

# VTU B.E/B.TECH QUESTION PAPER SET

## CBCS SEMESTER IV

# THEORY OF MACHINES

*Use bookmarks to easily navigate between question papers*

Visit [Studentmap.in](http://Studentmap.in)! Get access to all VTU resources for free!



Question Papers



Notes



Syllabus



Exams/Timetable



News



Results

# CBCS Scheme

USN

15MR42

## Fourth Semester B.E. Degree Examination, June/July 2017 Theory of Machines

Time: 3 hrs.

Max. Marks: 80

**Note:** Answer FIVE full questions, choosing one full question from each module.

### Module-1

- 1 a. With a neat sketch, explain Whit-worth Quick return mechanism. State its application. (08 Marks)
- b. State the conditions for a link to be in equilibrium.
  - (i) When two forces act.
  - (ii) When three forces act.
  - (iii) When two forces and a torque acts. (06 Marks)
- c. What is free body diagram? (02 Marks)

### OR

- 2 a. Determine the required input torque on the Crank of a slider mechanism as shown in Fig. Q2 (a) for static equilibrium. (10 Marks)

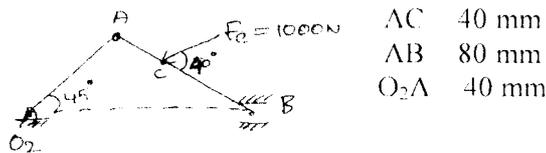


Fig. Q2 (a)

- b. Distinguish between machine, mechanism and structure. (06 Marks)

### Module-2

- 3 a. Briefly explain D'Alembert's principle on rectilinear motion and angular motion. (06 Marks)
- b. State the laws of friction. (05 Marks)
- c. Explain creep, slip and materials used in belts. (05 Marks)

### OR

- 4 a. Derive an expression for total frictional torque for a pivot bearing subjected to uniform pressure. (08 Marks)
- b. A pulley is driven by a flat belt 100 mm wide and 6 mm thick. The density of belt material is 1000 kg/m<sup>3</sup>. The angle of lap is 120° and the co-efficient of friction is 0.3. The maximum stress in belt does not exceed 2 MPa. Find the maximum power that can be transmitted and the corresponding speed of the belt. (08 Marks)

### Module-3

- 5 A shaft has three eccentrics of mass 1 kg each. The central plane of the eccentrics is 50 mm apart. The distances of the centres from axis of rotation are 20, 30 and 20 mm and their angular positions are 120° apart. If the shaft is balanced by adding two masses at a radius 70 mm and at a distance of 100 mm from central plane of middle eccentric. Find the amount of masses and their angular positions. (16 Marks)

OR

- 6 a. Discuss about static balancing and dynamic balancing. (04 Marks)  
 b. Prove that the resultant unbalanced force is minimum when half of the reciprocating masses are balanced by rotating masses i.e when  $C = \frac{1}{2}$ . (12 Marks)

Module-4

- 7 a. With a neat sketch, explain effect of gyroscopic couple on steering of ship when rotor turns clockwise. (08 Marks)  
 b. Each arm of a porter governors is 300 mm long and is pivoted on the axis of the governor. Each ball has a mass of 6 kg and the mass of sleeve is 18 kg. The radius of rotation of ball is 200 mm when the governor begins to lift and 250 mm when the speed is maximum. Determine maximum and minimum speed and range of governor. (08 Marks)

OR

- 8 a. Define : (i) Sensitiveness (ii) Stability (iii) Hunting (iv) Effort of governor (08 Marks)  
 b. Derive an expression for angle of heel of a two wheeler, while taking a turn. (08 Marks)

Module-5

- 9 a. Derive expression for displacement velocity and acceleration of a roller follower making contact with straight flank of symmetrical tangent cam. (10 Marks)  
 b. Discuss the different types of follower displacement diagrams. (06 Marks)

