NARSIMHA REDDY ENGINEERING COLLEGE
UGC AUTONOMOUS INSTITUTION
Maisammaguda (V), Kompally - 500100, Secunderabad, Telangana State, India
UGC - Autonomous Institute
Accredited by NBA & NAAC with 'A' Grade
Approved by AICTE
Permanently affiliated to JNTUH

Question Bank

Year/Sem: III/I
Course Title: Dynamics of Machinery
Course Code: 23ME501

Regulation: NR23

Course Objectives:

1. The components mainly used in IC Engines and make analysis of various forces involved.
2. Inertia forces in slider crank mechanism; IC Engine components & the analysis like governors.
3. The balancing of rotating & reciprocating parts and about balancing of multi cylinder engines, Radial engines etc. study of primary & secondary forces are considered while balancing.
4. The linear, longitudinal, & torsional vibrations and the concept of natural frequency and the importance of resonance and critical speeds

Course Outcomes: Upon completing this course, the student will be able to

CO1: **Analyze** gyroscopic effects and perform static and dynamic force analysis of planar mechanisms using D'Alembert's principle

CO2: **Evaluate** turning moment diagrams and design flywheels for energy fluctuation in reciprocating engines.

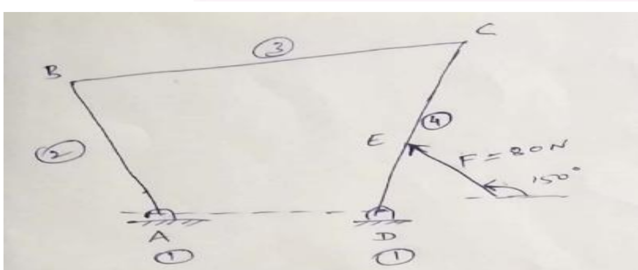
CO 3: **Examine** friction in machine elements and explain the working of clutches, brakes, and dynamometers.

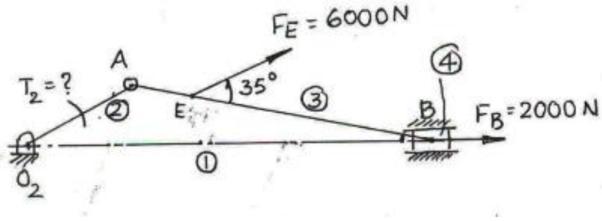
CO4: **Analyze** different governors and perform balancing of rotating and reciprocating systems in engines.

CO5: **Determine** natural frequencies, critical speeds, and torsional vibrations in mechanical systems.

Unit-I

S.No.		Question	BTL	CO	PO
Part – A (Short Answer Questions)					
1		What will be the effect of gyroscopic couple on a disc fixed at a certain angle to a rotating shaft?	L1	CO1	PO1,PO2,PO3
2		Which part of the automobile is subjected to the gyroscopic couple and define reactive gyroscopic couple?	L1	CO1	PO1,PO2,PO3
3		State the effect of gyroscopic couple on rolling of ship. Justify your answer	L4	CO1	PO1,PO2,PO3
4		Define steering, pitching and rolling. (Or) List some of the terms related to motion of ships using gyroscopic principle.	L1	CO1	PO1,PO2,PO3
5		Write the expression for gyroscopic couple and Give the application of gyroscopic principle.	L1	CO1	PO1,PO2,PO3
6		Explain briefly about spin, precession and gyroscopic planes?	L1	CO1	PO1,PO2,PO3
7		State D' Alembert's principle?	L1	CO1	PO1,PO2,PO3
8		Differentiate between static & dynamic equilibrium.	L2	CO1	PO1,PO2,PO3
9		Differentiate between static force analysis and dynamic force analysis.	L2	CO1	PO1,PO2,PO3
10		How you will reduce a dynamic analysis problem into an equivalent problem of static equilibrium and What is meant by Equivalent offset inertia force?	L3	CO1	PO1,PO2,PO3
Part – B (Long Answer Questions)					
11	a)	Describe the effect of the gyroscopic couple on a disc fixed at a certain angle to a rotating shaft?	L2	CO1	PO1,PO2,PO3
	b)	Develop the expression for gyroscopic couple.	L3	CO1	PO1,PO2,PO3
12		The turbine rotor of a ship has a mass of 2000 kg and rotates at a speed of 3000 rpm clockwise when viewed from stern. The rotor has radius of gyration of 0.5 m. (a) Determine the gyroscopic couple and its effect when the ship steers to the right in a curve of 100 m radius at a speed of 16.1 knots (1 knot = 1855 m/h). (b) Calculate the torque and its effects when ship pitches simple harmonic motion, the bow falling with its maximum velocity, the period of pitching is 50 seconds and the total angular displacement between two extreme positions of pitching is 12 degrees. Find the maximum acceleration during the pitching motion.	L3	CO1	PO1,PO2,PO3

