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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; February / March - 2022

Dynamics of Machines

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**			
1	a.	Define constraint force and applied force.	2	L1	CO1	PO1
	b.	State D'Alembert's principle.	2	L1	CO2	PO1
	c.	Define sensitiveness and stability of a governor.	2	L1	CO3	PO1
	d.	Define static and dynamic balancing.	2	L1	CO4	PO1
	e.	Define Gyroscopic effect.	2	L1	CO5	PO1
		II : PART - B	**90**			
		UNIT - I	**18**			
1.	a	For the mechanism shown in Fig. Q 1(a), find the required input torque for the static equilibrium. The lengths OA and AB are 250 mm and 650 mm respectively.	14	L3	CO1	PO2

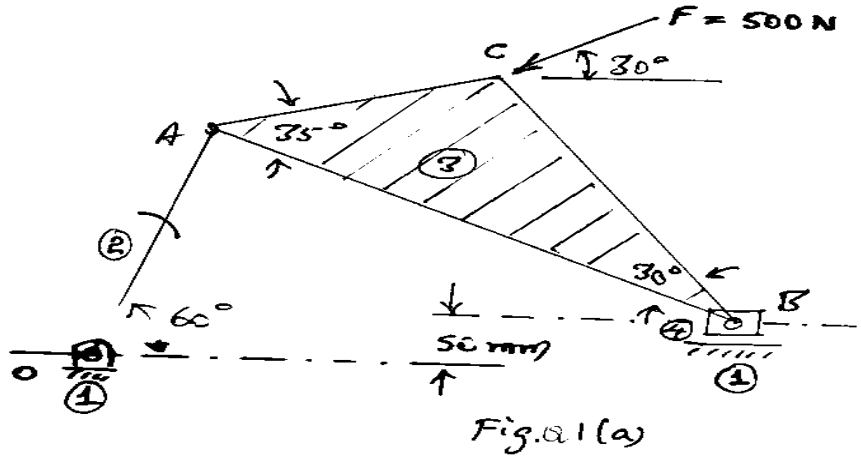

Fig.Q 1(a)

	b.	In a four link mechanism shown in Fig. Q1(b), torque T_3 and T_4 have magnitudes of 30 N.M and 20N.M respectively. The link length AD = 800 mm, AB = 300 mm, BC = 700 mm and CD = 400 mm. For the static equilibrium of mechanism, determine the required input torque T_2.	14	L3	CO1	PO2

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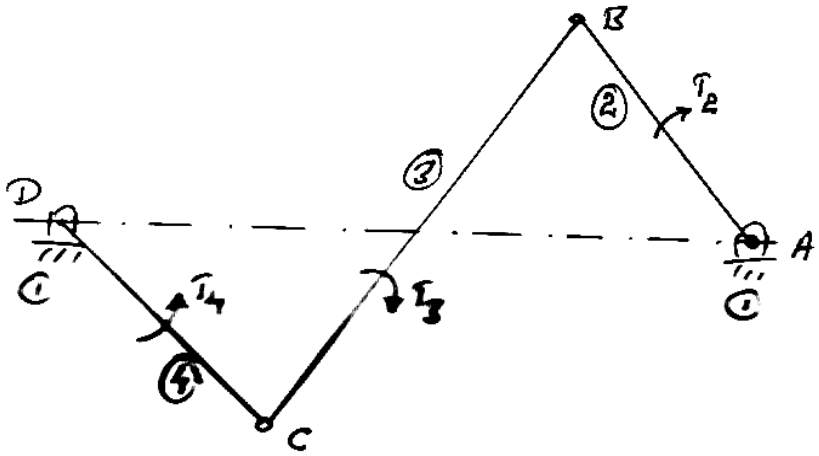

Fig.Q1 (b)