OR

- 10 The following data relate to a cam profile in which the follower moves with uniform acceleration and deceleration during ascent and descent:  
 Minimum radius of cam = 25 mm  
 Roller diameter = 7.5 mm  
 Lift = 28 mm  
 Offset of follower axis = 12 mm towards right.  
 Angle of ascent =  $60^\circ$   
 Angle of descent =  $90^\circ$   
 Angle of dwell between ascent and descent =  $45^\circ$   
 Draw the profile of cam. (16 Marks)

\* \* \* \* \*

## CBCS Scheme

USN

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

15MR42

**Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018**  
**Theory of Machines**

Time: 3 hrs.

Max. Marks: 80

**Note: Answer any FIVE full questions, choosing one full question from each module.**

**Module-1**

- 1 a. Explain Grubler's criterion for plane mechanisms. (06 Marks)  
 b. A slider crank mechanism is shown in Fig. Q1(b). The force applied to the piston is 1000N when the crank is at  $60^\circ$  from IDC, calculate the driving torque  $T_2$ . (10 Marks)

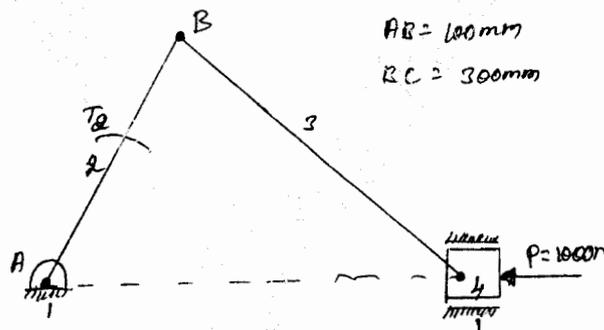


Fig. Q1 (b)

OR

- 2 a. What is the principle of virtual work? Explain. (06 Marks)  
 b. With a neat sketch, explain crank and slotted lever quick return motion mechanism. (10 Marks)

**Module-2**

- 3 a. Explain the inertia force and inertia torque. (06 Marks)  
 b. With a neat sketch explain inertia forces on a engine mechanism using slider crank mechanism. (10 Marks)

OR

- 4 a. Derive an expression for the ratio of belt tension. (06 Marks)  
 b. A flat belt required to transmit 35kW from a pulley of 1.5m diameter running at 300rpm. The angle of contact is spread over  $11/24$  of the circumference and the coefficient of friction between the belt and the pulley surface is 0.3. Determine taking centrifugal force into account width of belt required, it is given that the belt thickness is 9.5mm, density of material is  $1.1 \text{ Mg/m}^3$  and the permissible working stress is 2.5 MPa. (10 Marks)

**Module-3**

- 5 a. Explain balancing of several masses rotating in the same plane. (06 Marks)  
 b. A, B, C and D are 4 masses carried by a rotating shaft at radius 100, 125, 200 and 150mm respectively. The planes in which the masses revolve are spaced 600mm apart and the masses B, C and D are 10, 5, 4kg respectively. Find required mass A and the relative angular positions of the 4 masses to keep the shaft in balance. (10 Marks)

OR

- 6 a. What do you mean by static balancing and dynamic balancing. (06 Marks)
- b. Explain the direct and reverse crank method of analysis of radial engines for primary and secondary forces. (06 Marks)
- c. The following data are referred to a single cylinder engine. speed = 250 rpm  
stroke = 350mm mass of reciprocating parts = 60 kg, mass of revolving parts of 175mm radius is 40kg. If  $\frac{2}{3}$ <sup>rd</sup> of reciprocating parts and also the revolving parts are to be balanced find:
- Balancing mass required at 400mm radius
  - Residual unbalanced force when the crank has rotated,  $60^\circ$  from T.D.C (TOP dead centre) or inner dead centre (IDC) Data :
- n = 250rpm  
 $r = \frac{\text{Stroke}}{2} = \frac{350}{2} = 175\text{mm} = 0.175\text{m}$   
 M = 60kg  
 $M_1 = 40\text{kg at } 175\text{mm radius}$   
 c =  $\frac{2}{3}$   
 b = 400mm = 0.4m  
 $\theta = 60^\circ$