13	a)	An aero-plane makes a half circle of 100 m radius towards left when flying at 400 kmph. The engine and propeller of plane weigh 500 kg, and have a radius of gyration of 30 cm. The engine rotates at 3000 rpm ccw, when viewed from the front end. Determine the gyroscopic couple and state its effect.	L3	CO1	PO1,PO2,PO3
	b)	Develop equation for the limiting value of the Angle of heel (θ) to avoid skidding of two-wheeled vehicle.	L3	CO1	PO1,PO2,PO3
14		A rear engine automobile is travelling along a track of 100 m mean radius. Each of the four road wheels has a moment of inertia of 2.5 kg-m^2 and an effective diameter of 0.6 m. The rotating parts of the engine have a moment of inertia of 1.2 kg-m^2. The engine axis is parallel to the rear axle and the crank shaft rotates in the same sense as the road wheels. The ratio of engine speed to back axle speed is 3:1. The automobile has a mass of 1600 kg and has its centre of gravity 0.5 m above road level. The width of the track of the vehicle is 1.5 m. Determine the limiting speed of the vehicle around the curve for all four wheels to maintain contact with the road surface. Assume that the road surface is not cambered and centre of gravity of the automobile lies centrally with respect to the four wheels.	L3	CO1	PO1,PO2,PO3
15	a)	A motor cycle along with the rider weighs 2 KN, the center of gravity of the machine and rider combined being 60 cm above the ground, with the machine in vertical position. The moment of inertia of each road wheel is 1.030 kg-m^2, and the rolling diameter is 60 cm. The engine rotates at 6 times of the road wheels and in the same sense. The moment of inertia of rotating parts of the engine is 0.165 kg-m^2. Determine the angle of heel necessary if the unit is speeding at 62.5 km/h round a curve of 30.4 m. 	L3	CO1	PO1,PO2,PO3
16	a)	Determine T_2 to keep the body in equilibrium. O_2A =100mm, AB=250mm, AE=50mm, angle AO_2B is 30^0	L4	CO1	PO1,PO2,PO3

