SRK/KW/14/7031

# Faculty of Engineering & Technology

## Fourth Semester B.E. (Aeronautical Engg.) (CBS) Examination

## MECHANICS OF MACHINES

Time—Three Hours] [Maximum Marks—80

### INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Solve **SIX** questions as follows :

Que. No.–1 **OR** Que. No.–2
Que. No.–3 **OR** Que. No.–4
Que. No.–5 **OR** Que. No.–6
Que. No.–7 **OR** Que. No.–8
Que. No.–9 **OR** Que. No.–10
Que. No.–11 **OR** Que. No.–12.

(3) Due credit will be given to neatness and adequate dimensions.

(4) Illustrate your answers wherever necessary with the help of neat sketches.

(5) Retain the construction lines.

(6) Use of Drawing instruments is permitted.

(7) Use of non-programmable calculator is permitted.

(8) Assume suitable data wherever necessary.

1. (a) Define Kinematic chain. State various types of Kinematic chain. 2

(b) Differentiate between machine and mechanism giving example of each. 2

(c) Differentiate between class–I and Class–II four bar chain with Harding Notation. 2

(d) Define Grashof's Law ? State how it is useful in classifying the four-link mechanism. 3

(e) For the given mechanisms as shown in Fig. 1 (a) and (b) find the degree of freedom. 5

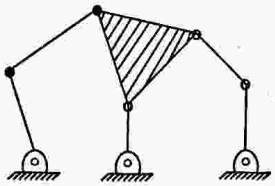

Fig. 1(a)

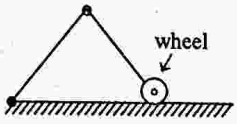


Fig. 1(b)

**OR**

2. (a) Describe the Watt's parallel mechanism for straight line motion and derive the condition under which the straight line is traced. 6

(b) Sketch and explain the following :

(i) Geneva wheel mechanism

(ii) Pawl and ratchet mechanism. 8



3. Locate all the instantaneous centres of the slider crank mechanism as shown in Fig. 3.1. 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/sec, find :

(i) Velocity of the slider A and

(ii) Angular velocity of the connecting rod AB.

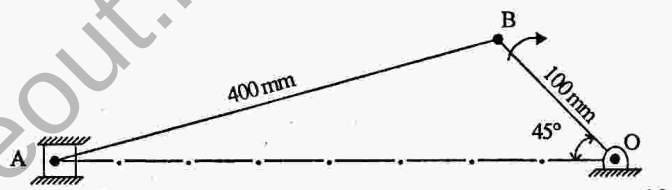


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Fig. 3.1

**OR**

4. (a) State and prove three centres in line theorem. 4

(b) State and explain in detail the Coriolis component of acceleration. 9

5. (a) Derive the expression for maximum velocity and acceleration for the follower moving with simple harmonic motion. 7

(b) What do you mean by cam and follower mechanism ? Explain various classification of followers with neat sketches. 6

**OR**

6. A cam is to be designed for a Knife edge follower with the following data :

(i) Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion.

(ii) Dwell for the next 30°.

(iii) During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion.

(iv) Dwell during the remaining 180°.

Draw the profile of the cam when :

(a) the line of stroke of the follower passes through the axis of the cam shaft.

(b) the line of stroke is offset 20 mm from the axis of the cam shaft.

The radius of the base circle of the cam is 40 mm. Determine the maximum velocity and acceleration of the follower during its ascent and descent, if the cam rotates at 240 r.p.m. 13



7. The following data relate to a horizontal reciprocating engine :

Mass of reciprocating parts = 120 kg

Crank length = 90 mm

Engine Speed = 600 rpm

Connecting rod :

Mass = 90 kg

Length between centres = 450 mm

Distance of centre of mass from big end centre = 180 mm

Radius of gyration about an axis through centre of mass = 150 mm.

Find the magnitude and direction of the inertia torque on the crankshaft when the crank has turned 30° from the inner dead centre.

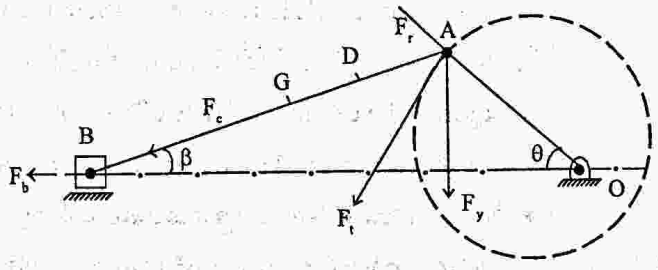


**Fig. 7.1** 14

**OR**

8. (a) With a neat sketch explain the conditions for a body to be in equilibrium under the action of two forces, three forces and two forces and a torque. 7

(b) What is the principle of virtual work ? Explain it with a neat sketch. 7

9. (a) A four wheeled trolley car of mass 2500 kg runs on rails which are 1.5 m apart and travels around a curve of 30 m radius at 24 km/hr. The rails are at the same level. Each wheel of the trolley is 0.75 m in diameter and each of the two axles is driven by a motor running in a direction opposite to that of the wheels at a speed of five times the speed of rotation of the wheels. The moment of Inertia of each axle with gear and wheels is 18 kg-$m^2$. Each motor with shaft and gear pinion has a moment of Inertia of 12 kg-$m^2$. The centre of gravity of the car is 0.9 m above the rail level. Determine the vertical forces exerted by each wheel on the rails taking into consideration the centrifugal and gyroscopic effects. 8



(b) Explain the effect of gyroscopic couple on an Aeroplane, with a neat sketch. 5

**OR**

10. (a) A porter governor has all four arms 250 mm long. The upper arms are attached on the axis of rotation and the lower arms are attached to the sleeve at a distance of 30 mm from the axis. The mass of each ball is 5 kg and the sleeve has a mass of 50 kg. The extreme radii of rotation are 150 mm and 200 mm. Determine the range of speed of the governor ? 8

(b) Derive an expression for the height in case of a watt governor. What are the limitations of a watt governor ? 5

11. (a) Explain with a neat sketch the balancing of several masses rotating in the same plane. 6

(b) Four masses $m_1$, $m_2$, $m_3$ and $m_4$ are attached to a shaft and revolve in the same plane. The masses are 12 kg, 10 kg, 18 kg and 15 kg respectively and their radii of rotations are 40 mm, 50 mm, 60 mm and 30 mm. The angular position of the masses B,

C and D are 60°, 135° and 270° from the mass A. Find the magnitude and position of the balancing mass at a radius of 100 mm. 7

**OR**

12. (a) Explain the term partial balancing of locomotives. 4

(b) A four crank engine has the two outer cranks set at 120° to each other and their reciprocating masses are each 400 kg. The distance between the planes of rotation of adjacent cranks are 450 mm, 750 mm and 600 mm. If the engine is to be in complete primary balance, find the reciprocating mass and the relative angular position for each of the inner cranks.

If the length of each crank is 300 mm, the length of each connecting is 1.2 m and the speed of rotation is 240 r.p.m., what is the maximum secondary unbalanced force ? 9