(04 Marks)

Module-4

- 7 a. Define: i) Controlling Force ii) Governor power iii) Isochronous Governor. (06 Marks)
- b. The arms of a porter governor are each 30cm long and are pivoted on the governor axis mass of each ball is 2kg. At mean speed of 150rpm, the arm makes  $30^\circ$  with the vertical. Determine the central load and the sensitivity of the governor if the sleeve movement is  $\pm 2.5\text{cm}$ . (10 Marks)

OR

- 8 a. Derive an expression for gyroscopic couple. (06 Marks)
- b. Analyse the stability of a two wheel vehicle taking left turn. Derive the necessary equations. (10 Marks)

Module-5

- 9 Derive an expression for displacement velocity and acceleration of follower when the roller is in contact with straight flank. (16 Marks)

OR

- 10 A cam has straight working surface which are tangential to the base circle of cam. The follower is a roller follower with line of stroke passing through the axis of the cam. The particulars are following :  
 Base circle diameter = 100mm ; Roller diameter = 50mm. The angle between the tangential faces of the cam =  $90^\circ$ . The face are joined by a nose circle of radius = 10mm. The speed of rotation of cam = 180 rpm.  
 Determine the acceleration of the roller centre
- When the roller just leaves contact of the flank on its ascent.
  - When the roller is at its outer end of its lift?
- Data:  $d_1 = 100\text{mm}$ ,  $r_1 = 50\text{mm}$  ;  $d = 50\text{mm}$ ,  $r = 25\text{mm}$ ,  $2\alpha = 90^\circ$ ,  $\alpha = 45^\circ$ ,  
 $r_2 = 10\text{mm}$ ,  $n = 180\text{ rpm}$ . (16 Marks)

\* \* \* \* \*

# CBCS Scheme

USN

--	--	--	--	--	--	--	--	--	--

15MR42

## Fourth Semester B.E. Degree Examination, June/July 2018 Theory of Machines

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.

### Module-1

1 a. Define :

- i) Link
- ii) Kinematic pair
- iii) Degrees of freedom
- iv) Kinematic chain.

(08 Marks)

b. What is inversion? Explain elliptical Trammel with neat sketch.

(08 Marks)

OR

2 a. What is principle of virtual work? Explain with necessary sketch.

(08 Marks)

b. In a four bar mechanism shown in Fig Q2(b) Torque  $T_3$  and  $T_4$  have magnitudes of 3000 Nm and 2000Nm respectively. Take  $AD = 800\text{mm}$ ,  $AB = 300\text{mm}$ ,  $BC = 700\text{mm}$  and  $CD = 400\text{mm}$ . For static equilibrium of mechanism, find the required input torque on the crank.

(08 Marks)

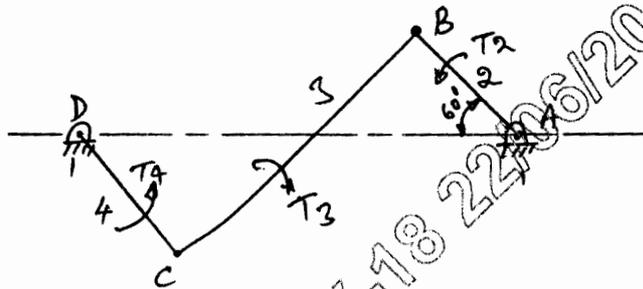


Fig Q2(b)

### Module-2

3 a. When the crank is  $45^\circ$  from the inner dead centre on the down stroke, the effective steam pressure on the Piston of a vertical steam engine is 2.5 bar. The diameter of the cylinder = 0.75m, stroke of the piston = 0.50m and length of connecting rod = 1m. Determine the torque on the crank shaft, if the engine runs at 350 rpm and the mass of reciprocating parts is 200kg.

