INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**DYNAMICS OF MACHINERY**				
Course Code	AMEB17				
Programme	B. Tech				
Semester	FIVE				
Course Type	Core				
Regulation	**IARE - R18**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	2	1	3	-	-
Chief Coordinator	Dr. K Viswanath Allamraju, Professor				

COURSE OBJECTIVES:

I	The concepts of precision, static and dynamic forces of planer mechanisms by neglecting friction of aero planes, sea vessels, auto mobiles and various force members.
II	The knowledge of engineering mechanics for identifying the coefficient of friction and engine speed of the various contact bodies (Clutches and Brakes) and speed controlled devices, variations of torques and fluctuation of speeds of IC engines.
III	The magnitude and direction of balanced mass for unbalanced rotary and reciprocating engines with the fundamentals of applied physics.
IV	Mathematical modelling of various degree of freedom systems to interpret the various vibration parameters.
V	The affluence of real world engineering problems and examples towards gaining the experience for how dynamics of machinery is applied in engineering practice.

COURSE OUTCOMES:

At the end of the course the students should be able to:

Course Outcomes		**Knowledge Level (Bloom's Taxonomy)**
CO 1	Discuss the Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aero-planes and ships.	Understand
CO 2	Determine the angle of heel to avoid upside down of a two wheeler vehicle while taking in left and right turns.	Evaluate
CO 3	Illustrate the static and dynamic force analysis of two and three force members by graphical super position method.	Understand
CO 4	Apply the laws of friction on clutches, brakes and dynamometers to reduce the power losses for the effective torque transmission.	Apply

CO 5	Justify the importance of torque and fluctuation of speeds for single and multi cylindered engines to increase the mechanical efficiency.	Evaluate
CO 6	Estimate the height of a governor to regulate the speed of a prime mover at various load conditions.	Apply
CO 7	Determine the balanced mass for unbalanced rotary and reciprocating engines by analytical and graphical methods.	Evaluate
CO 8	Develop a mathematical modelling of free and forced vibration systems under damped and un-damped conditions to avoid the vibratory damages of aero-mechanical-civil structures and electrical and electronic components at various operated frequencies.	Apply
CO 9	Use the resonance phenomenon to predict the critical or whirling or whipping speeds of various structures under vibrations to avoid catastrophic failures.	Analyze
CO 10	Apply the principles of dynamics of machinery to a real world problems for obtaining optimum solutions.	Apply

MAPPING OF EACH CO WITH PO(s) & PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	4	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	-	3	-	2	-	-	-	-	-	-	-	-	2	-	-
CO 7	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 8	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 9	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 10	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-

TUTORIAL QUESTION BANK

MODULE – I				
PRECESSION, STATIC AND DYNAMIC FORCE ANALYSIS OF PLANAR MECHANISMS				
PART - A (SHORT ANSWER QUESTIONS)				
S. No	**Question**	**Blooms Taxonomy Level**	**How does this Subsume the level below**	**Course Outcome**
1	Explain static and dynamic force analysis of planar mechanisms.	Understand	This would require the learner to **recall** the free body diagram concepts and equilibrium equations, then **describe** the static and dynamic force analysis of a body which is subjected various forces.	CO 1
2	Explain the magnitude of gyroscopic couple in an automobile?	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of four and two wheelers as application	CO 1
3	Explain the gyroscopic effect in a rotating disc.	Understand	This would require the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of rotating disc when rotates about precessional axis.	CO 1
4	Explain precessional angular velocity of spin vector.	Understand	This would require the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the precessional angular velocity of rotating disc when rotates about precessional axis.	CO 1
5	Demonstrate the expression for gyroscopic couple for a spinning disc.	Understand	This would require the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of rotating disc when rotates about precessional axis.	CO 1
6	Explain Dynamic force analysis of planar mechanisms.	Understand	This would require the learner is to **recall** the fundamentals of equilibrium equations , then **describe** the dynamic analysis of mechanisms	CO 3
7	Explain static force analysis of planar mechanisms.	Understand	This would require the learner is to **recall** the fundamentals of equilibrium equations , then **describe** the static analysis of mechanisms	CO 3
8	Illustrate the plane of precession as applied to an aeroplane.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of air plane as application	CO 1

