Course Code: 19ME0307 **R19**

SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:: PUTTUR (AUTONOMOUS)
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QUESTION BANK (DESCRIPTIVE)

Subject with Code: THEORY OF MACHINES(19ME0307) **Course & Branch**: B.Tech-AGE

Year & Sem: Regulation: III-II(R19)

UNIT –I
PRECESSION, TURNING MOMENT DIAGRAM & FLYWHEEL

1	a) A uniform disc of 150 mm diameter has a mass of 5 kg. It is mounted centrally in bearings which maintain its axle in a horizontal plane. The disc spins about it axle with a constant speed of 1000 r.p.m. while the axle precesses uniforml about the vertical at 60 r.p.m. If the distance between the bearings is 100mm, find the resultant reaction at each bearing due to the mass and gyroscopic effects. b) Define gyroscopic couple?	[L1][CO1] [L1][CO1]	[8M] [4M]
2	a) List out effect of gyroscopic couple in aeroplanes? b) An aeroplane makes a complete half circle of 50 metres radius, towards left,when flying at 200 km per hr. The rotary engine and the propeller of the plane has a mass of 400 kg and a radius of gyration of 0.3 m. The engine rotates at 2400 r.p.m. clockwise when viewed from the rear. Find the gyroscopic couple on the aircraft and state its effect on it.	[L4][CO1] [L1][CO1]	[4M] [8M]
3	a) List effect of gyroscopic couple on a naval ship during steering? b) The turbine rotor of a ship has a mass of 8 tonnes and a radius of gyration 0.6 m. It rotates at 1800 r.p.m. clockwise, when looking from the stern. Determine the gyroscopic couple, if the ship travels at 100 km/hr and steer to the left in a curve of 75 m radius.	[L4][CO1] [L5][CO1]	[4M] [8M]
4	a) List effect of gyroscopic couple during pitching? b) The heavy turbine rotor of a sea vessel rotates at 1500 r.p.m. clockwise looking from the stern, its mass being 750 kg. The vessel pitches with an angular velocity of 1 rad/s. Determine the gyroscopic couple transmitted to the hull when bow is rising, if the radius of gyration for the rotor is 250 mm. Also show in what direction the couple acts on the hull?	[L4][CO1] [L5][CO1]	[4M] [8M]
5	The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: 1. when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. 2. 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.	[L5][CO1]	[12M]
6	A four-wheeled trolley car of mass 2500 kg runs on rails, which are 1.5 m apart and travels around a curve of 30 m radius at 24 km / hr. The rails are at the same level. Each wheel of the trolley is 0.75 m in diameter and each of the two axles is driven by a motor running in a direction opposite to that of the wheels at a speed of five times the speed of rotation of the wheels. The moment of inertia of each axle with gear and wheels is 18 kg-m2 . Eachmotor with shaft and gear pinion has a moment of inertia of 12 kg-m2.The centre of gravity of the car is 0.9 m above the rail level. Determine the vertical force exerted by each wheel on the rails taking into consideration the centrifugal and gyroscopic effects. State the centrifugal and gyroscopic effects on the trolley.	[L5][CO1]	[12M]
7	Find the angle of inclination with respect to the vertical of a two wheeler negotiating a turn. Given : combined mass of the vehicle with its rider 250 kg ; moment of inertia of the engine flywheel 0.3 kg-m2 ; moment of inertia of each road wheel 1 kg-m2 ;	[L1][CO1]	[12M]

	speed of engine flywheel 5 times that of road wheels and in the same direction ; height of centre of gravity of rider with vehicle 0.6 m ; two wheeler speed 90 km/h ; wheel radius 300 mm ; radius of turn 50 m.		
8	a) Draw and explain turning moment diagram for four stroke single cylinder IC engine? b) Draw and explain turning moment diagram for single cylinder double acting steam engine?	[L2][CO1] [L2][CO1]	[6M] [6M]
9	a) Define co-efficient of fluctuation of speed and co-efficient of fluctuation of energy? b) The turning moment diagram for a multicylinder engine has been drawn to a scale 1 mm = 600 N-m vertically and 1 mm = 3° horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows : + 52, – 124, + 92, – 140, + 85, – 72 and + 107 mm2 , when the engine is running at a speed of 600 r.p.m. If the total fluctuation of speed is not to exceed ± 1.5% of the mean, find the necessary mass of the flywheel of radius 0.5 m.	[L1][CO1] [L1][CO1]	[4M] [8M]
10	a) What is function of a flywheel? How does it differs from governor? b) The turning moment diagram for a petrol engine is drawn to the following scales : Turning moment, 1 mm = 5 N-m ; crank angle, 1 mm = 1°. The turning moment diagram repeats itself at every half revolution of the engine and the areas above and below the mean turning moment line taken in order are 295, 685, 40, 340, 960, 270 mm2 . The rotating parts are equivalent to a mass of 36 kg at a radius of gyration of 150 mm. Determine the coefficient of fluctuation of speed when the engine runs at 1800 r.p.m.	[L4][CO1] [L5][CO1]	[4M] [8M]