(08 Marks)

b. Explain D'Alembert's principle with suitable example.

(08 Marks)

OR

4 a. Derive the expression for friction in flat pivot bearing considering uniform wear. (08 Marks)

b. Derive the expression for length of open belt drive. (08 Marks)

(08 Marks)

**Module-3**

- 5 A rotating shaft carries four masses 1, 2, 3 and 4 which are radially attached to it. The mass centers are 30mm, 38mm, 40mm and 35mm respectively from the axis of rotation. The masses 1, 3 and 4 are 7.5, 5 and 4 kg respectively. The axial distance between the planes 1 and 2 is 400mm and 2 and 3 is 500mm. The masses 1 and 3 are at right angles to each other. Find the complete balance,
- Angle between 1, 2 and 1, 4
  - Axial distance between 3 and 4
  - Magnitude of mass 2
- (16 Marks)

OR

- 6 a. Define static and dynamic balancing. (06 Marks)  
b. Explain partial primary balancing with neat sketch and expression. (10 Marks)

**Module-4**

- 7 a. Derive the expression for height of porter governor. (10 Marks)  
b. Explain briefly:  
  - Hunting
  - Stability
  - Governor effort.
- (06 Marks)

OR

- 8 a. What is Gyroscopic couple? Briefly explain. (06 Marks)  
b. Derive the relation between overturning couple and balancing couple in two wheeler. (10 Marks)

**Module-5**

- 9 Draw the profile of a cam operating a roller reciprocating follower and with the following data :  
Minimum radius of cam = 25mm, lift = 30mm, roller diameter = 15mm. The cam lifts the follower for 120° with SHM followed by a dwell period of 30°. Then the follower lowers down during 150° of the cam rotation with UARM followed by a dwell period. Calculate Maximum velocity and acceleration if cam rotates at 150 rpm. (16 Marks)

OR

- 10 Derive the expression for displacement, velocity and acceleration of follower when the roller is in contact with straight flank. (16 Marks)

\*\*\*\*\*

USN

--	--	--	--	--	--	--	--	--	--

15MR42

**Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019**  
**Theory of Machines**

Time: 3 hrs.

Max. Marks: 80

**Note: Answer FIVE full questions, choosing one full question from each module.**

**Module-1**

- 1 a. Define the following: (06 Marks)
- (i) Kinematic pair.
  - (ii) Kinematic chain.
  - (iii) Degree of freedom.
- b. Sketch and explain any two inversions of double slider crank chain. (10 Marks)

**OR**

- 2 a. What is principle of virtual work? Explain. (06 Marks)
- b. Explain the procedure for static force analysis of slider crank mechanism subjected to a force on the slider acting along line of stroke. (10 Marks)

**Module-2**

- 3 a. Explain D'Alembert's principle. (06 Marks)
- b. Explain the procedure for dynamic force analysis of slider crank mechanism subjected to a force on the slider acting along line of stroke. (10 Marks)

**OR**

- 4 a. Derive an expression for frictional torque in a conical pivot bearing. Assume uniform pressure across the bearing surface. (06 Marks)
- b. Two pulleys, one 450 mm diameter and the other 200 mm diameter are on parallel shafts 1.95 m apart and are connected by a crossed belt. Find the length of the belt required and the angle of contact between the belt and each pulley. What power can be transmitted by the belt when the larger pulley rotates at 200 rev/min, if the maximum permissible tension in the belt is 1 kN and the coefficient of friction between the belt and pulley is 0.25? (10 Marks)