9	Explain the axis of precession as applied to four wheeler?	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of four and two wheelers as application	CO 1
10	Explain the plane of spinning of rotor of a ship.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of ship as application	CO 1
11	Explain the plane of reactive gyroscopic couple for motor cycle.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of two wheelers as application	CO 1
12	Explain the axis of spinning in the case of a ship.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of ship.	CO 1
13	Explain the plane of active gyroscopic couple for a two wheeler.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the plane of gyro couple of two wheelers as application	CO 1
14	Demonstrate the magnitude of Gyroscopic couple in motor cycle?	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple and its magnitude of two wheelers as application	CO 1
15	Explain the gyroscopic acceleration of a disc in rotation.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of disc.	CO 1
16	Demonstrate the expression for gyroscopic acceleration of a rotating disc.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the gyro couple of disc.	CO 1
17	Explain the angle of heel in the case of a two wheeler negotiating curve.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **explain** the gyro couple of two wheeler.	CO 2
18	Explain the effect of gyroscopic couple on an automobile taking left turn.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **explain** the gyro couple of two wheeler when taking left turn.	CO 2
19	Explain the effect of gyroscopic couple on a ship pitching upward.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **explain** the gyro couple of ship	CO 1

20	With a neat sketch explain gyroscopic effect in a four wheeler.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **explain** the gyro couple of four wheeler to maintain orientation or stabilize the vehicle.	CO 1
PART - B (LONG ANSWER QUESTIONS)				
1	Derive the equation for the magnitude of gyroscopic couple of disc.	Apply	This would require the learner to **recall** the concepts of angular momentum and its principles, then **select** them for deriving the gyroscopic couple equation.	CO 1
2	Explain applied torque and reaction Torque of a four wheeler.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **outline** the gyro couple of four wheeler to maintain orientation or stabilize the vehicle.	CO 1
3	Build the gyroscopic effect on sea vessels with various free body diagrams.	Apply	This would require the learner to **recall** the concepts of angular momentum and its principles, then **select** them for constructing the gyroscopic torque equation of ship	CO 1
4	Explain the stability conditions of four wheelers with a free body diagram.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **outline** the gyro couple of four wheeler to maintain orientation or stabilize the vehicle.	CO 1
5	Derive the relation for limiting speed of a two wheeler.	Apply	This would require the learner to **recall** the concepts of angular momentum and its principles, then **select** them for deriving the gyroscopic couple equation of a two wheeler.	CO 1
6	Explain the gyroscopic effects on the motion of an air craft while taking a turn.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **outline** the gyro couple of aircraft to maintain orientation or stabilize the vehicle.	CO 1
7	Explain the plane of spinning, plane of precession and plane of gyroscopic couple with a free body diagrams.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **describe** the three planes and three axes.	CO 1
8	Explain the effects on gyroscopic couple and centrifugal force make the rider.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **interpret** the descriptions of gyro torque.	CO 1
9	Explain the axis of spinning, axis of precession and axis of gyroscopic couple.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles ,	CO 1

