ACE
Engineering College
Ankushapur (V), Ghatkesar (M), R.R.Dist – 501 301.

IMPORTANT QUESTIONS

2018-19 II Semester

Branch: Mechanical Year: II Section: B

Name of the Faculty: Ms.R.Mounika Subject: Dynamics of Machinery

UNIT -I

PRECESSION

THEORY QUESTIONS

1. What do you understand by Gyroscopic Couple? Derive a formula for its magnitude?
2. Explain the effect of the Gyroscopic couple on the reactions of Four Wheels of a vehicle negotiating a curve?
3. How do the effects of gyroscopic couple and Centrifugal force make the rider of a 2 wheeler tilt on one side? Derive a relation for limiting speed of the vehicle?
4. Discuss the Gyroscopic effect on Sea vessels?
5. What do you mean by Spin, precession & Gyroscopic Planes?
6. An aero plane makes a complete half circle of 50m radius, towards left when flying at 20kmph. The rotary engine and the propeller of the plane has a mass of 400kg with a radius of gyration of 300mm the engine runs at 2400 rpm clock wise when viewed from rear find the gyroscopic couple on the air craft and state its effect on it what will be the effect, if the aero plane turns to right instead of left.
7. Repeat the above problem when engine runs at 2400rpm clock wise when viewed from front.
8. Repeat problem 1. When engine runs at 2400rpm anti clock wise when viewed from rear.
9. Repeat problem 1. When engine runs at 2400 rpm anti clock wise when viewed from front

   Naval Ship:
10. The mass of turbine rotor of a ship is 8tons and have a radius of gyration 0.6m. It rotates at 1800rpm clock wise when looking from stern determines gyroscopic effect in the following cases.

    i)If the ship is travelling at 100kmph steers to left in curve of 75m radius

    ii) if the ship is pitching and bow is descending with maximum velocity. The pitching is SHM the periodic time being 20 seconds and the total angular movement between extreme positions is 10^0

iii) if the ship is rolling and at a certain instant has an angular velocity of 0.03rad/sec clock wise when looking from stern In each case explain how you determine the direction in which the ship tends to move as a result of gyroscopic action

11. Each paddle wheel of a steamer has a mass of 1600kg and a radius of gyration of 1.2m. The steamer turns to port in a circle of 160m radius at 24km/hr. the speed of the paddle being 90 rpm find the magnitude and effect of gyroscopic couple acting on steamer.
12. The turbine rotor of a ship has a mass of 20tons and radius of gyration of 0.75m. its speed is 2000rpm. The ship pitches 6^0 above and below the horizontal position. One complete oscillation takes 18 seconds and motion is simple harmonic calculate i) maximum couple tending to shear holding down bolts of turbine ii) the direction in which the bow will tend to turn when rising if the rotation of rotor is clockwise when looking from rear

Four wheeler

13. A motor car takes a bend of 30m radius at speed of 60km/ hr. Determine the magnitude of gyroscopic and centrifugal couples acting on vehicle and state the effect of each of these has on the road reactions to road wheels assume that each road wheel has a MI of 3kg-m^2 and an effective road radius of 0.4m. The rotating parts of engine and transmission are equivalent to flywheel of mass 75kg with radius of gyration of 100mm. the engine turns in clock wise direction when viewed from front. The back axle ratio is 4:1, this drive through gear box being direct. The gyroscopic effect, of half shaft at back axle is to be ignored.

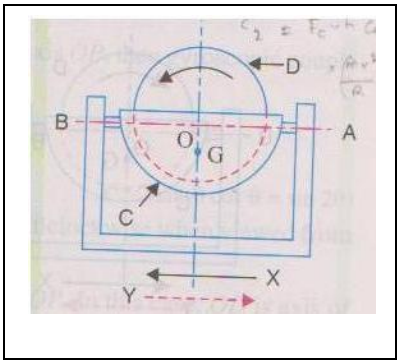
    The car has mass of 1200kg and its C.G is 0.6m above the road wheel and the turn is in right hand direction if the turn is in left hand direction, all other details being un altered, which answers, if any, need modification.