**Module-3**

- 5 a. What do you mean by static balancing and dynamic balancing? (06 Marks)
- b. A rotating shaft carries four masses 1, 2, 3 and 4 which are radially attached to it. The mass centre are 30 mm, 38 mm, 40 mm and 35 mm respectively from the axis of rotation. The masses 1, 3 and 4 are 7.5, 5 and 4 kg respectively. The axial distance between the planes 1 and 2 is 400 mm and between 2 and 3 is 500 mm. The masses 1 and 3 are at right angles to each other. Find for complete balance,
- (i) Angle of the masses 2 and 4 from 1.
  - (ii) Axial distance between 3 and 4.
  - (iii) Magnitude of mass 2. (10 Marks)

**OR**

- 6 A 5 cylinder inline engine running at 500 rpm has successive cranks at 144° apart. The distance between the cylinder centre line is 300 mm. Piston stroke is 240 mm length of connecting rod is 480 mm. Examine the engine for balance of primary and secondary forces and couples. Find the maximum value of these and position of central crank at which these maximum values occur. The reciprocating mass for each cylinder is 150 N. (16 Marks)

Module-4

- 7 a. Define the following:
- Isochronism.
  - Effort of a governor.
  - Stability of a governor.
- (06 Marks)
- b. The arms of a porter governor are 300 mm long. The upper arms are pivoted on the axis of rotation and the lower arms are attached to the sleeve at a distance of 35 mm from the axis of rotation. The mass of the sleeve is 54 kg and the mass of each ball is 7 kg. Determine the equilibrium speed when the radius of rotation of the ball is 225 mm. What will be the range of speed for this position, if the frictional resistance to the motion of the sleeve is equivalent to a force of 30 N at the sleeve? (10 Marks)

OR

- 8 a. Derive an expression for gyroscopic couple. (06 Marks)
- b. The rotor of the turbine of a ship has 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:
- When the ship is speeding at 40 km/hr and takes a right turn in a circular path of 200 m radius.
  - When the ship rolls and at the instant, its angular velocity is 0.5 rad/sec clockwise when viewed from the stern. (10 Marks)

Module-5

- 9 A cam of base circle radius 50 mm is to operate a roller follower of 20 mm diameter. The follower is to have SHM during ascent as well as descent. The speed of the cam is 360 rpm clockwise. Draw the cam profile for the cam lift of 40 mm. Angle of ascent =  $60^\circ$ , Angle of dwell =  $40^\circ$  and angle of descent =  $90^\circ$ , followed by dwell again. Also calculate the maximum velocity and acceleration during ascent and descent. (16 Marks)

OR

- 10 A cam has straight working surfaces which are tangential to the base circle of the cam. The follower is a roller follower with line of stroke passing through the axis of the cam. The particulars are the following Base circle diameter = 100 mm; Roller diameter = 50 mm; The angle between the tangential faces of the cam =  $90^\circ$ . The faces are joined by a nose circle of radius = 10 mm. The speed of rotation of cam = 180 rpm. Determine the acceleration of the roller centre.
- When the roller just leaves contact of the flank on its ascent.
  - When the roller is at its outer end of its lift. (16 Marks)

\*\*\*\*\*

## CBCS SCHEME

USN

--	--	--	--	--	--	--	--	--	--

15MR42

**Fourth Semester B.E. Degree Examination, June/July 2019**  
**Theory of Machines**

Time: 3 hrs.

Max. Marks: 80

**Note: Answer any FIVE full questions, choosing ONE full question from each module.**

Module-1

- 1 a. Define Link. Explain with neat sketch of Whit – worth Quick return Mechanism. (08 Marks)  
b. What is inversion? Explain elliptical Trammel with neat sketch. (08 Marks)

OR

- 2 a. What is free body diagram? Write a short note on three force member. (03 Marks)  
b. A slider crank Mechanism as shown in Fig Q2(b) the force applied to the piston is 1000N when the crank is at  $60^\circ$  from TDC. Calculate the driving Torque  $T_2$ .

