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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; Feb. - 2021

Dynamics of Machinery

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Solve graphically the static forces acting in different links of simple planar mechanisms.

CO2: Solve inertia forces acting on different links of simple planar mechanisms using graphical method.

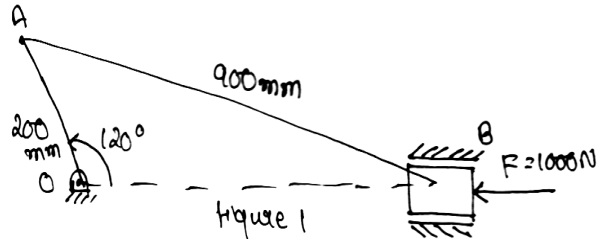
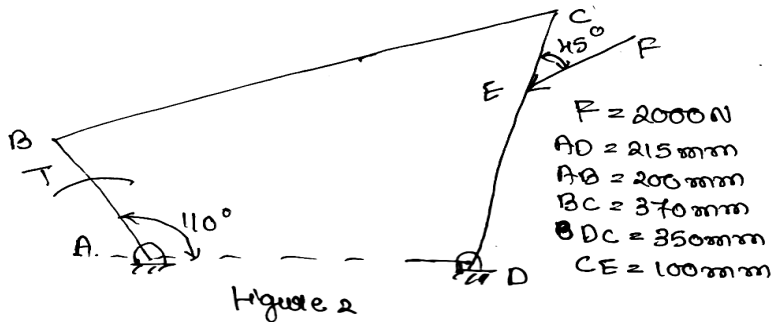
CO3: Explain turning moment diagram and Governors, Model flywheels.

CO4: Solve the magnitude and location of balancing masses for the rotating and reciprocating machines.

CO5: Explain working principle of Gyroscope and analyze the gyroscopic stability of mechanical systems. (airplane, ship, two and four wheeler).

***Note: I) PART - A** is compulsory. **Two** marks for each question.*

***II) PART - B**: Answer any **Two** sub questions (from a, b, c) for Maximum of **18 marks** from each unit.*

Q. No.	Questions	Marks	BLs	COs	POs
	I : PART - A	**10**			
I a.	Discuss the condition for equilibrium of a three force member.	2	L1	CO1	PO1
b.	Define inertia force.	2	L1	CO2	PO1
c.	Define flywheel.	2	L1	CO3	PO1
d.	Why is balancing of rotating parts necessary for high speed engines?	2	L1	CO4	PO1
e.	Define gyroscopic effect.	2	L1	CO5	PO1
	II : PART - B	**90**			
	UNIT - I	**18**			
1 a.	A slider crank mechanism is shown in Figure 1 the force applied to the piston is 1000 N, when the crank is at 120° from IDC. Determine the input torque *T* on the link *OA* for the static equilibrium of the mechanism for the given configuration.  Figure 1	14	L3	CO1	PO2
b.	In the Figure 2, a four bar mechanism is shown. Calculate the required value of *T* and various forces on links for the equilibrium of the system.  Figure 2	14	L3	CO1	PO2
c.	Discuss the condition for equilibrium of a four-force system.	4	L1	CO1	PO1

Contd....2

UNIT - II **18**

2 a.	When the crank is 45° from the inner dead centre on the down stroke, the effective steam pressure on the piston of a vertical steam engine is 2.5 bars. The diameter of the cylinder = 0.75 m, Stroke of the piston = 0.50 m and length of connecting rod = 1 m. Determine the torque on the crank shaft, if the engine runs at 350 rpm and mass of reciprocating parts is 200 kg.	14	L3	CO2	PO2
b.	In a vertical double acting engine, the connecting rod is 4.5 times the crank. Stroke of the piston is 400 mm and the mass of the reciprocating parts is 100 kg. The engine runs at 250 rpm. If the net load on the piston due to stream pressure is 25 kN when the crank has turned through an angle of 120° from the top dead center, determine; i) Net force on the piston or piston effect ii) Thrust in the connecting rod iii) Thrust on the sides of cylinder wall iv) Crank pin effort v) Thrust on crank shaft bearing vi) Turning moment	14	L3	CO2	PO2
c.	State and explain D-Alembert's principle.	4	L2	CO2	PO1

UNIT - III **18**

3 a.	The turning moment diagram for one revolution of a multi cylinder engine shows the following intercepted area in mm^2 above and below the load torque line: −5, +63, −42, +51, −49, +36, −58, +42, and −38. The vertical and horizontal scales are 1 mm equal to 1000 N-m and 5° respectively. The mean speed is 500 rpm and the overall fluctuation of speed is not to exceed 1.5% of the mean speed. Determine; i) Mass of the flywheel ii) Cross sectional area of the rim, if the mean peripheral speed is limited to 15 m/s Assume the mass of the rim is 90% of the mass of the flywheel and the mass density of the flywheel material is 7200 kg/m^2.	14	L3	CO3	PO2
b.	The cycle of operations performed by a machine extends over three revolutions. The torque required has a constant value of 400 N-m for one revolution, zero for the next revolution 550 N-m for the first half of the third revolution and zero for the second half. If the driving torque is constant. The mean speed is 180 rpm and the flywheel has a mass of 500 kg at a radius of gyration of a 0.5 m. Calculate; i) The power required ii) The percentage fluctuation of speed iii) The greatest acceleration and retardation	14	L3	CO3	PO2
c.	Write the difference between the functions of flywheel and governor.	4	L1	CO3	PO1

Contd….3

UNIT - IV **18**

4 a.	A rotating shaft carries four masses *A*, *B*, *C* and *D* of 10 kg, 15 kg, 18 kg, and 20 kg at radii 50 mm, 60 mm, 70 mm and 80 mm respectively. The masses *B*, *C* and *D* revolve in planes 400 mm, 600 mm, and 800 mm respectively measured from the plane of mass '*A*' and are angularly located at 60°, 145°, and 270° respectively measured anticlockwise from the mass *A* viewing from the mass *A*. The shaft is dynamically balanced by two masses both located at 50 mm radii and revolving in planes mid-way between the masses *A* and *B* and midway between those of masses *C* and *D*. Determine the magnitudes of the balancing masses and their respective angular position.	14	L3	CO4	PO2
b.	The firing order in a 6 cylinder vertical 4 stroke in line engine is 1–4–2–6–3–5, the piston stroke is 100 mm. Length of each C.R = 200 mm. The pitch distance between cylinder centerline are 100 mm, 100 mm,150 mm, 100 mm, and 100 mm. Determine the out of balance primary and secondary forces and couples on this engine taking a plane midway between cylinders 3 and 4 as reference plane . The reciprocating mass per cylinder is 2 kg and the engine runs at 1500 rpm.	14	L3	CO4	PO2
c.	What are In-line engines? State how they are balanced?	4	L2	CO4	PO1

UNIT - V **18**

5 a.	Describe the effect of the gyroscopic couple on an aeroplane.	14	L2	CO5	PO2
b.	The motor of a marine having a mass of 1000 kg and radius of gyration 300 mm rotates at 1550 rpm clockwise when looking from the bow. Determine the gyroscopic couple and its effect on the ship in the following cases: I) When the ship pitches with an angular velocity of 1 rad/s when the bow; i) Rising ii) Falling II) When the ship is speeding at 40 km/hr and takes a right turn in a circular path of 200 m radius III) When the ship rolls at certain instant, it has an angular velocity of 0.5 rad/s when viewed from the stern	14	L3	CO5	PO3
c.	Derive the gyroscopic effect on a disc.	4	L2	CO5	PO2

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