FATIMA MICHAEL COLLEGE OF ENGINEERING & TECHNOLOGY
Madurai – Sivagangai Main Road, Madurai - 625 020.
[An ISO 9001:2008 Certified Institution]

QUESTION BANK

SUB CODE & NAME: **AT 6302-MECHANICS OF MACHINES**

STAFF IN CHARGE : **R.PANDI**

UNIT-I (KINEMATIC OF MECHANICS)

PART-A

1. Define the terms Kinematic chain and kinematic pair.**(Apr/May 2003)**
2. What is meant by the inversion of a kinematic chain? **(Apr/May 2003)**
3. Enumerate the difference between a Machine and a Structure.
(Nov/Dec 2003) (Nov / Dec 2010) (Nov/Dec 2011) (May / June 2012)
4. Using Gruebler's equation proves that the degrees of freedom of four bar chain.
(Nov/Dec 2003) (Nov / Dec 2010) (Nov/Dec 2011)
5. How are kinematic pairs classified? **(Apr/May 2004)**
6. Explain the term "kinematic pair". **(Apr/May 2004)**
7. List out the inversions of a single slider crank chain.**(Nov/Dec 2004)**
8. Differentiate completely constrained motion and successfully constrained motion. **(Nov/Dec 2004)**
9. State the difference between planar mechanism spatial mechanisms**. (Nov/Dec 2009)**
10. State the difference between a machine and a mechanism **(May/June 2009)**
11. What are the types of instantaneous centres (IC) and how many number of IC are available for a four bar chain **(May/June 2009)**
12. Why a roller follower is preferred to that of a knife edged follower?**(May/June 2009)**
13. Sketch any two inversion of a double slider mechanism. **(May / June 2011)**
14. Write the degrees of freedom of the following (i) Structure (ii) Mechanism (iii) Preloaded structure (iv) Engine **(May / June 2011)**
15. Give the examples for double slider crank chain mechanism **(May /June 2012)**

16. Define the Grublers mechanism for plane mechanism. **(Nov/Dec 2012) (May/June2013)**
17. Name any two inversions of single slider crank chain. **(Nov/Dec 2012)**
18. Define the term kinematic chain with example. **(May/June 2013)**
19. Define kinematic pair and name any two types **(Nov / Dec 2013)**
20. Define Grashoff's law **(Nov / Dec 2013)**
21. Differentiate between mechanism and kinematic chain. **(Nov / Dec 2014)**
22. Name the cam follower extensively used in air craft engines. **(Nov / Dec 2014)**
23. What do you mean by inversion of a mechanism? Give example. **(May/June 2015)**
24. Define prime circle and pitch circle of a cam. **(May/June 2015)**

PART-B

1. ABCD is a 4 bar chain with link AD fixed. The lengths of the links are AB= 5.25 cm, BC= 17.5cm, CD=11.3 cm, DA= 20cm. The crank AB makes 180 rpm. Find acceleration of C and the angular acceleration of BC and CD when angle BAD is 15 degree. And B and C lie on opposite sides of AD. **(Apr/May 2003)**

2. In a four bar chain ABCD link AD is fixed and is 600mm apart and the crank AB rotates at 10 rad/sec and an acceleration of 30 rad/s^2 both clockwise direction. Lengths of the links are AB= 300mm, BC=CD= 360mm. When the angle BAD= 60 degree and both B and C lie on the same side of AD. Find angular velocities and angular acceleration of BC and CD and velocity and acceleration of joint C. **(Nov/Dec 2003)**

3. Sketch and explain any two inversions of a double slider crank chain. **(Apr/May 2004)**

4. Sketch and explain various inversions of single slider crank chain. **(Nov/Dec 2008)**

5. In a pin jointed 4 bar mechanism, crank AB of length of 300mm rotates uniformly at 100 rpm. The length of coupler (BC) and the follower (CD) in the 4 bar chain are each 360mm. The distance between the supports AD is 600mm. The angle BAD= 60 degree. Locate all instantaneous centers and find the angular velocity of the link BC. **(May/June 2009)**

6. In a four bar chain ABCD, link AD is fixed and is 600 mm apart and the crank AB rotates at 1 rad/sec and an acceleration of 30 rad/sec2 both clockwise direction. Lengths of the links are AB = 300 mm, BC = CD = 360 mm. When angle BAD = 60 deg. And both B and C lie on the same side of AD, Find angular velocities and angular acceleration of BC and CD and velocity and acceleration of joint C. **(Nov / Dec 2010) (Nov / Dec 2011)**

7. PQRS is a four bar chain with link PS fixed. The length of the links are PQ=62.5 mm QR=175 mm RS=112.5 m and PS=200 mm. The crank PQ rotates at 10 rad /sec clockwise. Draw the velocity and acceleration diagram when angle QPS=60 degree and Q and R lie on the same side of PS. Find the angular velocity and angular acceleration of links QR and RS.
   (May / June 2011.)

8. Sketch and explain various inversions of single slider crank chain **(Nov/Dec 2012)**

9. Explain any 3 inversion of single slider mechanism. Determine the degrees of freedom (mobility) of the 3 bar, 4 bars and 5 bar mechanism. **(May/June 2013)**

10. In a pin jointed 4 bar mechanism ABCD, the lengths of various links are AB = 25 mm; BC = 87.5 mm; CD = 50 mm and AD = 80 mm. The link AD is fixed and the angle of BAD = 135°. If the velocity of B is 1.8 m/s in the clockwise direction. Find the velocity and acceleration of the midpoint of BC, angular velocity and angular acceleration of link CB and CD. **(Nov /Dec 2013)**

11. Draw the profile of a cam to operate a roller of 1.5cm dia. The centre line of the follower of this cam passes through the centre of the cam shaft. The least distance between the centre of the camshaft and centre of roller should be 6cm. The follower executes SHM with a rise of 4cm during 2/3 revolution and returns to its original position during the remainder of revolution. Find the max. Velocity and max. Acceleration of the follower. **(Apr/May 2003)**