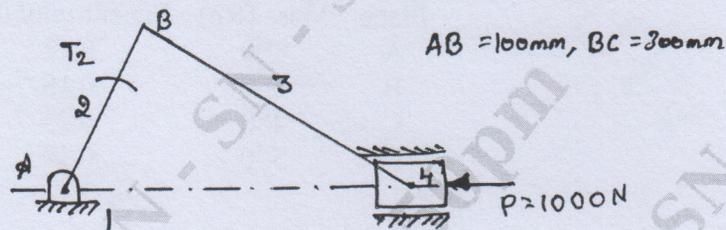


Fig Q2(b)

(13 Marks)

Module-2

- 3 a. Write D'Alembert's principle. (08 Marks)  
b. A gas engine works on – 4 stroke engine develops 11.04 kW at 250 rpm. Assuming that the resistance is uniform and that the speed is not to vary more than 1% above or below the mean speed. Calculate the mass of fly wheel required if the mean diameter is 1m and the fluctuation of energy is equal to 0.3 pressures WD/cycle. (08 Marks)

OR

- 4 a. Write the law of friction. (03 Marks)  
b. Derive an expression for ratio of belt Tension. (06 Marks)  
c. The initial Tension in a flat belt drives is 1800N. The angle of lap on the smaller pulley is  $170^\circ$ . The coefficient of friction of the belt of pulley surface is 0.25. The pulley has a diameter of 0.9m and it runs at 540 rpm. Determine the power that can be transmitted at the above speed. Neglect the centrifugal tension. (07 Marks)

**Module-3**

- 5 Define static balancing. Determine the masses to be added at planes L and u at radii 600mm if the system show in Fig Q5 a) and b) is to be dynamically balanced.

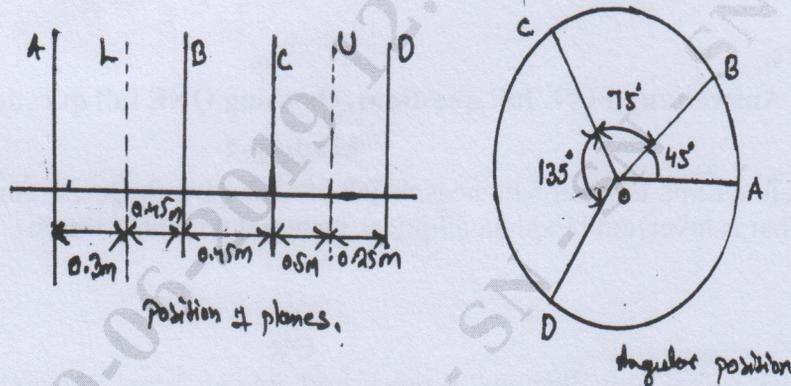


Fig Q5(a)

Fig Q5(b)

The unbalance mass and the eccentricities are given in table.

Plane	Mass (Kg)	Eccentricity (m)
A	400	0.22
B	600	0.18
C	480	0.25
D	520	0.30

(16 Marks)

OR

- 6 The reciprocating masses of first three cylinders of a four cylinder engine are 4.1, 6.2 and 7.4 tonnes respectively. The centre lines of three cylinders are 5.2m, 3.2m and 1.2m from the fourth cylinder. If the cranks for all cylinders are equal, determine the reciprocating mass of 4<sup>th</sup> cylinder of angular position of crank such that system is completely balanced for the primary force and couple. If the crank radius 80cm, connecting rod 3.8m and speed of the engine 75rpm find the maximum unbalanced secondary force and crank angle at which it occurs. (16 Marks)

**Module-4**

- 7 a. Write the types of governors. (04 Marks)  
 b. A loaded porter governor has 4 links each 25cm long, 2 revolving masses each weighing 30N and a central dead weight weighting 200N. All the links are attached to respective sleeves at radial distances of 4cm from the axis of rotation. The masses revolve at a radius of 15cm at minimum speed and at a radius of 20cm at maximum speed. Determine the range of speed. (12 Marks)

