

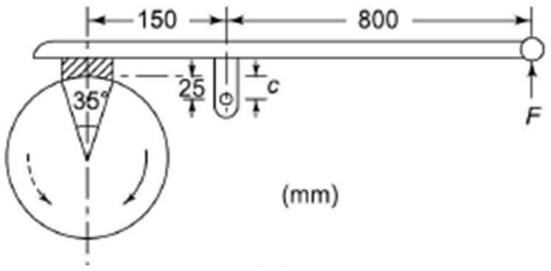
End Semester Examination, December 2023

Course: Theory of Machines
Semester: V
Program: BTech. Mechanical **Time : 03 hrs.**
Course Code: MECH 3031 **Max. Marks: 100**

Instructions:
1. While Solving the Problem by Graphical Construction Method, Assume Suitable Scale for Linear and Angular Dimensions.

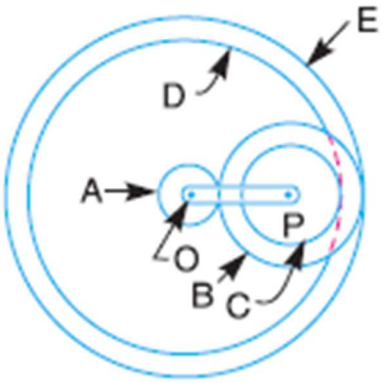
SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Define the pitch circle diameter, circular pitch, module, and pressure angle in Gear terminology.	**4**	**CO3**
Q 2	Define the instantaneous centre of rotation of a rigid body. Also, explain the Aronhold Kennedy theorem.	**4**	**CO2**
Q 3	Determine the maximum, minimum and average pressure in plate clutch. When the axial force is 4 kN. The inside radius of the contact surface is 50 mm, and the outside radius is 100 mm. Assume uniform wear.	**4**	**CO3**
Q 4	Explain the scotch yoke mechanism and its function.	**4**	**CO1**
Q 5	In a Whitworth quick return motion mechanism, the distance between the fixed centres is 50 mm and the length of the driving crank is 75 mm. The length of the slotted lever is 150 mm and the length of the connecting rod is 135 mm. Determine the ratio of the time of cutting stroke to the time of return stroke.	**4**	**CO1**
SECTION B **(4Qx10M= 40 Marks)**			
Q 6	A leather belt is required to transmit 7.5 kW from a pulley 1.2 m in diameter, running at 250 rpm. The angle embraced is 165° and the coefficient of friction between the belt and the pulley is 0.3. If the safe working stress for the leather belt is 1.5 MPa, density of leather 1000 kg/m^3 and thickness of belt 10 mm, determine the width of the belt taking centrifugal tension into account.	**10**	**CO3**
Q 7	Locate all the instantaneous centres of the slider crank mechanism. The lengths of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s, determine the velocity of the slider A, and angular velocity of the connecting rod AB.	**10**	**CO2**

Q 8	Derive a relation for minimum number of teeth on the gear wheel and the pinion to avoid interference. If two 20^0 involutes spur gear have a module of 10mm. The addendum is equal to one module, the larger gear has 40 teeth while the pinion has 20 teeth. Will the gear interfere with the pinion? **Or,** A block brakes are shown in figure. The diameter of brake drum is 1 m. Brake sustain 240 N-m of torque at 400 rpm. The coefficient of friction is 0.32. Determine the required force to be applied when the angle of contact is 35°. Also determine the modified value of parameter ***c*** for self-locking of the brake. 	**10**	**CO4**
Q 9	Two involute gears of 20° pressure angle are in mesh. The number of teeth on pinion is 20 and the gear ratio is 2. If the pitch expressed in module is 5 mm and the pitch line speed is 1.2 m/s, assuming addendum as standard and equal to one module. Determine the angle turned through by pinion when one pair of teeth is in mesh and the maximum velocity of sliding.	**10**	**CO4**
SECTION-C (2Qx20M=40 Marks)			
Q 10	A cam, with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion described as: to raise the valve through 50 mm during 120° rotation of the cam, to keep the valve fully raised through next 30°, to lower the valve during next 60° and to keep the valve closed during rest of the revolution i.e. 150°. The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm. Draw the profile of the cam when the line of stroke of the valve rod passes through the axis of the cam shaft. The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion. Determine the maximum acceleration of the valve rod when the cam shaft rotates at 100 rpm. Draw the displacement, the velocity and the acceleration diagrams for one complete revolution of the cam. Draw the displacement, velocity and acceleration diagrams for one complete revolution of the cam.	**20**	**CO5**
Q 11	Figure shows diagrammatically a compound epicyclic gear train. Wheels A, D and E are free to rotate independently on spindle O, while B and C are compound and rotate together on spindle P, on the end of arm OP.	**20**	**CO4**

All the teeth on different wheels have the same module. A has 12 teeth, B has 30 teeth and C has 14 teeth cut externally. Determine the number of teeth on wheels D and E which are cut internally.

If the wheel A is driven clockwise at 1 rpm. while D is driven counterclockwise at 5 rpm, determine the magnitude and direction of the angular velocities of arm OP and wheel E.



Or,

A reverted epicyclic gear train for a hoist block is shown in Fig. The arm *E* is keyed to the same shaft as the load drum and the wheel *A* is keyed to a second shaft which carries a chain wheel, the chain being operated by hand. The two shafts have common axis but can rotate independently. The wheels *B* and *C* are compound and rotate together on a pin carried at the end of arm *E*. The wheel *D* has internal teeth and is fixed to the outer casing of the block so that it does not rotate.

The wheels *A* and *B* have 16 and 36 teeth respectively with a module of 3 mm. The wheels *C* and *D* have a module of 4 mm. **a.** Determine the number of teeth on wheels *C* and *D* when the speed of *A* is ten times the speed of arm *E*, both rotating in the same sense. **b.** Determine the speed of wheel *D* when the wheel *A* is fixed, and the arm *E* rotates at 450 rpm anticlockwise.