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UNIT –II
CLUTCHES BRAKES & DYNAMOMETERS

1	a. What is the function of a clutch? And what are its types b. Explain with neat sketch working of an multiple disc clutch	[L2][CO2] [L2][CO2]	[6M] [6M]
2	Explain with neat sketch working of an single plate clutch	[L2][CO2]	[12M]
3	Determine the maximum, minimum and average pressure in plate clutch when the axial force is 4 kN. The inside radius of the contact surface is 50 mm and the outside radius is 100 mm. Assume uniform wear.	[L5][CO2]	[12M]
4	A single plate clutch, effective on both sides, is required to transmit 25 kW at 3000 r.p.m. Determine the outer and inner radii of frictional surface if the coefficient of friction is0.255, the ratio of radii is 1.25 and the maximum pressure is not to exceed 0.1 N/mm2. Also determine the axial thrust to be provided by springs. Ass ume the theory of uniform wear.	[L5][CO2]	[12M]
5	Describe the working of an cone clutch with neat sketch	[L1][CO2]	[12M]
6	An engine developing 45 kW at 1000 r.p.m. is fitted with a cone clutch built inside the flywheel. The cone has a face angle of 12.5º and a maximum mean diameter of 500 mm. The coefficient of friction is 0.2. The normal pressure on the clutch face is not to exceed 0.1N/mm2. Determine: 1. the axial spring force necessary to engage to clutch, and 2. the face width required.	[L5][CO2]	[12M]
7	Describe the working of an centrifugal clutch with neat sketch	[L1][CO2]	[12M]
8	a. What is the function of an break and how its classified. b. In a single block brake the diameter of the drum is 250 mm and the angle of contact is90°. If the operating force of 700 N is applied at the end of a lever and the coefficient of friction between the drum and the lining is 0.35, determine the torque that may be transmitted by the block brake.	[L2][CO2] [L5][CO2]	[4M] [8M]
9	A simple band brake operates on a drum of 600 mm in diameter that is running at 200 r.p.m. The coefficient of friction is 0.25. The brake band has a contact of 270°, one end is fastened to a fixed pin and the other end to the brake arm 125 mm from the fixed pin. The straight brake arm is 750 mm long and placed perpendicular to the diameter that bisects the angle of contact. 1. What is the pull necessary on the end of the brake arm to stop the wheel if 35 kW is being absorbed ? What is the direction for this minimum pull ? 2. What width of steel band of 2.5 mm thick is required for this brake if the maximum tensile stress is not to exceed 50 N/mm2 ?	[L5][CO2]	[12M]
10	a.What is mean by Dynamometer? How it is classified? b. Explain in detail with neat sketch about Prony brake dynamometer. Derive an expression to calculate brake power of an engine.	[L2][CO2] [L2][CO2]	[6M] [6M]