12. A cam rotating clockwise at a uniform speed of 1000 rpm is required to give a roller follower. 1) the follower to move outwards through 50mm during 120 degree of cam rotation, 2) follower to dwell for next 60 degree, 3) follower to dwell for the rest of the cam rotation. 4) Follower to dwell for the rest of the cam rotation. The min. radius of cam is 50mm and dia of roller is 10mm. The line of the stroke of the follower is offset is 20mm from the axis of the cam shaft. If the displacement of the displacement the follower takes with uniform acceleration and retardation for both outward and return strokes, draw the profile of the cam and find the maximum velocity and acceleration during outstroke and return stroke.**(Apr/May 2004)**

13. A cam with 30 mm as minimum diameter rotates clockwise at a uniform speed of 1200 rpm and has to give the following motion to a roller follower of 10 mm diameter. (i) Follower to complete outward stroke of 25 mm during 120° of cam rotation with equal uniform acceleration and retardation. (ii) Follower to dwell for 60° of cam rotation (iii) Follower to return to its initial position during 90° of cam rotation with equal uniform acceleration and retardation. (iv) Follower to dwell for the remaining 90° of cam rotation.

Draw the cam profile if the axis of the roller follower passes through the axis of the cam. Determine the maximum velocity of the follower during the outstroke and return stroke and also the uniform acceleration of the follower on the outstroke and return stroke. **(APR 2003)**

14. Draw the profile of cam which raises a valve with SHM through 3cm in 1/3 revolution keep it fully raised through 1/12 revolution and it is closed in next 1/3 revolution with SHM. The valve remains closed during the rest of the revolution. The diameter of the roller is 1cm and the minimum radius of the cam is 2cm, the axis of the valve rod is offset by 1cm from the axis of cam shaft. **(May/June 2009)**

15. Draw the profile for the disc cm offset 20 mm to the right of the centre of the cam shaft. The base circle diameter is 75 m and the diameter of the roller is 10 mm. The follower is to move outward a distance of 40 mm with SHM in 140° of cam rotation to dwell for 40° of cam rotation to move inward with 150° of cam rotation with uniform acceleration and retardation. Calculate the maximum velocity and acceleration of the follower during each stroke if the cam shaft rotates at 90 rpm. **(May/June 2011)**

16. A cam, with a minimum radius of 40 mm, rotating clockwise at a uniform speed is required to give a knife edge follower the motion as described below.

    i. To move outwards through 40 mm during 100° rotation of the cam
    ii. To dwell for next 80°
    iii. To return to its starting position during next 90° and
    iv. To dwell for the rest period of revolution **(Nov / Dec 2011)** **(Nov / Dec 2010)**

    The displacement of the follower is to take place with uniform acceleration and uniform retardation. Determine the maximum velocity and acceleration of the follower when the cam shaft rotates at 900 rpm. Draw the displacement, velocity and acceleration diagrams for one complete revolution of the cam **(Nov / Dec 2003), (May/June 2015)**

17. Design a cam for operating the exhaust valve of an oil engine. It is required to give equal uniform acceleration and retardation during opening and closing of the valve each of which corresponds to 60° of cam rotation. The valve must remain in the fully open position for 20° of cam rotation. The lift of the valve is 37.5 mm and the least radius of the cam is 40 mm. The follower is provided with a roller of radius 20 mm and its line of stroke passes through the axis of the cam. **(Nov/Dec 2012)**

18. A cam rotating clockwise at a uniform speed is required to give a roller follower. 1) the follower to move outwards through 40mm during 120 degree of cam rotation, 2) follower to dwell for next 60 degree, 3) follower to return to its initial position during 90 deg of cam rotation . The min. radius of cam is 45mm and dia of roller is 30mm. The offset is 15mm.Draw the profile of cam and the displacement the follower takes with simple harmonic motion for both outward and return strokes.**(May/June 2013)**

19. A cam rotating clockwise at a uniform speed of 200 rpm is required to move a roller follower with a uniform and equal acceleration and retardation on both the outward and return strokes. The angle of ascent the angle of dwell (between ascent and descent) and the angle of descent is 120°, 60°, and 90° respectively. The follower dwells for the rest of cam rotation. The least radius of the cam is 50 mm, the lift of the follower is 25 mm and the diameter of the roller is 10 mm. Draw the cam profile and find the maximum velocity and acceleration of the follower during the outstroke. **(Nov / Dec 2013)**

20. A cam of base circle 55 mm diameter is to operate a roller follower of 30 mm diameter.
The follower is to have SHM. The angular speed of the cam is 240 rpm. Draw the cam
profile for the cam lift of 35 mm. Angle of ascent 70° angle of dwell is 30° and angle of
descent is 100°,followed by angle of dwell again. Also determine the maximum velocity
and acceleration during ascent and descent. **(Nov / Dec 2014)**

21. Describe with neat sketch, the mechanism obtained by the inversions of four bar chain.
(Nov / Dec 2014)

22. The crank and connecting rod of a steam engine are 0.5 m and 2 m long respectively. The crank makes 180 rpm in the clockwise direction. When it has turned 45° from the inner dead centre position. Determine (i) velocity of piston, (ii) angular velocity of connecting rod (iii) position and linear velocity of any point on the connecting rod which has the least velocity relative to crank shaft. **(May/June 2015)**

UNIT-II (GEARS AND GEAR TRAINS)

PART-A

1. What are the different types of followers? And sketch them. **(Apr/May 2003)**
2. What are the advantages of using involute as gear tooth profile? **(Apr/May 2003)**
3. Define the law of gearing with the equation. **(Nov/Dec 2003)**
4. What are the three pitches associated with gear manufacturing. **(Nov/Dec 2003)**
5. Classify followers based on surfaces in contact. **(Nov/Dec 2003)**
6. What are the types of gear trains? **(Apr/ may 2004) (Nov/Dec 2011)**
7. A single reduction gear 120kw with a pinion 250mm pitch circle diameter and speed 650 rpm is supported in bearings on either side. Calculate the total load due to power transmitted the pressure angle is 20 degree. **(Apr/ may 2004)**
8. Name the different type of cam followers. **(Nov/Dec 2008)**
9. Define line of action and pressure angle. **(Nov/Dec 2008)**