			then **outline** the terms used for gyro couple.	
10	Explain the gyroscopic effect on a ship during pitching.	Understand	The prerequisite for the learner is to **recall** the fundamentals of angular momentum principles , then **outline** the gyro couple of ship during simple harmonic motion in a rough sea.	CO 1
11	Explain the applied and constraint forces in relation to application of mechanisms.	Understand	The prerequisite for the learner is to **recall** the fundamentals of coplanar concurrent forces to **describe** the various action forces and reaction forces when the body is subjected to external forces.	CO 3
12	Explain the conditions for a body to be in equilibrium under the action of two forces.	Understand	The prerequisite for the learner is to **recall** the fundamentals of coplanar concurrent forces to **describe** the various action forces and reaction forces when the body is subjected to external forces.	CO 3
13	Explain the conditions for a body to be in equilibrium under the action of two forces and a torque.	Understand	The prerequisite for the learner is to **recall** the fundamentals of coplanar concurrent forces to **describe** the various action forces and reaction forces when the body is subjected to external forces.	CO 3
14	Explain the free body diagrams useful in estimating the various forces acting on different members of the mechanism.	Understand	The prerequisite for the learner is to **recall** the fundamentals of coplanar concurrent forces to **describe** the various action forces and reaction forces when the body is subjected to external forces.	CO 3
15	Explain the principle of superposition as applicable to a system of forces in a mechanism.	Understand	The prerequisite for the learner is to **recall** the fundamentals of coplanar concurrent forces to **describe** the principle of super position when the body is subjected to external forces.	CO 3
16	Explain the principle of virtual work with a neat sketch.	Understand	The prerequisite for the learner is to **recall** the fundamentals of work energy equations to **describe** the virtual work when the body is subjected to external forces.	CO 3
17	Explain the conditions for a body to be in equilibrium under the action of four forces.	Understand	The prerequisite for the learner is to **recall** the fundamentals of coplanar concurrent forces to **describe** the various action forces and reaction forces when the body is subjected to external forces.	CO 3
18	Explain static equilibrium for a planar mechanism.	Understand	The prerequisite for the learner is to **recall** the fundamentals equilibrium equations to **describe** the various action forces and reaction forces when the body is subjected to external forces of various mechanisms.	CO 3
19	Explain dynamic equilibrium of a planar mechanism.	Understand	The prerequisite for the learner is to **recall** the fundamentals	CO 3

			equilibrium equations to **describe** the various action forces and reaction forces when the body is subjected to external forces of various mechanisms.	
20	Explain the conditions for a body to be in equilibrium under the action of three forces.	Understand	The prerequisite for the learner is to **recall** the fundamentals equilibrium equations to **describe** the various action forces and reaction forces when the body is subjected to external forces of various mechanisms.	CO 3
PART - C (ANALYTICAL QUESTIONS)				
1	The mass of turbine rotor of a ship is 8 tonnes and has a radius of gyration of 0.6 meters. It rotates at 1800 rpm clockwise when looking from the front. Determine the gyroscopic effect if i) The ship is travelling at 100 km/h and steers to the right in a curve of 70 meters radius. ii) The ship is pitching and the bow descends with maximum velocity. The complete oscillation takes 20seconds.The pitching is simple harmonic and the total angular movement between the extreme positions is 10 degrees. iii) The ship is rolling and at a certain instant has an angular velocity of 0.03 radians/second clockwise when looking from bow.	Apply	This would require the learner to **recall** the formula and its parameters, then **assigning** correct values for the parameters and solving and converting units.	CO 1
2	The mass of the motor cycle along with the rider is 180 kg. The height of the centre of gravity of total mass is 600mm above the ground when it moves straight. Each wheel has a diameter of 700mm and mass moment of inertia of 2 kgm The engine rotates at a speed of 5 times the road wheel and engine rotating parts have mass moment of inertia of 0.2 kgm . Estimate the angle of heel if it is travelling at 50 km/h and is taking a turn of 30 meters radius.	Apply	This would require the learner to **recall** the formula and its parameters, then **assigning** correct values for the parameters and solving and converting units.	CO 2
3	A racing car has a mass of 2500kg.It has a wheel base of 2m, track width of 1m and height of C.G 300mm above ground level and lies midway between the front and rear axles. The engine flywheel rotates at 3000 rpm clockwise when viewed from the front. The moment of inertia of the flywheel is 4kgm and the moment of inertia of each wheel is 3kgm Estimate the reactions between the wheels and the ground when the car takes a curve of 15m towards right at 30 km/hr, taking into consideration the gyroscopic and centrifugal effects. Each wheel radius	Apply	This would require the learner to **recall** the formula of gyroscopic effect and its parameters, then **assigning** correct values for the parameters and solving and converting units.	CO 2