14. Repeat problem no 8 if engine parts rotate in the sense rotation of wheels
15. Repeat problem no 8 if engine parts rotate in the opposite sense of rotation of wheels.
16. A rail car has a mass of 4ton there are two axle each of which together with its wheels and gearing has a total M.I of 30kg.m^2. The centre distance between the two wheels and axle is 1.5m and each wheel is of 375mm radius. Each axle is driven by motor, the speed ratio between the two being 1:3. Each motor with its gear has a M.I of 15kg.m^2 and runs in a direction opposite to that of axle C.G of car is 1.05m above rails determine limiting speed for this car, when it rounds a curve of 240m radius such that no wheels leave the rail. Consider the centrifugal and gyroscopic effects completely. Assume that no cant is provided to outer rails
17. A four wheeler trolley car of total mass 2000kg running on rails of 1.6m gauge rounds a curve of 30m radius at 54km\h. The track is banked at 8^0. The wheels have an external diameter of 0.7m and each pair with axle has mass of 200kg radius of gyration for each pair is 0.3m. Height of C.G of car above wheel base is 1m. Determine, allowing for centrifugal force and gyroscopic couple action. The pressure on each rail.

18. A pair of locomotive driving wheels with the axle, have a moment of inertia 180kg.m^2. the diameter of wheel tread is 1.8m and the distance between wheel centre's is 1.5m when the locomotive is travelling on a level track at 95km\h, defective ballasting causes one wheel to fall 6mm and to rise again in a total time of 0.1seconds. If the displacement of the wheel takes place with SHM. Find (i) the gyroscopic couple set up (ii) the reaction between the wheel and rail due to this couple

<u>Two Wheeler</u>:

19. Each road wheel of a motor cycle has a M.I of 1.5kg.m^2 rotating parts of engine of motor cycle has M.I of 0.25kg.m^2 speed of engine is 5 times speed of wheels and in the same sense. Mass of the motor cycle with its rider is 250 kg and its C.G is 0.6m above ground level. Find the angle of heel if the cycle is travelling at 50kmph and is taking a turn of 30m radius. The wheel diameter is 0.6m.
20. A uniform disc of 150 mm diameter has a mass of 5kg. It is mounted centrally in bearings which maintain its axle in a horizontal plane. The disc spins about its axle with a constant speed of 1000 rpm while the axle precesses uniformly about vertical at 60rpm. Direction of rotation is as shown in figure. If the distance between bearings is 100mm, find the resultant reacting at each bearing due to the mass and gyroscopic effects.



21. A gyrowheel D of mass 0.5kg. with a radius of gyration of 20mm, is mounted in a pivoted frame C as shown in the axis AB of pivots passes through the centre of rotation o of the wheel , but the centre of gravity G of the frame C is rotation of the wheel is 3000 r.p.m. in the anticlockwise direction as shown.
22. The entire unit is mounted on a vehicle so that the axis AB is parallel to the direction of motion of the vehicle. If the vehicle travels at 15 m/s in curve of 50 meters radius, find the inclination of the gyrowheel from the vertical, when i) The vehicle moves in the direction of the arrow 'X' taking a left hand turn along the curve, and ii) the vehicle reverse at the same speed in the direction of arrow 'Y' along the same path.
23. A shaft carries a uniform thin disc of 0.6m diameter and mass 30kg. the disc is out of truth and makes an angle of 1^0 with a plane at right angles to the axis of the shaft . find the gyroscopic couple acting on the bearing when the shaft rotates at 1200 r.p.m
24. A racing motor cyclist travels at 140km/h round a curve of 120m radius measured horizontally. The cycle and rider have mass of 150kg and their centre of gravity lies at