10. How the velocity ratio of epicyclic gear train is obtained by tabular method. **(May/June 2009)**
11. Compare involute and cycloidal tooth **(Nov/Dec 2009)**
12. What is reverted gear train? **(Nov/Dec 2009)**
13. Define pressure angle. **(Nov/Dec 2011)**
14. Define (i) circular pitch (ii) pressure angle **(Nov/Dec 2012)**
15. What are the types of follower motions? **(Nov/Dec 2012)**
16. Define module and pressure angle. **(May/June 2013)**
17. Draw the different shapes of cams. **(May/June 2013)**
18. Define the pressure angle and module with respect to gears. **(Nov/Dec 2014)**
19. What are the different types of gear train? **(Nov/Dec 2014)**
20. Define module of a gear. **(May/June 2015)**
21. What are the ways to avoid interference in gears? **(May/June 2015)**

PART-B

1. State and prove law of gearing. A sun wheel of 28 teeth is in mesh with a planet of 18 teeth and both are held in arm. The planet wheel is in contact with an internal wheel of 64 teeth which is coaxial with the sun wheel. Sketch the arrangement of the gears and compute the angular velocity ratio between arm and the internal wheel if sun wheel is fixed. **(Apr/May 2003)**
2. Two mating gears have 20 and 40 involute teeth of module 10 mm and 20° pressure angle. The addendum on each wheel is to be made of such a length that the line of contact on each side of the pitch point has half the maximum possible length. Determine the addendum height for each gear wheel, length of the path of contact, arc of contact and contact ratio. **(Nov/Dec 2003)**

3. A pair of 20 degree full depth involute spur gears having 30 and 50 teeth respectively of module 4mm is in mesh. The smaller gear rotates at 1000 rpm. Determine 1) sliding velocities at engagement and at disengagement of pair of teeth. **(Apr/May 2004)**

4. A pair of involute spur gears with 16° pressure angle and pitch of module 6 mm is in mesh. The number of teeth in pinion is 16 and its rotational speed is 240 rpm. The gear ratio is 1.75. In order to avoid the interference, determine (1) addenda on pinion and wheel (2) length of path of contact (3) maximum velocity of sliding on either side of pitch point. **(Nov/Dec 2008)**

5. The following data refer to two mating involute gears of 20 deg pressure angle: no.of teeth=20, gear ratio=2, speed of pinion=250 rpm, module=12mm, if the addendum of each wheel is such that the path of approach and path of recess on each side are half the max possible length each, find 1) addendum for both the

wheels 2) the length of arc of contact 3) the max. sliding velocity during approach and recess. **(May/June 2009)**

6. 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, determine the angle turned through by pinion, when one pair of teeth is in mesh. Also calculate the maximum velocity of sliding. Take addendum as one module. **(Nov/Dec 2009)**

7. In a epicyclic gear train an arm carries two gears A and B having 40 and 60 teeth. If arm rotates at 200 rpm in clockwise direction about the centre of gear A which is fixed makes 300 rpm in the anticlockwise direction, what will be the speed of gear B. **(May/June 2013) (Nov/Dec 2014)**

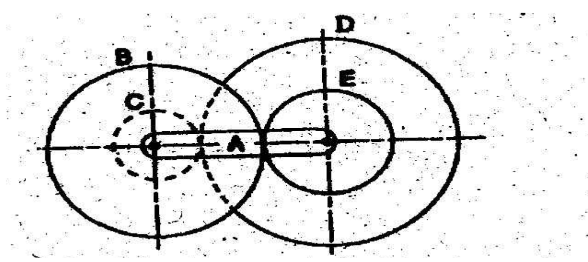
8. The pressure angle of two gears in mesh is 14.5° and has a module of 12 mm. The number of teeth on pinion are 24 and on gear 60. The addendum of pinion and gear is same and equal to on module. Determine (i) The number of pairs of teeth in contact,

   (ii) The angle of action of pinion and gear and (iii) The ratio of sliding to rolling Velocity at the beginning of contact, at pitch point and at the end of contact. **(Nov/Dec 2014)**

9. Two gear wheels mesh externally and are to give a velocity ratio of 3. The teeth are of involute form of module 6. The standard addendum is 1 module. If the pressure angle is 18° and pinion rotates at 90 rpm, find (i) the number of teeth on each wheel,

   (ii) The length of the path of contact, and (iii) the maximu8m velocity of sliding between the teeth. **(May/June 2015)**

10. In a reverted epicyclic gear train, the arm A carries two gears B and C and a compound gear D-E, the gear B meshes with gear E and the gear C meshes with gear D. The number of teeth on gears B,C and D are 75,30 and 90 respectively. Find the speed and direction of gear C when gear B is fixed and the arm A makes 100 rpm clockwise **(May/June 2015)**



UNIT- III (FRICTION)

PART-A

1. How does the centrifugal tension affect the power transmission in belt drive? **(Apr/May 2003)**
2. What is creep in belts? **(Nov/Dec 2003)**
3. Calculate the power loss in conical pivot bearing if it supports a vertical shaft of dia 200mm and is subjected to a load of 30KN angle of cone is 120 degree and μ is 0.025. Assume uniform pressure. **(Nov/Dec 2003)**
4. Define the term "Limiting friction". **(Apr/May 2004)**
5. State any 4 advantages of V belt drive over flat belt drive. **(Apr/May 2004)**
6. Why the screw jack must be designed with the efficiency always less than 50%? **(Nov/Dec 2008)**
7. Write the equation of ratio of tensions for a V belt drive. **(Nov/Dec 2008)**
8. Define limiting angle of friction and angle of repose. **(May/June 2009) (Nov/Dec 2008)**
9. What is meant by crowning of pulley with regards to belts used for power transmission? **(May/June 2009).**
10. Why the pulley is face given a convex curvature and is never kept flat?**(Nov/Dec 2009)**
11. Compare slip and creep in belt drive. **(Nov/Dec 2011)**
12. Two pulleys of diameters 100mm and 50mm at a distance 0.5m apart are connected by means of an open belt drive. What is the length of the belt? **(Nov/Dec 2011)**
13. What are the different types of friction clutches? **(Nov/Dec 2012)**
14. What is the velocity ratio due to slip in the belt drive? **(Nov/Dec 2012)**
15. Define coefficient of friction and angle of friction. **(May/June 2013).**
16. Define the co-efficient of friction and angle of repose. **(Nov/Dec 2014)**
17. Write the relation between speeds and diameters of the driver and driven. **(Nov/Dec 2014)**
18. Define self-locking and overhauling with respect to screw jack. **(May/June 2013).**
19. What is the relation between the ratio of tensions, angle of lap and coefficient of friction for a belt drive? **(May/June 2013).**