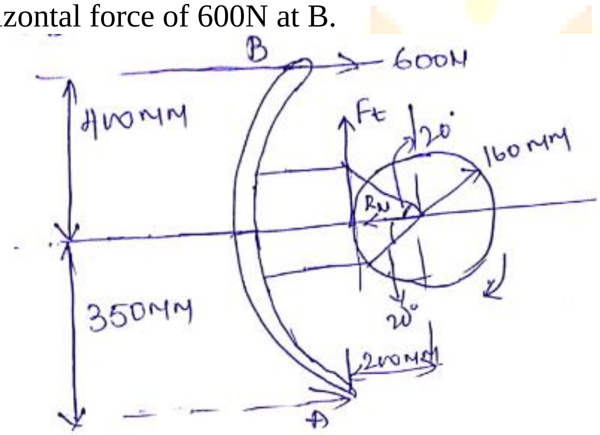
UNIT–II

S.No.		Questions	BTL	CO	PO
Part – A (Short Answer Questions)					
1		Differentiate between flywheel and governor	L2	CO2	PO1,PO2,PO3
2		Define the following terms: (a) Coefficient of Fluctuation of Speed, (b) Coefficient of steadiness, (c) Maximum fluctuation of energy and (d) Coefficient of Fluctuation of Energy	L1	CO2	PO1,PO2,PO3
3		Explain the concept of fluctuation of energy related with turning moment diagram with sketch.	L2	CO2	PO1,PO2,PO3
4		State the function of flywheel in IC engine.	L1	CO2	PO1,PO2,PO3
5		Define turning moment diagram? Draw T-θ diagram for Single Cylinder Double Acting Steam Engine	L2	CO2	PO1,PO2,PO3
6		Smaller fly wheels are used in multi cylinder engines. Justify your answer.	L3	CO2	PO1,PO2,PO3
7		Define crank pin effort. And Define crank effort.	L1	CO2	PO1,PO2,PO3
8		What types of stresses are set up in the flywheel rims? And state the advantages of having elliptical section of flywheel arm?	L2	CO2	PO1,PO2,PO3
9		Why variation in the turning moment of single cylinder 4-stroke IC engine is more as compared to the multi cylinder IC engines?	L2	CO2	PO1,PO2,PO3
10		Define flywheel with its functions.	L1	CO2	PO1,PO2,PO3
Part – B (Long Answer Questions)					
11	a)	Derive the equation for energy stored in the fly wheel	L2	CO2	PO1,PO2,PO3
	b)	Deduce effective force acting on piston and connecting rod.	L2	CO2	PO1,PO2,PO3
12		A shaft fitted with a flywheel rotates at 250 r.p.m. and drives a machine. The torque of the machine varies in a cyclic manner over a period of 3 revolutions. The torque rises from 750 N-m to 3000 N-m uniformly during 1⁄2 revolution and remains constant for the following revolution. It then falls uniformly to 750 N-m during the next 1⁄2 revolution and remains constant for one revolution, the cycle being repeated thereafter. Determine the power required to drive the machine and percentage fluctuation in speed, if the driving torque applied to the shaft is constant and the mass of the flywheel is 500 kg with radius of gyration of 600 mm.	L3	CO2	PO1,PO2,PO3
13		The turning moment diagram for a 4-stroke gas engine	L3	CO2	PO1,PO2,PO3

		may be assumed for simplicity to be represented in 4 triangles. The area of which from line of zero pressure suction stroke=$0.45*10^{-3}m^2$, compression stroke=$1.7*10^{-3}m^2$, expansion stroke=$6.8*10^{-3}m^2$, exhaust stroke=$0.65*10^{-3}m^2$. Each m^2represents 3MN-m of energy. Assume resisting torque to be uniform. Determine the mass of the rim of fly wheel required to keep the speed between 202&198rpm. The mean radius of rim is 1.2m.			
14	a)	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 I.D.C., 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 r.p.m. and if the effect of piston rod diameter is neglected, calculate : 1. pressure on slide bars, 2. thrust in the connecting rod, 3. tangential force on the crank-pin, and 4. turning moment on the crank shaft.	L3	CO2	PO1,PO2,PO3
S		The turning moment diagram for a multi-cylinder engine has been drawn to a scale of 1 mm to 500 N-m torque and 1 mm to 6° of crank displacement. The intercepted areas between output torque curve and mean resistance line taken in order from one end, in sq. mm are– 30, + 410, – 280, + 320, – 330, + 250, – 360, + 280, –260 sq. mm, when the engine is running at 800 r.p.m. The engine has a stroke of 300 mm and the fluctuation of speed is not to exceed ± 2% of the mean speed. Determine a suitable diameter and cross-section of the flywheel rim for a limiting value of the safe centrifugal stress of 7 MPa. The material density may be assumed as 7200 kg/m^3.The width of the rim is to be 5 times the thickness.	L3	CO2	PO1,PO2,PO3
16		The crank and connecting rod of a reciprocating engine are 200 mm and 700mm respectively. The crank is rotating in clockwise direction at 120 rad/s. Find with the help of Klein's construction: 1. Velocity and acceleration of the piston, 2. Velocity and acceleration of the midpoint of the connecting rod, and 3. Angular velocity and angular acceleration of the connecting rod, at the instant when the crank is at 30° to I.D.C. (inner dead centre).	L4	CO2	PO1,PO2,PO3