0.7m above the ground level when the motor cycle is vertical. Each wheel is 0.6 m in diameter and has moment of inertia about its axis of rotation1.5kg-m^2. The engine has rotating parts whose moment of inertia about their axis of rotation is 0.25kg- m^2 and it rotates at five times the wheel speed in the same direction. Find:1. The correct angle of banking of the track so that there id no tendency to side slip, and 2. The correct angle of inclination of the cycle and rider to the vertical

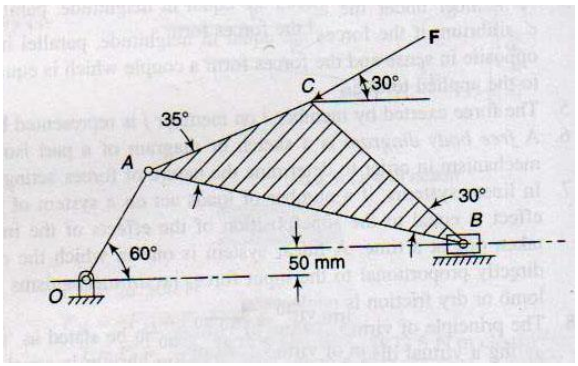
STATIC AND DYNAMIC FORCE ANALYSIS OF PLANAR MECHANISMS

THEORY QUESTIONS:

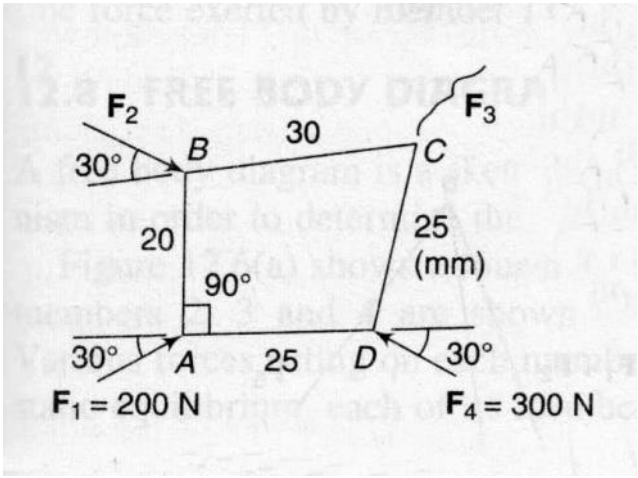
25. What do you mean by applied and constraint forces? Explain.
26. What are conditions for a body to be in equilibrium under action of two forces, three forces and two forces and a torque?
27. What are free body diagrams of a mechanism? How are they helpful in finding various forces acting on various members of the mechanism?
28. Define and explain superposition theorem as applicable to a system of forces acting on a mechanism.
29. State and explain D'Alembert's principle.
30. What do you mean by equivalent offset inertia force? Explain.
31. Derive an expression for velocity and acceleration of piston and angular acceleration of connecting rod.
32. What do you mean by piston effort and crank effort?

Numerical Problems:

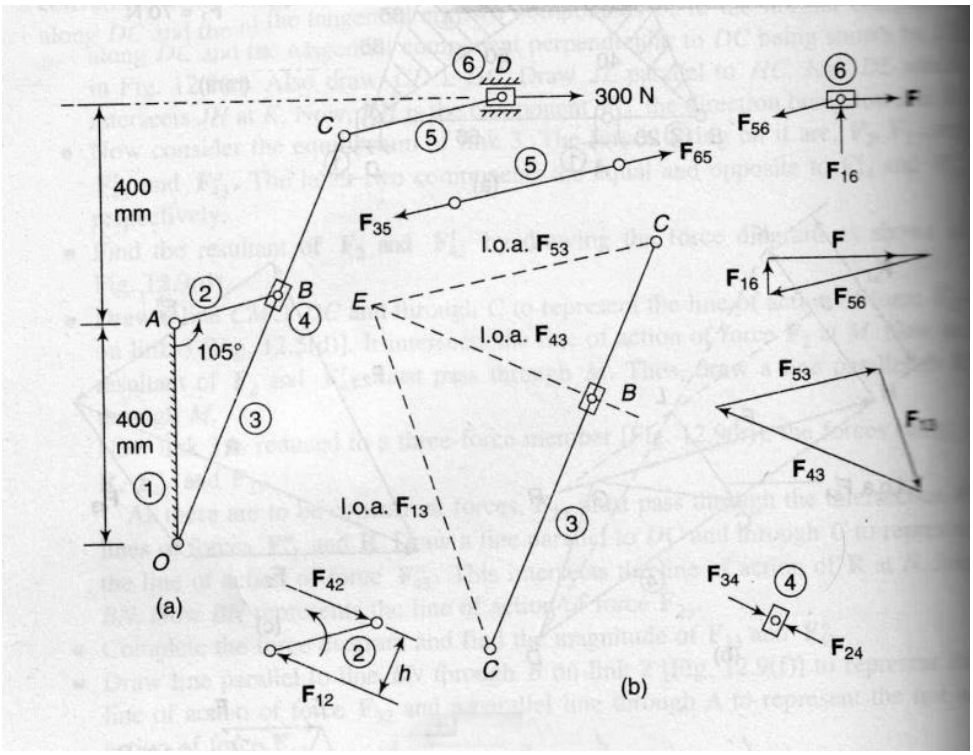
33. A four link mechanism with the following dimensions is acted upon by a force of 80 angle 150^o N on link DC. AD=50mm; AB=40mm, BC=100mm, DC=75mm, DE=35mm. Determine the input torque 'T' on the link AB for the static equilibrium of the mechanism for the given configuration i.e. Angle DAB=120^o
34. For the mechanism shown in fig, find the required input torque for the static equilibrium. Take OA=250mm, AB=650mm and F=500N.



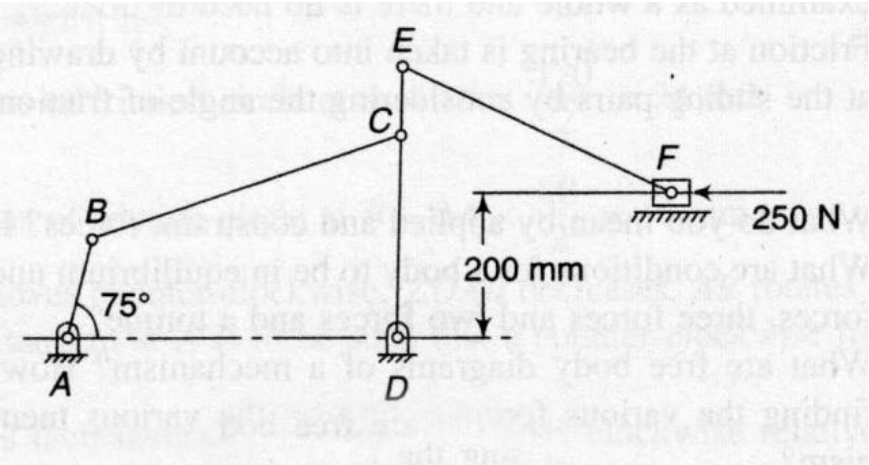
35. Fig. shows a quaternary link 'ABCD' under the action of forces F1, F2, F3, and F4 acting at A, B, C and D respectively. The link is in static equilibrium. Determine the magnitude of forces F2 and F3 and the direction of F3



36. For static equilibrium of quick return mechanism shown in fig., determine the input torque 'T2' to be applied on link 'AB' for a force of 300N on slider D. take OA=400mm, AB=200mm, OC=800mm, CD=300mm.



37. Determine the required input torque on the crank of a slider-crank mechanism for the static equilibrium when the applied piston load is 1500 N. the lengths of the crank and the connecting rod are 40mm, and 100mm, respectively and the crank has turned through 45^0 from the inner-dead centre.
38. For static equilibrium of mechanism shown in fig., find required input Torque. Take AB=150mm, BC=AD=500mm, DC=300mm, CE=100mm and EF=450mm.