PART-B

1. A single plate clutch both sides effective is required to run a machine from a constant speed shaft rotating at 300 rpm. The moment of inertia of the rotating parts of the machine is 6 kgm^2. The inner and outer dia of the friction plate are 12cm and 20cm respectively. Assuming uniform pressure of 0.8 bar and coefficient of friction to be 0.25, determine the time taken for the machine to attain full speed when the clutch is suddenly engaged. Also find the power

transmitted by the clutch and the energy transmitted during clutch slip. **(Apr/May 2003)**

2. A multiplate clutch has three pairs of contact surfaces. The outer and inner radii of the contact surfaces are 100mm and 50mm respectively. The axial spring force is limited to 1kN. Assuming uniform wear, find the power transmitted at 1500 rpm. Take $\mu = 0.35$
   (Nov/Dec 2003)

3. (i) A V-belt drive consists of three V belts in parallel on grooved pulleys of the same size. The angle of groove is 30 degree and the co-efficient of friction is 0.12. The cross sectional area of each belt is 750 mm^2 and the permissible safe stress in the material is 7 MPa. Calculate the power that can be transmitted between two pulleys 400 mm in
   diameter rotating at 960 rpm. (10)

   (ii). Derive the condition for maximum power transmission in the belt drives (6)

   (Nov/Dec 2003)

4. The following data refer to open belt drive Diameter of the larger pulley= 400mm, diameter of smaller pulley= 250mm, distance between 2 pulleys = 2m, coefficient of friction= 0.4 maximum tension= 1200N. Find the power at speed of 10 m/s. It is is desired to increase the power. Which of the following two methods you will select?. Increase the initial tension in the belt by 10% (ii) Increasing the coefficient of friction by 10%. Find the possible percentage increase in power. **(Apr/May 2004)**

5. An open belt running over two pulleys 240 mm and 600 mm diameter connects two parallel shafts 3 meters apart and transmits 4 kW from the smaller pulley that rotates at 300 r.p.m. Coefficient of friction between the belt and the pulley is 0.3 and the safe working tension is 10N per mm width. Determine: **1.** minimum width of the belt, **2.** initial belt tension, and **3.** length of the belt required. **(Nov/Dec 2006)**

6. A shaft rotating at 200 rpm drives another shaft at 300 rpm and transmits 6kw through a belt. The belt is 100mm wide and 10mm thick. The distance between the shafts is 4m. The smaller pulley is 0.5m in diameter. Calculate the stress in the belt, if it is i. an open belt drive ii. Cross belt drive. **(Nov/Dec 2008) (Nov/Dec 2011)**

7. A shaft running at 500 rpm carries a pulley 100cm dia which drives another pulley in the same direction with a speed reduction of 2:1 by means of ropes. The drive transmits 187kw. Angle of groove is 40 degree. The distance between pulley centres is 200cm. The coeff of frictions is 0.2. The mass of the rope is 0.12kg/m and allowable stress of 175 N/cm^2. It is recommended that initial tension in the rope should not exceed 800N. Find the no. of ropes requires and rope dia. Calculate the length of rope **(May/June 2009)**

8. A simple plate clutch with both sides effective has outer and inner dia 300mm and 200mm respectively. The max intensity of pressure at any point in the contact surface is not to exceed 10^5 N/m².Determine the power transmitted by a clutch at a speed 2500 rpm. **(May/June 2009)**

9. An open belt drive is used ti connect 2 parallel shafts 4m apart. The diameter of bigger pulley is 1.5m and that of the smaller pulley is 0.5m. The mass if the belt is 1kg/m length. The max. tension is not to exceed 1500N. The coeff of friction is 0.25The larger pulley which is the driver runs at 250 rpm. Due to slip the speed of the driven pulley is 726 rpm. Calculate the power transmitted, power lost in friction and efficiency of drive. **(Nov/Dec 2009)**

10. A single plate clutch effective on both sides is required to transmit 25kw at 3000 rpm. Determine the outer and inner radi of frictional surface if the coefficient of friction is 0.255 the ratio is radii is 1.25 and the max. pressure is not exceed 0.1 N/mm2. Also determine the axial thrust to be provided by springs. Assume the theory of uniform wear. **(Nov/Dec 2011)**

11. An open belt drive connects two pulleys 120 cm and 50 cm diameters on parallel shafts 4 m apart. The maximum tension in the belt is 1855 N. The coefficient of friction is 0.3. The driver pulley of diameter 120 cm runs at 200 rpm. Calculate: (i) the power transmitted (ii) the torque on each of the two shafts. **(Nov/Dec 2012), (May/June 2015)**

12. Outside diameter of a square threaded spindle of a screw jack is 44 mm. The screw pitch is 12 mm. If the coefficient of friction between the screw and the nut is 0.15, friction between the nut and the collar is 0.08, determine (i) force to be applied at the screw to raise a load of 3 Kn. (ii) Efficiency of the screw jack.(iii) Force to be applied at the pitch radius to lower the same load of 3kN and (iv) Efficiency while lowering the load. **(Nov/Dec 2014)**

13. A pulley is driven by flat belt, the angle of lap being 160°. The belt is 14 cm wide by 10 cm thick and weighs 1.5 gm/cm^3. If the coefficient of friction is 0.3 and the maximum stresses in the belt is not exceed 2.5MPa, Find the greatest HP, which the belt can transmit and the corresponding speed of the belt. **(Nov/Dec 2014)**