UNIT–III

S.No.		Questions	BT	CO	PO
Part – A (Short Answer Questions)					
1		Differentiate between uniform pressure and uniform wear theories adopted in the design of clutches.	L2	CO3	PO1,PO2,PO4
2		How the "uniform rate of wear" assumption is valid for clutches?	L3	CO3	PO1,PO2,PO4
3		Why is it necessary to dissipate the heat generated during clutch operation?	L2	CO3	PO1,PO2,PO4
4		Define self-locking and self-energizing brake	L1	CO3	PO1,PO2,PO4
5		What is the disadvantage of block brake with one short shoe? What is the remedy?	L2	CO3	PO1,PO2,PO4
6		Why in automobiles, braking action when traveling in reverse is not as effective as when moving forward?	L2	CO3	PO1,PO2,PO4
7		What factors should be considered when designing friction clutches?	L2	CO3	PO1,PO2,PO4
8		Why are cone clutches better than disc clutches?	L3	CO3	PO1,PO2,PO4
9		What is friction axis?	L2	CO3	PO1,PO2,PO4
10		Discuss the factors upon which the torque capacity of a clutch depends and When do we use multiple disk clutches?	L2	CO3	PO1,PO2,PO4
Part – B (Long Answer Questions)					
11	a)	Deduce the equation for torque considering uniform wear for flat pivot bearing.	L2	CO3	PO1,PO2,PO4
	b)	A vertical shaft 150 mm in diameter rotating at 100 r.p.m. rests on a flat end footstep bearing. The shaft carries a vertical load of 20 kN. Assuming uniform pressure distribution and coefficient of friction equal to 0.05, estimate power lost in friction.	L2	CO3	PO1,PO2,PO4
12	a)	Deduce the equation for torque considering uniform pressure for conical pivot bearing.	L2	CO3	PO1,PO2,PO4
	b)	A conical pivot supports a load of 20 kN, the cone angle is 120° and the intensity of normal pressure is not to exceed 0.3 N/mm^2. The external diameter is twice the internal diameter. Find the outer and inner radii of the bearing surface. If the shaft rotates at 200 r.p.m. and the coefficient of friction is 0.1, find the power absorbed in friction. Assume uniform pressure	L2	CO3	PO1,PO2,PO4
13	a)	Deduce the equation for torque considering uniform wear for truncated pivot bearing.	L2	CO3	PO1,PO2,PO4
	b)	A conical pivot bearing supports a vertical shaft of 200 mm diameter. It is subjected to a load of 30 KN. The angle of the cone is 120° and the coefficient of friction is 0.025.Find the power lost in friction when the speed is 140 r.p.m., assuming 1. Uniform pressure; and2. Uniform wear.	L2	CO3	PO1,PO2,PO4
14		The external radius of a friction plate of a single plate clutch having both sides as effective is 150mm. The power transmitted is 20KW at a speed of 1000rpm. The	L3	CO3	PO1,PO2,PO4

		maximum intensity of pressure at any point of contact surface is $0.8*10^5 N/mm^2$. If the co-efficient of friction is 0.30, then determine: 1. Internal radius of friction plate. 2. Axial thrust at which the friction surfaces are held together.			
15	a)	Deduce the equation for a shoe brake to determine the braking torque when line of action tangential braking force passes through a distance 'a' below fulcrum	L4	CO3	PO1,PO2,PO4
	b)	Following figure shows a brake applied to a drum by a lever AB which is pivoted at a fixed point A and rigidly fixed to the shoe. The radius of drum is 160mm. The coefficient of friction at brake lining is 0.3. If the drum rotates in clockwise, calculate the braking torque due to horizontal force of 600N at B. 	L2	CO3	PO1,PO2,PO4
16	a)	With a neat sketch explain the working principle of Prony Brake Dynamometer.	L2	CO3	PO1,PO2,PO4