c.	Define free body diagram and superposition.	4	L1	CO1	PO1

UNIT - II **18**

2 a.	The connecting rod of a vertical reciprocating engine is 2 m long between centres and weights 250 kg. The mass centre is 800 mm from the big end bearing. When suspended as a pendulum from the gudgeon pin axis, it makes 8 complete oscillations in 22 seconds. Calculate the radius of gyration of the rod about an axis through its mass centre. The crank is 400 mm long and rotates at 200 rpm. Find the inertia torque exerted on the crankshaft, when the crank has turned through 40° from the TDC and the piston is moving upwards.	14	L3	CO2	PO2
b.	A horizontal gas engine running at 210 rpm has a bore of 220 mm and a stroke of 440 mm. The connecting rod is 924 mm long and the reciprocating parts weigh 20 kg. When the crank has turned through an angle of 30° from the inner dead centre, the gas pressure on the cover and the crank sides are 500 kN/m^2 and 60 kN/m^2 respectively. Diameter of the piston rod is 40 mm. Determine; i) Turning moment on the crank shaft ii) Thrust on the bearings iii) Acceleration of the flywheel, which has a mass of 8 kg and radius of gyration of 600 mm while the power of the engine is 22 kW	14	L3	CO2	PO2
c.	Define the following: i) Piston effort ii) Crank effort	4	L2	CO2	PO1

Contd... 3

UNIT - III **18**

3 a.	The turning moment diagram for a multi-cylinder engine has been drawn to a vertical scale has been drawn to a vertical scale of 1 mm = 650 N.M and a horizontal scale of 1 mm = 4.5°. The areas above and below the mean torque line are −28, +380, −260, +310, −300, +242, −380, +265 and −229 mm^2. The fluctuation of speed is limited to ±1.8% of the mean speed which is 400 rpm. Density of the rim material is 7000 kg/m^3 and width of the rim is 4.5 times its thickness. The centrifugal stress (hoop stress) in the rim material is limited to 6 N/mm^2. Neglecting the effect of the boss and arms, determine the diameter and cross-section of the fly wheel rim.	14	L3	CO3	PO2
b.	A three-cylinder single acting engine has its cranks at 120°. The TMD for each cycle is a triangle for the power stroke with a maximum torque of 60 N.M at 60° after the dead centre of the corresponding crank. There is no torque on the return stroke. The engine runs at 400 rpm. Determine; i) The power developed ii) The coefficient of fluctuation of speed, if the mass of the flywheel is 10 kg and radius of gyration is 88 mm iii) The coefficient of fluctuation of energy iv) The maximum angular acceleration of flywheel	14	L3	CO3	PO2
c.	Define governor and list the types of governors.	4	L1	CO3	PO1

UNIT - IV **18**

4 a.	A shaft supported in bearings 1.6 m apart projects 400 mm beyond bearings at each end. It carries three pulleys one at each end and one at the centre of its length. The masses of the end pulleys are 40 kg and 22 kg and their centre of mass at 12 mm and 18 mm respectively from the shaft axes. The mass of the centre pulley is 38 kg and its centre of mass is 15 mm from the shaft axis. The pulleys are arranged in a manner that they give static balance. Determine; i) The relative angular positions of the pulleys ii) The dynamic forces developed on the bearings, when the shaft rotates at 210 rpm	14	L3	CO4	PO2

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b.	The successive cranks of a five-cylinder in-line engine are at 144° apart. The spacing between cylinder centre lines is 400 mm. The length of the crank and the connecting rod are 100 mm and 450 mm respectively and the reciprocating mass for each cylinder is 20 kg. The engine speed is 630 rpm. Determine the maximum values of the primary and secondary forces and couples and the position of the central crank at which these occur.	14	L3	CO4	PO2
c.	List the conditions to be satisfied for complete balancing of reciprocating parts.	4	L2	CO4	PO1

UNIT - V **18**

5 a.	An aeroplane flying at 240 km/h turns towards the left and completes a quarter circle of 60 m radius. The mass of the rotary engine and the propeller of the plane is 450 kg with a radius of gyration of 320 mm. The engine speed is 2000 rpm CW, when viewed from the rear? Determine the gyroscopic couple on the aircraft and state its effect. In what way is the effect changed when the; I) Aeroplane turns towards right II) Engine rotates clockwise, when viewed from the front and the aeroplane turns, i) left ii) right	14	L3	CO5	PO3
b.	Each wheel of a motor cycle is of 600 mm diameter and has a moment of inertia of 1.2 kg/.m^2. The total mass of the motorcycle and the rider is 180 kg and the combined centre of mass is 580 mm above the ground level, when the motor cycle is upright. The moment of inertia of the rotating parts of the engine is 0.2 kg.m^2. The engine speed is 5 times the speed of the wheels and is in the same sense. Determine the angle of heel necessary when the motorcycle takes a turn of 35 m radius at a speed of 54 km/hr.	14	L3	CO5	PO3
c.	Derive an expression for gyroscopic couple.	4	L2	CO5	PO2

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