14. A plate clutch has three discs on the driving shaft and two discs on the driven shaft, providing four pairs of contact surfaces . The outside diameter of the contact surfaces is 240 mm and inside diameter 120 mm. Assuming uniform pressure and coefficient of friction as 0.3, find the total spring load pressing the plates together to transmit 25 kW at 1575 rpm. If there are 6 springs each of stiffness 13 kN/m and each of the contact surfaces has worn away by 1.25 mm,

find the maximum power that can be transmitted assuming uniform wear. **(May/June 2015)**

UNIT-IV (FORCE ANALYSIS)

**PA
RT
A**

1. What is free body diagram?
2. Define static force analysis.
3. Differentiate between static and dynamic equilibrium.
4. Define applied and constraint forces.
5. Differentiate between static force analysis and dynamic force analysis.
6. Define inertia force.
7. Define inertia torque.
8. State D'Alembert's principle. **(Nov/Dec 2014) (May/June 2015)**
9. State the principle of superposition.
10. Define piston effort.
11. Define crank effort and crank-pin effort.
12. What is meant by turning moment diagram or crank effort diagram?
13. Explain the term maximum fluctuation of energy in fly wheel.
14. Define coefficient of fluctuation of energy.
15. Define coefficient of fluctuation of speed.
16. Define coefficient of steadiness.
17. Why flywheels are needed in forging and pressing operations?
18. What is cam dynamics?
19. Define unbalance and spring surge.
20. Define windup. What is the remedy for camshaft windup?
21. What are the effect and causes of windup?
22. What is the force acting along the connecting rod of a single slider crank mechanism? . **(Nov/Dec 2014)**
23. What is difference between inertia torque and inertia force? **(May/June 2015)**

PART-B

1. For reciprocating engine, derive the expression for (i)Velocity and acceleration of the piston (ii)Angular velocity and angular acceleration of the connecting rod (16)

2. In a reciprocating engine mechanism, if the crank and connecting rod are 300mm and 1m long respectively and the crank rotates at a constant speed of 200r.p.m.Determine analytically,

1. The crank angle at which the maximum velocity occurs and
2. Maximum velocity of piston.

3. Derive the relevant equations. (16)

3. (i) Deduce the expression for the inertia force in the reciprocating force neglecting the weight of the connecting rod. (8)

(ii)A vertical petrol engine with cylinder of 150mm diameter and 200mm strokes has a connecting rod of 350mm long. The mass is 1.6kg and the engine speed is 1800 rpm. On the expansion stroke with crank angle 30° from TDC, the gas pressure is 750KPa.Determine the net thrust on the piston. (8)

4. (i) Define coefficient of fluctuation of speed and coefficient of fluctuation of energy. (4)

(ii)The radius of gyration of a fly wheel is 1meter and fluctuation of speed is not to exceed 1% of the mean speed of the flywheel. If the mass of the flywheel is 3340kg and the steam develops 150KW at 135rpm, then find, 1.Maximum fluctuation of energy 2. Coefficient of fluctuation of energy (12)

5. The length of crank and connecting rod of a horizontal reciprocating engine are 100mm and 500mm respectively. The crank is rotating at 400rpm.When the crank has turned 30° from the IDC, find analytically 1.Velocity of piston
2. Acceleration of piston
3. Angular velocity of connecting rod
4. Angular acceleration of connecting rod. (16)

6. The length and connecting rod of a horizontal reciprocating engine are 200mm and 1meter respectively. The crank is rotating at 400rpm.When the crank has turned 30° from the inner dead center, the difference of pressure between cover end and piston rod is 0.4 N/mm2. If the mass of the reciprocating parts is 100Kg and a cylinder bore is 0.4meters.Calculate (i) Inertia force (ii) Force on piston (iii) Piston effort (iv) Thrust on the side of the cylinder walls in the connecting rod (vi) Crank effort. (v) Thrust (16)

7. A horizontal gas engine running at 210rpm has a bore of 220mm and a stroke of 440mm. The connecting rod is 924mm long the reciprocating parts weight 20kg.When the crank has turned through an angle of 30° from IDC, the gas pressure on the cover and the crank sides are 500KN/m2 and 60KN/m2 respectively. Diameter of the piston rod is 40mm.Determine,
1. Turning moment on the crank shaft
2.Thrust on bearing

4. Acceleration of the flywheel which has a mass of 8kg and radius of gyration of 600mm while the power of the engine is 22KW.(16)

8. A single cylinder vertical engine has a bore of 300mm and a stroke of 400mm.The connecting rod is 1000mm long. The mass of the reciprocating parts is 140kg.On the expansion stroke with the crank at 30°from the top dead center, the gas pressure is 0.7MPa.If the runs at 250rpm, determine;
1. Net force acting on the piston 2.resultant load on the gudgeon pin

3. Thrust on cylinder walls
4. The speed above which other things remaining same, gudgeon pin loads would be reversed in direction. (16)

9. A vertical double acting steam engine has a cylinder 300mm diameter and 450mm stroke and runs at 200rpm.The reciprocating parts has a mass of 225kg and the piston rod is 50mm diameter. The connecting rod is 1.2m long. When the crank has turned 125˚ from IDC the steam pressure above the piston is 30KN/m2.calculate,

(i)Crank-pin effort
(ii)The effective turning moment on the crank shaft. (16)

10. The turning moment diagram for a petrol engine is drawn to a scale of 1mm to 6N-9-9m and the horizontal scale of 1mm to 1˚.The turning moment repeat itself after every half revolution of the engine. The area above and below the mean torque line are 305, 710, 50,350,980and 275mm2. The mass of rotating parts is 40kg at a radius of gyration of 140mm.Clculate the coefficient of fluctuation of speed if the mean speed is 1500rpm. (16)