UNIT–IV

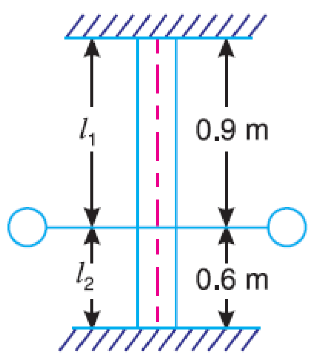
S.No.	Questions	BT	CO	PO
Part – A (Short Answer Questions)				
1	Classify the governors with its function.	L2	CO4	PO1,PO2,PO3
2	Define governor effort.	L2	CO4	PO1,PO2,PO3
3	Define sensitiveness & coefficient of sensitiveness of a governor	L2	CO4	PO1,PO2,PO3
4	Explain the term stability of governor	L2	CO4	PO1,PO2,PO3
5	What is meant by isochronous condition in governors?	L2	CO4	PO1,PO2,PO3
6	Differentiate between governor and flywheel?	L2	CO4	PO1,PO2,PO3
7	Differentiate between the unbalanced force caused due to rotating and reciprocating masses?	L3	CO4	PO1,PO2,PO3
8	Why is only a part of the unbalanced force due to reciprocating masses balanced by revolving mass? (Or) Why complete balancing is not possible in reciprocating engine?	L3	CO4	PO1,PO2,PO3
9	Define tractive force and swaying couple	L2	CO4	PO1,PO2,PO3

10		State the effects hammer blow and swaying couple. and What are the conditions to be satisfied for complete balance of in- line engine?	L2	CO4	PO1,PO2,PO3
Part – B (Long Answer Questions)					
11	a)	Deduce the relation between speed and height of the Porter governor	L2	CO4	PO1,PO2,PO3
	b)	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.	L3	CO4	PO1,PO2,PO3
12	a)	Deduce the relation between speed and height of the Proell governor	L2	CO4	PO1,PO2,PO3
	b)	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 and200 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.	L3	CO4	PO1,PO2,PO3
13		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; and3. The initial compression of spring.	L3	CO4	PO1,PO2,PO3
14		In a spring-controlled governor of the Hartung type, the length of the ball and sleeve arms are 80 mm and 120 mm respectively. The total travel of the sleeve is 25 mm. In themid position, each spring is compressed by 50 mm and the radius of rotation of the mass centres is140 mm. Each ball has a mass of 4 kg and the spring has a stiffness of 10 kN/m of compression. The equivalent mass of the governor gear at the sleeve is 16 kg. Neglecting the moment due to the revolving masses when the arms are inclined, determine the ratio of the range of speed to the mean speed of the	L3	CO4	PO1,PO2,PO3

		governor. Find, also, the speed in the mid-position.			
15		A rigid motor has all its unbalance in one plane and can be considered to consist of 3 masses m_1=5kg; m_2=3kg at an angle of 165^o CCW from m_1&m_3=8kg @ angle 85^oCW from m_1. The radii r_1=20cm, r_2=8cm & r_3=14cm. Determine the balancing mass required at radius 10cm. Specify the location of this mass with respect to m_1 by using graphical method.	L3	CO4	PO1,PO2,PO3
16		Three masses are attached to a shaft as follows: 10kg@90mm radius; 15kg@120mm radius and 9 kg @ 150mm radius. The masses are to be arranged so that the shaft is in static balance. Determine the angular position of masses relative to 10kg mass by analytical method. All masses are in same plane	L3	CO4	PO1,PO2,PO3