39. In a four-link mechanism ABCD, the link AB revolves with an angular velocity of 10 rad / S and angular acceleration of 25 rad / S^2 at the instant when it makes angle of 45^o with AD, the fixed link. The lengths of the links are:

    AB = CD = 800mm, BC = 1000mm and AD = 1500mm.

    The mass of the links is 4 kg / m length. Determine the torque required to overcome the inertia forces, neglecting the gravitational effects. Assume all links to be of uniform cross-sections.

40. The effective steam pressure on the piston of a vertical steam engine is 200 KN/m^2 N when the crank is 40^0 from the inner-dead centre on the down stroke. The crank length is 300 mm and the connecting rod length 1200 mm. the diameter of the cylinder is 800 mm. what will be the torque on the crankshaft if the engine speed is 300 rpm and the mass of the reciprocating parts 250 kg?
41. The length of the connecting rod of a gas engine is 500 mm and its centre of gravity lies at 165 mm from the crank pin centre. The rod has a mass of 80 kg and a radius of gyration of 182 mm about an axis through the centre of mass. The stroke of piston is 225 mm and the crank speed is 300 rpm. Determine the inertia force on the crankshaft when the crank has turned(a) 30^o and (b) 135^o from the inner-dead centre. (302.3N.m; 226.7N.m)

UNIT-II

TURNING MOMENT DIAGRAM &FLYWHEELS

THEORY QUESTIONS:

42. Write short notes on turning moment diagram of (i) Double acting steam engine (ii) 4-stroke engine
43. Write short notes on
    (i) Co-efficient of fluctuation of speed (ii) Max fluctuation of energy
44. What is the function of a flywheel? How does it differ from that of governor?
45. Derive an equation for maximum fluctuation of energy in Flywheel of Punching press?
46. Derive the expression for the acceleration of the piston of a reciprocating engine

NUMERICAL QUESTIONS:

47. A vertical double acting steam engine develops 75kw at 250rpm maximum fluctuation of energy is 30% of work done per stroke maximum and minimum permissible speeds are not to vary more than 1% on either side of mean speed .Find the mass of the flywheel if the radius of gyration is 0.6m also determine angular acceleration of flywheel and kinetic energy of flywheel after 10 seconds from start.

48. The turning moment diagram for a multi cylinder engine has been drawn to scale of 1mm= 4500N-m vertically and 1mm=2.4^0 horizontally the intercepted areas between output torque curve and mean resistance line taken in order from one end are 342,-23,+245,-303,+115,-232,+227,-164mm^2 when the engine is running at 150rpm if mass of fly wheel is 1000kg and total fluctuation of speed doesn't exceed 3% of mean speed, find the minimum value of radius of gyration.

49. Determine suitable diameter and cross section of fly wheel rim for a limiting value of safe centrifugal stress of 7Mpa. Density of material of flywheel is 7200kg/m^2 width of the flywheel rim is to be 5 times thickness.

50. In the above problem if hub and spokes provide 5% of rotational inertia of flywheel determine suitable dimensions of flywheel rim.

51. The turning moment diagram for a 4 stroke gas engine may be assumed, for simplicity, to be represented by 4 triangles. The area of which from the line of zero pressure are as follows.
    Expansion stroke = 3550mm^2 , exhaust stroke = 500mm^2, suction stroke = 350mm^2, compression stroke= 1400mm^2, each mm^2 represents 3N-m assuming the resisting torque

to be uniform find the mass of the rim of the flywheel required to keep mean speed 200rpm within +or- 2% . mean radius of rim may be taken as 0.75m also determine crank positions for minimum and maximum speed.