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UNIT –III
GOVERNORS

1	a.What is the function of an Governor? How it is classified. b. Calculate the vertical height of a Watt governor when it rotates at 60 r.p.m.Also find the change in vertical height when its speed increases to 61 r.p.m.	[L2][CO3] [L4][CO3]	[6M] [6M]
2	Explain with neat sketch the working of an centrifugal governor.	[L2][CO3]	[12M]
3	A Porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the minimum and maximum speeds and range of speed of the governor.	[L1][CO3]	[12M]
4	The arms of a Porter governor are each 250 mm long and pivoted on the governor axis. The mass of each ball is 5 kg and the mass of the central sleeve is 30 kg. The radius of rotation of the balls is 150 mm when the sleeve begins to rise and reaches a value of 200 mm for maximum speed. Determine the speed range of the governor. If the friction at the sleeve is equivalent of 20 N of load at the sleeve, determine how the speed range is modified.	[L5][CO3]	[12M]
5	In an engine governor of the Porter type, the upper and lower arms are 200 mm and 250 mm respectively and pivoted on the axis of rotation. The mass of the central load is 15 kg, the mass of each ball is 2 kg and friction of the sleeve together with the resistance of the operating gear is equal to a load of 25 N at the sleeve. If the limiting inclinations of the upper arms to the vertical are 30° and 40°, find, taking friction into account, range of speed of the governor.	[L1][CO3]	[12M]
6	A Proell governor has equal arms of length 300 mm. The upper and lower ends of the arms are pivoted on the axis of the governor. The extension arms of the lower links are each 80 mm long and parallel to the axis when the radii of rotation of the balls are 150 mm and 200 mm. The mass of each ball is 10 kg and the mass of the central load is 100 kg. Determine the range of speed of the governor.	[L5][CO4]	[12M]
7	A Hartnell governor having a central sleeve spring and two right-angled bell crank levers moves between 290 r.p.m. and 310 r.p.m. for a sleeve lift of 15 mm. The sleeve arms and the ball arms are 80 mm and 120 mm respectively. The levers are pivoted at 120 mm from the governor axis and mass of each ball is 2.5 kg. The ball arms are parallel to the governor axis at the lowest equilibrium speed. Determine : 1. loads on the spring at the lowest and the highest equilibrium speeds, and 2. stiffness of the spring.	[L5][CO4]	[12M]
8	In a spring loaded Hartnell type governor, the extreme radii of rotation of the balls are 80 mm and 120 mm. The ball arm and the sleeve arm of the bell crank lever are equal in length. The mass of each ball is 2 kg. If the speeds at the two extreme positions are 400 and 420 r.p.m., find : 1. the initial compression of the central spring, and 2. the spring constant.	[L1][CO4]	[12M]
9	A spring loaded governor of the Hartnell type has arms of equal length. The masses rotate in a circle of 130 mm diameter when the sleeve is in the mid position and the ball arms are vertical. The equilibrium speed for this position is 450 r.p.m., neglecting friction. The maximum sleeve movement is to be 25 mm and the maximum variation of speed taking in account the friction to be 5 per cent of the mid position speed. The mass of the sleeve is 4 kg and the friction may be considered equivalent to 30 N at the sleeve. The power of the governor must be sufficient to overcome the friction by one per cent change of speed either way at mid-position. Determine, neglecting obliquity effect of arms ; 1. The value of each rotating mass : 2. The spring stiffness in N/mm ; and 3. The initial compression of spring.	[L5][CO4]	[12M]
10	Define sensitivitiness of governor, Stability of Governor, Isochronous Governor & Hunting in Governor	[L1][CO4]	[12M]

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UNIT –IV
BALANCING

1	a) Define balancing of rotating masses b) Four masses m1, m2, m3and 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 angles between successive masses are 45°, 75° and 135°. Find the position and magnitude of balance mass required, if its radius of rotation is 0.2 m.	[L1][CO5] [L1][CO5]	[4M] [8M]
2	A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg,400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, Determine their magnitudes and angular positions.	[L5][CO5]	[12M]
3	Four masses A, B, C and D are attached to a shaft and revolve in the same plane. The mass are 12kg,10kg,18kg and 15kg respectively and their radii of rotation are 40mm,50mm,60mm and 30mm.The angular position of the masses B,C and D are 60°,135°and 270° from the mass A. Find the magnitude and position of the balancing mass at a radius 100mm.	[L1][CO5]	[12M]
4	A Single cylinder reciprocating engine has speed 240rpm stroke 300mm,mass of reciprocating parts 50kg,mass of revolving parts at 150mm radius 37kg.If two third of the reciprocating parts and all the revolving parts are to be balanced, Determine 1) The balance mass required at a radius of 400mm 2) The residual unbalanced force when the crank has rotated 60° from top deal centre	[L5][CO5]	[12M]
5	The three cranks of a three cylinder locomotive are all on the same axle and are set 120°.The pitch of the cylinder is 1metre and the stroke of each piston is 0.6m. The reciprocating masses are 300kg for inside cylinder and 260kg for each outside cylinder and the planes of rotating of the balance masses are 0.8m from the inside crank. If 40% of the reciprocating parts are to be balanced Find:1.The magnitude and the position of the balancing masses required at a radius of 0.6m and 2.The hammer blow per wheel when the axle makes 6rpm	[L1][CO5]	[12M]
6	A rotating shaft carries four unbalanced masses 18kg,14kg,16kg and 12kg at radii 5cm,6cm,7cm and 6cm respectively.The 2^{nd},3^{rd} and 4^{th} masses revolve in planes 8cm,16cm,and 28cm respectively measured from the plane of the first mass and are angulariy located at 60°,135° and270° respectively measured clockwise from the first mass looking from the mass end of the shaft.The is dynamically balanced by two masses,both located at 5cmradii and revolving in planes mid-way between those 3^{rd} and 4^{th}masses.Determine graphically or otherwise the magnitude of the masses and their respective angular position	[L5][CO5]	[12M]
7	A shaft carries four rotating masses A,B,C and D which are completely balanced. The masses B,C and D are50kg,80kgand 70kg respectively. The masses C and D make angle of 90° and 150° respectively with mass B in the same sense. The masses A,B,C and D are concentrated the same sense. The masses A,B,C and D are concentrated at radius 75mm,100mm,50mm and 90mm respectively with mass B in the same sense The plane of rotation of masses B and C are 250mm apart. Determine 1)The magnitude of mass A and it's angular position and 2)The position of planes A and D	[L5][CO5]	[12M]
8	The following data refer to two cylinder locomotive with cranks at 90° : Reciprocating mass per cylinder = 300 kg ; Crank radius = 0.3 m ; Driving wheel diameter = 1.8 m ; Distance between cylinder centre lines = 0.65 m ; Distance between the driving wheel central planes = 1.55 m. Determine : 1. the fraction of the reciprocating masses to be balanced, if the hammer blow is not to exceed 46 kN at 96.5 kmph. ; 2. the variation in tractive effort and 3. the maximum swaying couple.	[L5][CO5]	[12M]
9	The four masses A,B,C and D are 100kg,150kg,120kg and 130kg attached to a shaft	[L1][CO5]	[12M]