	is 400mm.The ratio of engine speed to back axle speed is 3:1.			
4	An aero-plane makes a complete half circle of 50 m radius towards left in a time of 20 seconds when flying at 200kmph. The rotary engine and the propeller of the plane has a mass of 400kg and a radius of gyration of 0.3 m. The engine rotor rotates at 2400 rpm clockwise when seen from the rear. Estimate the gyroscopic couple on the air craft and state its effect on the aero-plane.	Apply	This would require the learner to **recall** the formula of gyroscopic effect and its parameters, then **assigning** correct values for the parameters and solving and converting units.	CO 1
5	A uniform disc having a mass of 8 kg and radius of gyration 150 mm is mounted on one end of a horizontal arm of length 200 mm. The other end rotates freely in a bearing. The disc is given a clockwise spin of 240 rpm. Determine the motion of the disc if its arm remains horizontal.	Apply	This would require the learner to **recall** the formula of gyroscopic effect and its parameters, then **assigning** correct values for the parameters and solving the asked paramters	CO 1
6	Determine the required input torque on the crank of a slider crank mechanism for static equilibrium when the applied piston load is 1500N. The length of the crank and connecting rod are 40 mm and 100 mm respectively and the crank has turned through 45^0 from the inner dead center.	Apply	This would require the learner to **recall** the formula of gyroscopic effect and its parameters, then **assigning** correct values for the parameters and solving the asked paramters	CO 3
7	In a four link mechanism ABCD, the link AB revolves with an angular velocity of 10 radians/second and angular acceleration of20 radians/s^2 at the instant when it makes an angle of 45˚ 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 4kg/m length. Determine the torque required to overcome the inertia forces, neglecting the gravitational effects. Assume the links to be of uniform cross-section.	Apply	This would require the learner to **recall** the formula of gyroscopic effect and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 3
8	In a four bar mechanism, the link 3 and 4 are subjected to forces of 100N at an angle of 60˚ and 50N at an angle of 45˚. The dimensions of the links are O_2O_4= 800 mm = 800 mm, O_2B=500 mm, BC=450 mm, O_4C= 300mm, BD=200 mm and O_4E=150mm. Estimate the shaft torque on link2 for static equilibrium of the mechanism along with the constraint forces.	Apply	This would require the learner to **recall** the formula of gyroscopic effect and its parameters, then **assigning** correct values for the parameters and solving the asked paramters	CO 3
9	A vertical petrol engine 150 mm diameter and 200 mm stroke has a connecting rod 350 mm long. The mass of the piston is 1.6 kg and the engine speed is 1800 rpm. On the expansion stroke with crank angle 30˚ from top	Apply	This would require the learner to **recall** the formula of gyroscopic effect and its parameters, then **assigning** correct values for the parameters and solving the asked paramters	CO 3

	dead center, the gas pressure is 750 kN/m^2. Determine the net thrust on the piston.			
10	For the static equilibrium of a quick return mechanism of crank and slotted lever, determine the required input torque for a force of 5000N acting from left to right on the slider. The dimensions of various links are crank AB=120mm, fixed link AC =175 mm, connecting link DE=250mm and slotted link CD= 300 mm. The crank makes 60 ˚with the vertical.	Apply	This would require the learner to **recall** the formula of gyroscopic effect and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 3
MODULE-II				
CLUTCHES, BRAKES AND DYNAMOMETERS				
PART - A (SHORT ANSWER QUESTIONS)				
1	Explain the function of clutch which can be used in an automobile.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
2	Explain the function of brakes in a crane lifting loads.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brakes	CO 4
3	Explain the different dynamometers based on absorption of friction.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of dynamo meter	CO 4
4	Describe with a neat sketch absorption type dynamometer.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of dynamo meter	CO 4
5	Explain the centrifugal clutch as applicable to a two wheeler.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
6	Explain the cone clutch as applied to a two wheeler.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
7	Describe a transmission type dynamometer.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of dynamo meter	CO 4
8	Describe an internal expanding brake with a neat sketch.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brakes.	CO 4
9	Explain the expression for the friction torque for a flat collar bearing considering uniform wear.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
10	Explain the expression for the friction torque for a flat collar bearing considering uniform pressure.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4