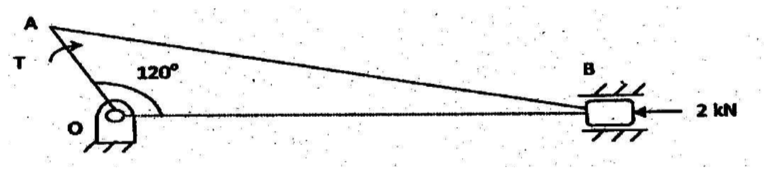
11. The torque delivered by a two stroke engine is represented by T=(1000+300sin2θ-500cos2θ) N-m where θ is the angle turned by the crank from the IDC. The engine speed is 250rpm.The mass of the flywheel is 400kg and radius of gyration 400mm. Determine , (i)the power developed (ii)the total percentage fluctuation of speed (iii)the angular acceleration of flywheel when the crank has rotated through an angle of 60˚ from the IDC. (iv) the maximum angular acceleration and retardation of the flywheel. (16)

12. The following data refer to a steam engine test: Net effective steam pressure is 0.8 MPa, the position of the crank from IDC 30°, acceleration of the piston is 22 m/s^2 diameter of the cylinder is 25 cm, crank radius is 24 cm, length of the connecting rod is 96 cm , mass of the reciprocating parts 200 kg; Determine (i) Normal reaction on the cross head guides, (ii) the resultant load on the gudgeon pin, (iii) torque on the crankshaft. **(Nov/Dec 2014)**

13. An internal combustion engine runs at 1500 rpm. The length of connecting rod is 48 cm and crank radius is 12 cm. Determine at 30% of the outstroke (i) the angular position of the crank, (ii) the angular velocity of the connecting rod, (iii) the linear acceleration of the piston, (iv) the angular acceleration of the connecting rod. **(Nov/Dec 2014)**

14. The crank pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from IDC the difference between the driving and the back pressures is 0.35 N/mm^2. The connecting rod length between centers is 1.2 m and the cylinder bore is 0.5 m. If the engine runs at 250 rpm and if the effect of piston rod diameter is neglected, calculate (i) pressure on slide bars, (ii) thrust in the connecting rod, (iii) tangential force on the crank pin, (iv) turning moment on the crank shaft. **(May/June 2015)**

15. A slider crank mechanism with the following dimensions is acted upon by a force is 2 kN at B as shown in figure below. OA=100 mm and AB=450 mm. determine the input torque t on the link OA for the static equilibrium of the mechanism for the given configuration **(May/June 2015)**



UNIT-V (BALANCING AND VIBRATION)

PART A

1. What is the difference between balancing of rotating masses and balancing of reciprocating masses? **(Apr/May 2003)**
2. What is meant by primary and secondary crank. **(Apr/May 2003)**
3. Explain the terms: (a) Tractive force and (b) Hammer blow. **(Nov/Dec 2003)**
4. Define static balancing and dynamic balancing. **(Apr/May 2004) (Nov/Dec 2014)**
5. What do you mean by primary and secondary balancing? **(Apr/May2004)**
6. State the conditions for static and dynamic balancing. **(Nov/Dec 2008) (Nov/Dec 2012)**
7. Explain why only a part of the unbalanced force due to reciprocating masses is balanced by revolving mass. **(May/June 2009) (Nov/Dec 2009)**
8. Define static balancing and dynamic balancing and state the necessary condition to achieve them. **(May/June 2009) (Nov/Dec 2009)**
9. Why rotating masses are to be dynamically balanced? **(Nov/Dec 2011)**
10. Define (a) Hammer blow and (b) Swaying couple. (**Nov/Dec 2011)**
11. What is the inclination of the crank with the line of stroke at which the primary unbalanced force is maximum. **(Nov/Dec 2012)**
12. Differentiate between static balancing and dynamic balancing.**(May/June 2013) (May/June 2015)**
13. What is meant by primary balancing of reciprocating masses**.(May/June 2013)**
14. Define the term ‘whirling speed’ of a shaft and state on what parameters does it depend? **(Apr/May 2003) (Nov/Dec 2011)**
15. What is meant by logarithmic decrement? What is the use of determining the logarithmic decrement? **(Apr/May 2003)**
16. Write short notes on (a) Critical speed (b) Isolation factor. **(Nov/Dec 2003)**
17. What are the causes and effects of vibration? **(Apr/May 2004) (May/June 2015)**
18. A shaft of 100 mm diameter and 1 meter long has one of its free end fixed and the other end carries a disc of mass 500 kg at a radius of gyration 450 mm. The modulus of rigidity for the shaft material is 80 GN/m^2. Determine the frequency of torsional vibration. **(Apr/May 2004)**
19. Differentiate between free and forced vibrations. **(Nov/Dec 2008 & 2012) (May/June 2013)**
20. Explain vibration isolation and transmissibility. **(May/June 2009)**
21. What is meant by whirling speed**. (May/June 2009) (Nov/Dec 2009)**

22. Why torsional equivalent length of a shaft as referred to stepped shaft? **(Nov/Dec 2011)**
23. What is dynamically equivalent shaft? **(May/June 2013)**
24. Write the equation of motion for the forced vibration. **(Nov/Dec 2014)**

PART-B

1. The spacing of the 4-cylinders A, B, C and D of a vertical in-line engine is 650 mm, 500 mm and 650 mm. The reciprocating masses of the inner cylinders B and C are 80 kg and their cranks are at 60 degree to one another. The stroke is 325 mm and connecting rods are 600 mm long. Find the magnitude of the reciprocating masses for the outer cylinders A and D and the relative angular position of all the cranks if primary forces and couples are to be balanced. What is the maximum unbalanced secondary force when the speed of engines 375 rpm. **(Apr/May 2003)**

2. A shaft is supported in bearing 1.8 m apart and projects 0.45 m beyond bearings at each end. The shaft carries three pulleys one at each end and one at the middle of its length. The masses of end pulleys are 48 kg and 20 kg and their centre of gravity are 15 mm and 12.5 mm, respectively from the shaft axis. The centre pulley has a mass of 56 kg and its centre of gravity is 15 mm from the shaft axis. If the pulleys are arranged so as to give static balance, determine: (i) relative angular positions of the pulleys, and (ii) dynamic forces produced on the bearings when the shaft rotates at 300 rpm. . **(Apr/May 2003)**