UNIT–V

S.No.		Questions	BT	CO	PO
Part – A (Short Answer Questions)					
1		Define resonance	L1	CO5	PO1,PO2,PO3
2		Classify vibrations and define them	L2	CO5	PO1,PO2,PO3
3		What is the limit beyond which damping is detrimental and why?	L3	CO5	PO1,PO2,PO3
4		What is meant by critical damping?	L2	CO5	PO1,PO2,PO3
5		Explain the Dunkerly's method used in natural transverse vibration?	L2	CO5	PO1,PO2,PO3
6		Define critical or whipping speed of a shaft	L2	CO5	PO1,PO2,PO3
7		Critical speed of shaft is the same as the natural frequency of transverse vibration. Justify?	L4	CO5	PO1,PO2,PO3
8		Define torsional equivalent shaft?	L2	CO5	PO1,PO2,PO3
9		When do you say a vibration system in under-damped?	L2	CO5	PO1,PO2,PO3
10		State the factors that affect the critical speed of a shaft?	L2	CO5	PO1,PO2,PO3
Part – B (Long Answer Questions)					
11	a)	A shaft of length 0.75 m, supported freely at the ends, is carrying a body of mass 90 kg at 0.25 m from one end. Find the natural frequency of transverse vibration. Assume E = 200 GN/$m^2$and shaft diameter = 50 mm.	L3	CO5	PO1,PO2,PO3
	b)	A cantilever shaft 50 mm diameter and 300 mm long has a disc of mass100 kg at its free end. The Young's modulus for the shaft material is 200 GN/m^2. Determine the frequency of longitudinal vibrations of the shaft.	L3	CO5	PO1,PO2,PO3
12	a)	Deduce the equation for natural frequency of free transverse vibrations for a shaft subjected to a number of point loads using Rayleigh's method	L3	CO5	PO1,PO2,PO3
	b)	A shaft 50 mm diameter and 3 metres long is simply	L3	CO5	PO1,PO2,PO3

		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 shaft material is 200 GN/m^2.Determine the frequency of transverse vibration			
13		A shaft 1.5 m long, supported in flexible bearings at the ends carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7700 $kg/m^3$and its modulus of elasticity is 200 GN/m^2. Calculate the lowest whirling speed of the shaft, taking into account the mass of the shaft.	L3	CO5	PO1,PO2,PO3
14		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 = 200 GN/m^2.	L3	CO5	PO1,PO2,PO3
15	a)	A flywheel is mounted on a vertical shaft as shown in Fig. The both ends of a shaft are fixed and its diameter is 50 mm. The flywheel has a mass of 500 kg and its radius of gyration is 0.5 m. Find the natural frequency of torsional vibrations, if the modulus of rigidity for the shaft material is 80 GN/m^2. 	L3	CO5	PO1,PO2,PO3
	b)	A shaft of 100 mm diameter and 1 metre long has one of its ends fixed and the other end carries a disc of mass 500 kg at a radius of gyration of 450 mm. The modulus of rigidity for the shaft material is 80 GN/m^2. Determine the frequency of torsional vibrations.	L3	CO5	PO1,PO2,PO3
16		A steel shaft ABCD 105m long has flywheel at its ends A&B. the mass of flywheel A is 600kg with radius of gyration 0.6m. The mass of flywheel D is 800kg with radius of gyration 0.9m. The connecting shaft has the diameter 50mm for the portion AB which is 0.4m long and diameter of 60mm for portion BC which is 0.5m long	L4	CO5	PO1,PO2,PO3

		and diameter of d mm for portion CD which is 0.6m long. Determine: (i) the diameter'd' of portion CD to that node of torsional vibration of system will be at centre of length BC. (ii) Natural frequency of torsional vibration. The modulus of rigidity for the shaft material is 80 GN/m^2.			

* **Blooms Taxonomy Level (BT)**(L1 – Remembering; L2 – Understanding; L3 – Applying; L4 – Analyzing; L5 – Evaluating; L6 – Creating)