	and revolve in the same plane. The corresponding radii of rotating are 22.5cm,17.5cm,25cm and 30cm and the angles measured from A and 45°,120° and 255°.Find the position and magnitude of the balancing mass,if the radius of rotation is 60cm.		
10	A single cylinder reciprocating engine has speed 250rpm stroke 200mm,mass of reciprocating parts 40kg,mass of the revolving parts at 100mm radius 35kg,if two third of the reciprocating parts and all the revolving parts are to be balanced find 1) The balance mass required at a radius of 500mm 2) The residual unbalanced force when the crank rotated 60° from the top deal centre	[L1][CO5]	[12M]

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UNIT –V
MECHANICAL VIBRATIONS

1	Define vibration, list out types of vibrations and explain the cause of vibrations and suggest methods of elimination/reduction of the undersirable vibrations	[L1][CO6]	[12M]
2	Derive an energy equation for natural frequency of undamped free longitudinal vibrations by equilibrium or Newton's method, energy method.and Rayleigh method.	[L3][CO6]	[12M]
3	a) A shaft of 100mm diameter and 1 metre long is fixed at one end and other end carries a flywheel of mass 1 tonnes, taking Young's modulus for the shaft material as 200 GN/M² find the natural frequency of longitudinal vibrations.	[L1][CO6]	[6M]
	b) A spring -mass system has spring stiffness S N/M and a mass of 'm' kg it has the natural frequency of vibrations as 12 HZ an extra 2 kg mass is coupled to 'm' and The natural frequency reduces by 2 HZ find the value of'S' and 'm'	[L1][CO6]	[6M]
4	Determine the equivalent spring stiffness and the natural frequency of the vibrating system show in fig 7 : 18 (a) to (e) A) the mass is suspended to a spring B) the mass is suspended at the bottom of two spring in series C) the mass is fixed in between two springs.D) the mass is fixed to the mind - point of a spring , and E) the mass is suspended at the bottom of two spring in parallel . Take S1= 1500N/M ; S2= 900N/M ; M = 12kg	[L3][CO6]	[12M]
5	For the system shown in fig 7.20; S1=S3 =500N/M ; S3 =1500N/M S4 = 300N/M ; SS= 2000N/M find the mass 'm' such that the system has a natural frequency of 6.75Hz	[L1][CO6]	[12M]
6	A vibrating system consists of a mass of 8 kg spring of stiffness N/M/ S . Find a) The critical damping coefficient. b) the damping factor. c) The natural frequency of damped vibrations d) The logarithmic decrement. e) The ratio of two consecutive amplitudes f) the number of cycles after which the original amplitudes is reduced to 20 percent.	[L1][CO6]	[12M]
7	An instrument vibrations with a frequency of 1.24HZ when there is No damping when the damping is provided, the frequency of damped vibrations was observed to be 1.03HZ find:1) the damping factor, and 2) the logarithmic decrement.	[L1][CO6]	[12M]
8	In a single degree damped vibrating system, and the suspended mass of 3.75 kg makes 12 oscillations in 7 seconds when disturbed from its equilibrium position the amplitude decrease to 0.33 of the initial value after 4 oscillations. Determine : 1) the stiffness of the spring 2) the logarithmic decrement3) the damping factor, and ,4) damping coefficient.	[L5][CO6]	[12M]
9	Derive an energy equation for natural frequency of free transverse vibrations for a shaft carrying several loads by DunKerleys empirical method and energy method (or Rayleigh method)	[L3][CO6]	[12M]
10	A shaft 30mm diameter and 1.5 long has a mass of 16 kg per metre length . it's is simply supported at the ends and carries three isolated loads 1kN.1.5 KN and 2 kN at 0.4 m ,0.6m. And 0.8m respectively form the left support .find. The frequency of the transverse vibrations; 1.Neglecting the mass of the shaft, and 2. Considering the mass of the shaft .take E= 200Gpa.	[L1][CO6]	[12M]

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