OR

- 8 a. Write about stability of a two wheel vehicle. (08 Marks)  
 b. The turbine rotor of a ship is of mass 3500kg. It has radius of gyration of 0.45m and a speed of 3000rpm clockwise when looking from stern. Determine the Gyroscopic couple and its effect upon the ship.  
 i) When the ship is steering to the left on a curve of 100m radius at a speed of 36km/hr.  
 ii) When the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees. (08 Marks)

15MR42

**Module-5**

- 9 Draw the cam profile of a cam operating a knife edged follower from the following data :
- It lifts the follower through 3.75cm during its  $60^\circ$  rotation with SHM
  - The follower remains at rest for next  $40^\circ$  rotation of cam.
  - The follower then descends to its original position during  $90^\circ$  rotation of the cam with SHM
  - The follower remains at rest for the rest of revolution.
- The last radius of cam is 5cm, if the cam rotates at 3000rpm. Find maximum velocity and acceleration of the follower during ascent and descent. (16 Marks)

**OR**

- 10 The minimum radius, lift and nose radius of a tangent cam are 4.2cm, 1.4cm and 1.6cm respectively. The roller follower axis passes through the cam axis and radius is 2.0cm. semi-cycle of cam action is  $70^\circ$ . Draw displacement, velocity and acceleration diagrams for follower's motion for one rotation of the cam. (16 Marks)

\*\*\*\*\*

USN

--	--	--	--	--	--	--	--	--	--

17MR42

**Fourth Semester B.E. Degree Examination, June/July 2019**  
**Theory of Machines**

Time: 3 hrs.

Max. Marks: 100

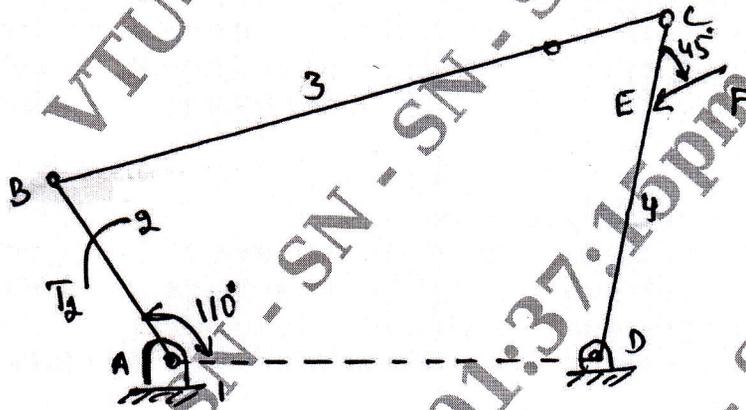
*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

**Module-1**

- 1 a. Define the following:  
 i) Link    ii) Kinematic chain    iii) Degree of freedom    iv) Inversion    (06 Marks)  
 b. Explain with neat sketch beam engine and Whitworth quick return mechanism.    (08 Marks)  
 c. Explain Crubler's criterion for plane mechanisms.    (06 Marks)

OR

- 2 a. Explain principle of virtual work.    (08 Marks)  
 b. In the four bar mechanism as shown in Fig.Q2(a), calculate the required value of  $T_2$  and various forces on links for the equilibrium of the system.



$F = 2000 \text{ N}$   
 $AD = 215 \text{ mm}$   
 $AB = 200 \text{ mm}$   
 $BC = 370 \text{ mm}$   
 $DC = 350 \text{ mm}$   
 $CE = 100 \text{ mm}$

Fig.Q2(a)

- c. What is free body diagram? List any two advantages of free body diagram.    (04 Marks)

**Module-2**

- 3 a. Explain the inertia force and inertia torque.    (10 Marks)  
 b. When the crank is  $45^\circ$  from the inner dead centre on the down stroke, the effective steam pressure on the piston of a vertical steam engine is 2.5 bar. The diameter of the cylinder = 0.75 m, stroke of the piston = 0.50m and length of connecting rod = 1 m. Determine the torque on the crank shaft, if the engine runs at 350 rpm and the mass of reciprocating parts is 200 kg.    (10 Marks)