52. A single cylinder single acting four stroke cycle gas engine develops 20kw at 250rpm the work done by the gas during expansion stroke is 3 times work done on the gas during the compression stroke work done on suction and exhaust strokes may be neglected if the flywheel has a mass of 1.5tons and has a radius of gyration of 0.6m, find the cyclic fluctuations of energy and coefficient of fluctuation of speed

53. A shaft fitted with a flywheel rotates at 250rpm and drives a machine, torque of the machine varies in a cyclic manner over a period of 3 revolutions the torque raises from 750N-m to 3000N-m uniformly during half revolution and remains constant for the following revolution. It then falls uniformly to 750N-m during next ½ revolution and remains constant for the following revolution the cycle being repeated thereafter determine power required to drive the machine and percentage fluctuation m=500 and k=0.6.
    Also determine the cross –sectional dimension of the rim if rim contributes 92% of the rotational inertia of the flywheel and allowable tensile stress of the rim material.

54. During forward stroke of piston of double acting steam engine, the turning moment has a maximum value of 2000N-m when crank makes an angle of 80^0 with IDC. During backward stroke, the maximum turning moment is 1500N-m when crank makes an angle of 80^0 with ODC the turning moment diagram for the engine may be assumed for simplicity to be represented by two triangles.
    If the crank makes 100rpm and radius of gyration of flywheel is 1.75m, find coefficient of fluctuation of energy and mass of flywheel to keep speed within +or -0.75% of mean speed also determine the crank angle at which speed has its minimum and maximum value.

55. An Otto cycle engine develops 50kw at 150rpm with 75 explosions per minute the change of speed from the commencement to end of power stroke must not exceed 0.5% of mean speed on either side find the mean diameter of flywheel and a suitable rim cross section having width four times the depth so that hoop stress doesn't exceed 4mpa assume that flywheel stores 16/15 times the energy stored by rim and work done during power stroke is 1.4 times work done during the cycle take density(ρ) of rim material is 7200 kg/m^3

56. The Torque delivered by a two stroke engine is represented by $T=(1000+300\sin 2\theta-500\cos 2\theta)$N-m. When '$\theta$' is the angle turned by crank from inner dead centre. Engine

speed is 250rpm mass of the flywheel is 400kg and radius of gyration is 400mm determine the (i) power developed (ii) total % of fluctuation of speed (iii) angular acceleration of flywheel when crank has rotated through 60^0 from IDC(iv) maximum angular acceleration and retardation of flywheel.

57. The torque developed by a two stroke engine is represented by T= (1200+1400sinθ+210sin2θ+21 sin3θ)N-m where 'θ' is the angle turned by the crank from IDC. Engine speed is 210 rpm. Determine power of the engine and the minimum mass of flywheel if its radius of gyration is 800mm and maximum fluctuation of speed is to +or- 1.5% of the mean.

58. A three cylinder single acting engine has its cranks at 120^0 the turning moment diagram for each cycle is a triangle for the power stroke with a maximum torque of 60N-m at 60^0 after TDC of the corresponding crank there is no torque on the return stroke. Engine runs at 400rpm determine (i) power developed (ii) C_s if the mass of flywheel is 10kg and radius of gyration is 88mm (iii) coefficient of fluctuation of energy (iv) maximum angular acceleration of flywheel.

59. A constant torque of 4kw motor drives a riveting machine. A flywheel of mass 130kg and radius of gyration 0.5m is fitted to riveting machine each riveting operation takes 1 second and requires 9000n-m of energy. If speed of flywheel is 420rpm before riveting find (i) the fall in speed of flywheel after riveting and (ii) the number of rivets fitted per hour.

60. A machine has to carryout punching operation at the rate of 10holes per minute. It does 6KN-m of work per mm^2 of sheared area in cutting 25mm diameter hole in 20mm thick plate. A flywheel is fitted to the machine shaft which is driven by a constant torque. Fluctuation of speed is between 180 and 200rpm. The actual punching takes 1.5seconds. Frictional losses are equivalent to 1/6 of work done during punching find (i) power required to drive the punching machine (ii) mass of flywheel, if radius of gyration of wheel is 0.5m

Prepared by

Ms.R.MOUNIKA

ASSISTANT PROFESSOR

MECH