3. A,B, C and D are four masses carried by a rotating shaft at radii 100 mm, 125 mm, 200 mm and 150 mm respectively. The planes in which the masses revolve are spaced 600mm apart and the masses of B, C and D are 10kg,5kg and 4kgrespectively.Find the required mass A and relative angular setting of the four masses so that the shaft be in complete balance. **(Nov/Dec 2003) (Nov/Dec 2008) (Apr/May 2015)**

4. A five cylinder in-line engine running at 750 rpm has successive cranks 144° apart, the distance between the cylinder centre lines being 375 mm. The piston stroke is 225 mm and the ratio of the connecting rod to the crank is 4. Examine the engine for balance of primary and secondary force couples. Find the maximum values of these and the position of the central crank at which these maximum values occur. The reciprocating mass for each cylinder is 15 kg. **(Apr/May 2004)**

5. A shaft carries 4 rotating masses A, B, C and D in this order along its axis. The mass A may be assumed concentrated at a radius 12cm, B at 15cm, C at 14cm and D at 18cm. The masses of A,C and D are 15kg, 10kg and 8kg respectively. The planes of revolution of A and B are 15cm apart and of B and C are 18cm apart. The angle between A and C is 90 deg. If the shaft is in complete dynamic balance, determine the angles between radii of A, B and D and the distance between the planes of revolution of C and D .
(May/June 2009)

6. A twin cylinder uncoupled locomotive has its cylinders 60cm apart and balanced masses are 60 deg apart the planes being symmetrically placed about the centre line. For each cylinder the revolving masses are 300kg at crank pin radius of 32cm and reciprocating parts are 285kg. All the revolving and 2/3rd of reciprocating parts are balanced. The driving wheels are 1.8m dia. When the engine runs at 60kmph. Find the swaying couple, variation in tractive effort and hammer blow and the distance centre line of wheels is 1.5m.**(May/June 2009) (Nov/Dec 2009)**

7. A shaft carries five masses A,B,C,D and E which revolve at the same radius in planes which are equidistant from one another, The magnitude of the masses in planes A,C and D are 5 kg, 40 kg and 80 kg respectively. The magnitude of the masses in planes which are equidistant from one another. The angle between A and C is 900 and between C and D is 1650. Determine the magnitude of the masses in planes B and E and their positions to put the shaft in completing rotating balance **(Nov/Dec 2011) (Nov/Dec 2014)**

8. Four masses m1, m2, m3, and m4 are 200 kg, 300 kg, 240 kg and 260 kg, respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m, respectively and the angle between successive masses are 45°, 75°, and 135°. Find the position and magnitude of the
balance mass required if its radius of rotation is 0.2 m.
(Nov/Dec 2012)

9. A rotating shaft carries 4 unbalanced masses 18kg, 14kg, 16kg and 12kg at radii 50mm, 60mm, 70mm and 60mm respectively. The 2nd , 3rd and 4th masses revolve in planes 80mm, 160mm and 2870mm respectively measured from the plane for the first mass and are angularly located at 60 deg, 135 deg and 270 deg respectively measured clockwise from the first mass looking from this mass end of the shaft. The shaft is dynamically balanced by 2 masses both located at 50mm radii and revolving in planes mid way between those 1st and 2nd masses and midway between those of the 3rd and 4th masses. Determine the magnitudes of the masses and their respective angular position.
(May/June 2013)

10. An inside cylinder locomotive has its cylinder centre lines 0.7 m apart and has a stroke of 0.6 m. The rotating masses per cylinder are equivalent to 150 kg at the crank pin, and the reciprocating masses per cylinder to 180 kg. The wheel centre lines are 1.5 m apart. The cranks are at right angles. The whole of the rotating and 2/3 of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Find the magnitude and direction of the balancing masses. Find the variation of tractive effort and the magnitude of swaying couple at a crank speed of 300 r.p.m.
(May/June 2013)

11. Two equal masses of weight 5000 N and radii of gyration 375 mm are keyed to the opposite ends of shaft 600 mm long. The shaft is 100 mm in diameter for the first 250 mm, 175 mm in diameter and 150 mm for the rest. Find the frequency of torsional vibration and the position of the node along the length of the shaft. Take modulus of rigidity of the shaft material is 80 GN/m^2. **(Apr/May 2003)**

12. In a single cylinder reciprocating engine supported and dash pots, the total mass =400 kg, mass of the reciprocating parts = 15 kg. State deflection of spring due to the systems weight 50 mm stroke, 200 mm, ratio of consecutive amplitude in free vibration of the system = 1: 0.42.The connecting rod length is long enough to generate near harmonic motion of the reciprocating parts. Determine the amplitude of engine vibration at 250 rpm and the dynamic force transmitted to the ground at this speed. **(Apr/May 2003)**

13. A vertical steel shaft 15 mm diameter is held in long bearings 1 meter apart and carries at its middle a disc of mass 15 Kg. The eccentricity of the centre of gravity of the disc from the centre of the rotor is 0.30 mm. The modulus of elasticity for the shaft materials is 200 GN/m^2 and the permissible stress is 70MN/m^2. Determine (i) the critical speed of the shaft (ii) The range of speed over which it is unsafe to run the shaft. Neglect the mass of the shaft. **(Nov/Dec 2003) (Apr/May 2004)**

14. A steel shaft 1.5m long has flywheel at its ends A and D. The mass of the flywheel A is 600kg and has a radius of gyration of 0.6m. The mass of the flywheel D is 800kg. and has radius if gyration of 0.9m the connecting shaft has dia of 550mm for the position AB which is 0.4m long and has a dia of 60mm for the position BC that is 0.5m long and has dia d for the portion CD which 0.6m long. Determine the dia d of the portion CD so that the node of the torsional vibration of the system will be at the centre of the length BC and the natural frequency of the torsional vibration. **(Nov/Dec 2003) (Apr/May 2004)**

15. A single cylinder oil engine drives directly a centrifugal pump. The rotating mass of the engine, flywheel and the pump with the shaft is equivalent to a three rotor system as shown in Fig. The mass moment of inertia of the rotors A, B and C are 0.15, 0.3 and 0.09 kg-m^2. Find the natural frequency of the torsional vibration. The modulus of rigidity for the shaft material is 84 kN/mm^2. **(Apr – 2003)**