OR

- 4 a. Derive an expression for the ratio of belt tensions.    (08 Marks)  
 b. Define friction. What are the types of friction on belt drives?    (04 Marks)  
 c. A belt drive is required to transmit 10 KW from a motor running at 600 rpm. The belt is 12 mm thick and has a mass density of  $0.001 \text{ gram/mm}^3$ . Safe stress in the belt is not to exceed  $2.5 \text{ N/mm}^2$ . Diameter of the driving pulley is 250 mm whereas the speed of the driven pulley is 220 rpm. Two shafts are 1.25 m apart. The coefficient of friction is 0.25. Determine the width of the belt.    (08 Marks)

**Module-3**

- 5 a. Explain balancing of several masses rotating in the same plane. (10 Marks)  
 b. A shaft carries 4 rotating masses A, B, C and D in this order along the axis. The mass A may be assumed to be concentrated at 160 mm radius, B at 180 mm, C at 200 mm, and D at 120 mm radius. The masses B, C and D are 40, 30 and 50 kg respectively. The planes containing B and C are 300 mm apart. The angular spacings of C and D are  $90^\circ$  and  $210^\circ$  respectively. With respect to B measured in the same direction. If the shaft and masses are to be in complete dynamic balance, determine: (i) Mass and angular positions of A, (ii) Positions of planes A and D. (10 Marks)

OR

- 6 a. Explain partial primary balancing with neat sketch and expression. (10 Marks)  
 b. A 5 cylinder inline engine running at 500 rpm has successive cranks at  $144^\circ$  apart. The distance between the cylinder centre line is 300 mm. Piston stroke = 240 mm, length of CR = 480 mm. Examine the engine for balance of primary and secondary forces and couples. Find the maximum value of these and position of central crank at which these maximum values occur. The reciprocating mass for each cylinder is 150 N. (10 Marks)

**Module-4**

- 7 a. Define: i) Controlling force ii) Governor power iii) Sensitiveness iv) Stability (08 Marks)  
 b. A porter governor has all four arms 300 mm long, the upper arms are pivoted on the axis of rotation and lower arms are attached to the sleeve at a distance 35 mm from axis. The mass of each ball is 7 kg and the load on the sleeve is 540 N. Determine the equilibrium speed for the two extreme radii of 200 mm and 260 mm of rotation of governor balls. (12 Marks)

OR

- 8 a. What is gyroscopic couple? Briefly explain. (08 Marks)  
 b. A ship is propelled by a turbine rotor which has a mass of 5000 kg and has a speed of 2100 rpm. The rotor has a radius of 0.5 m and rotates in clockwise direction when viewed from stern. Find the gyroscopic effect in the following conditions.  
 i) The ship runs at a speed of 16 knots (knot = 1860 m/hr). It steers to the left in a curve of 60 m radius.  
 ii) The ship pitches  $6^\circ$  above and  $6^\circ$  below the horizontal position. The bow descends with its maximum velocity. The motion due to pitching is SHM and the periodic time is 20 secs.  
 iii) The ship rolls at a certain instant has an angular velocity of 0.03 rad/sec clockwise when viewed for the stern. (12 Marks)

**Module-5**

- 9 a. Write a note on types of followers used in Cam's. (06 Marks)  
 b. Drive an expression for displacement, velocity and acceleration of follower when the roller is in contact with straight flank. (14 Marks)

OR

- 10 Draw the full size profile of cam which will give a lift of 38 mm to a follower carrying a roller of 25 mm diameters. The axis of the follower is off-set by 18 mm to the right of the axis of cam. Ascent of the follower takes place with SHM in 0.05 second followed by a period of rest 0.0125 sec. The follower by then descent with UARM during 0.125 second, the acceleration being  $3/5$  times retardation. The cam rotates in clockwise direction at a constant speed of 240 rpm and the base circle radius is 50 mm. (20 Marks)

\*\*\*\*\*