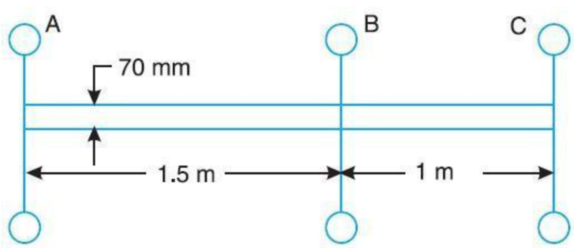


Fig.11

16. A vertical shaft 120mm in dia and 1m length has its upper end fixed. At the other end it carries a disc of weight 5500N. The modulus of elasticity is 210Gpa. Neglecting the weight of the shaft, determine the frequency of longitudinal vibrations and transverse vibrations. **(Nov/Dec 2008)**

17.A vibrating system is defined by following parameters: m=2kg, k=100N/m C=3N sec/m Determine the damping factor, the natural frequency of damped vibration, logarithmic decrement, the ratio of 2 consecutive amplitudes and the number of cycles after which the original amplitude is reduced to 20 percent. **(May/June 2009)**

18. Two equal masses of weight 400kg each and radius of gyration 40cm are keyed to opposite ends of a shaft 60cm long. The shaft is 7.5cm dia for the first 25cm of its length, 12.5cm dia for the next 10cm and 8.5cm dia for the remaining of its length. Find the frequency of free torsional vibrations and the position of node. **(May/June 2009) (Nov/Dec 2009)**

19. A vibrating system is defined by following parameters: m=2kg, k=100N/m C=3N sec/m Determine the damping factor, the natural frequency of damped vibration, logarithmic decrement, the ratio of 2 consecutive amplitudes and the number of cycles after which the original amplitude is reduced to 10 percent. **(Nov/Dec 2009)**

20. A 4-cylinder engine and flywheel coupled to a propeller are approximated to a 3-rotor system in which the engine is equivalent to a rotor of moment of inertia 800 kg- m^2, the flywheel to a second rotor of 320 kg-m^2 and the propeller to a third rotor of 20 kg-m^2. The first and second rotors being connected by 50 mm diameter and 2 meter long shaft and the second and the third rotors being connected by a 25 mm diameter and 2 meter long shaft. Neglecting the inertia of the shaft and taking its modulus of rigidity as 80 GN/m^2, determine: (1) Natural frequencies of torsional oscillations, and (ii) The positions of the nodes. **(AU TRN May – 2011)**

21. A shaft 50 mm diameter and 3 metre long is simply supported at the ends and carries three loads of 1000 N, 1500 N and 750 N at 1 m, 2 m and 2.5 m from the left support. The young's modulus for the shaft material is 200 GN/m^2. Find the frequency of transverse vibration. **(AU TRN Nov - 2010)**

22. The measurements on a mechanical vibrating system show that it has a mass of 8 kg and that the spring can be combined to give an equivalent spring of stiffness 5.4 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N when the mass has a velocity of 1 m/s, find: (i) Critical damping co-efficient, (ii) Damping factor, (iii) Logarithmic decrement and (iv) Ratio of two consecutive amplitudes**. (AU Che Nov – 2006, AU TRN May – 2011)**

23. The mass of a single degree damped vibrating system is 7.5 kg and makes 24 free oscillations in 14 seconds when disturbed from its equilibrium position. The amplitude of vibration reduces to 0.25 of its initial value after five oscillations. Determine: (i) stiffness of spring, (ii)
logarithmic decrement and (iii) damping factor, i.e., the ratio of the
system damping to critical damping. **(AU TRN May – 2011)**

24. A machine of mass 75kg is mounted on springs of stiffness 1200kn/m and with as assumed damping factor of 0.2. A piston within the machine of mass 2kg has aa reciprocating motion with a stroke of 80mm and a speed of 3000 cycle/min. Assuming

the motion to be simple harmonic, find the amplitude of motion of machine, its phase angle with respect to the exciting force, the phase angle of transmitted force with respect to the exciting force. **(Nov/Dec 2011)**

25. A vertical shaft of 5 mm diameter is 200 mm long and is supported in long bearings at its ends. A disc of mass 50 kg is attached to the centre of the shaft. Neglecting any increase in stiffness due to the attachment of the disc to the shaft, find the critical speed of rotation and the maximum bending stress when the shaft is rotating at 75% of the critical speed. The centre of the disc is 0.25 mm from the geometric axis of the shaft. E = 200GN/m2.**(Nov/Dec 2012)**

26. A single-cylinder engine of total mass 200 kg is to be mounted on an elastic support which permits vibratory movement in vertical direction only. The mass of the piston is 3.5 kg and has a vertical reciprocating motion which may be assumed simple harmonic with a stroke of 150 mm. It is desired that the maximum vibratory force transmitted through the elastic support to the foundation shall be 600 N when the engine speed is 800 r.p.m. and less than this at all higher speeds. Then (i) Find the necessary stiffness of the elastic support, and the amplitude of vibration at 800 r.p.m., and (ii). If the engine speed is reduced below 800 r.p.m. at what speed will the transmitted force again becomes 600N? **(Nov/Dec 2012)**

27. The mass of a single degree damped vibrating system is 7.5kg and makes 24 free oscillations in 14 sec. when disturbed from its equilibrium position. The amplitude of vibrating reduces to 0.25 of its initial value after 5 oscillations. Determine the stiffnes of the spring and logarithmic decrement and damping factor. A shaft of 100mm dia and 1 meter long has one of its end fixed and the other end carries a disc of mass 500kg at a radius of gyration of 450mm the modulus of rigidity for the shaft is 80GN/m^2 **(May/June 2013)**

28. The measurements on a mechanical vibrating system show that it has a mass of 8 kg and that the springs can be combined to give an equivalent spring of stiffness 5.4 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N when the mass has a velocity of 1 m/s, find (i) critical damping coefficient, (ii) damping factor, (iii) logarithmic decrement and (iv) ratio of two consecutive amplitudes. **(May/June 2015) (Nov/Dec 2014)**