11	Explain the expression for the friction torque for a conical collar bearing considering uniform wear.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
12	Explain the expression for the friction torque for conical collar bearing considering uniform pressure.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
13	Describe the working of a single plate clutch and give its applications.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
14	Explain the working of a multi plate clutch with a neat sketch.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
15	Explain the expression for the friction torque for a centrifugal clutch.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
16	Explain the difference between brake and clutch?	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch.	CO 4
17	Describe briefly the various types of brakes.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brakes	CO 4
18	Explain the relation for ratio of tensions in a band brake.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brakes	CO 4
19	Explain the relation for friction torque in an internal expanding shoe brake.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brakes	CO 4
20	Explain absorption type dynamometer with a neat sketch.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of dynamo meter	CO 4
PART - B (LONG ANSWER QUESTIONS)				
1	Derive expression for the friction torque for a flat collar bearing considering uniform wear.	Apply	This would require the learner to **recall** the basics of friction and assign them to develop a mathematical modeling of bearing under various conditions	CO 4
2	Derive expression for the friction torque for a flat collar bearing considering uniform pressure.	Apply	This would require the learner to **recall** the basics of friction and assign them to develop a mathematical modeling of bearing under various conditions	CO 4
3	Derive expression for the friction torque for a conical collar bearing considering uniform wear.	Apply	This would require the learner to **recall** the basics of friction and assign them to develop a mathematical modeling of bearing under various conditions	CO 4

4	Derive expression for the friction torque for a conical collar bearing considering uniform pressure.	Apply	This would require the learner to **recall** the basics of friction and assign them to develop a mathematical modeling of bearing under various conditions	CO 4
5	Describe the working of a single plate clutch in an automobile.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch	CO 4
6	Explain the working of a multi plate clutch with a neat sketch.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch	CO 4
7	Derive expression for the friction torque for a centrifugal clutch.	Apply	This would require the learner to **recall** the basics of friction and assign them to develop a mathematical modeling of bearing under various conditions	CO 4
8	What is the difference between brake and clutch?	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of clutch	CO 4
9	Describe briefly the various types of brakes.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brake	CO 4
10	What is self locking and self energized brake?	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brake	CO 4
11	Derive the relation for ratio of tensions in a band brake.	Apply	This would require the learner to **recall** the basics of friction and assign them to develop a mathematical modeling of bearing under various conditions	CO 4
12	Derive the relation for friction torque in an internal expanding shoe brake.	Apply	This would require the learner to **recall** the basics of friction and assign them to **develop** a mathematical modeling of bearing under various conditions	CO 4
13	Explain any one type of absorption dynamometer.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of dynamo meter.	CO 4
14	Explain any one type of transmission dynamometer	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of dynamo meter.	CO 4
15	Explain transmission type dynamometer with a neat sketch.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of dynamo meter.	CO 4
16	Explain double band brake with a neat sketch.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brake to reduce the speed.	CO 4
17	Explain shoe brake with a neat sketch. Derive the relation for ratio of tight side	Understand	This would require the learner to **recall** the principles of friction in	CO 4

	and slack side tensions.		order to **describe** the function of brake to reduce the speed	
18	Explain internal expanding band brake with a neat sketch.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brake to reduce the speed	CO 4
19	Discuss the effectiveness of a band brake under various conditions.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brake to reduce the speed	CO 4
20	What are various types of brakes? Describe briefly.	Understand	This would require the learner to **recall** the principles of friction in order to **describe** the function of brake to reduce the speed.	CO 4
PART - C (CRITICAL THINKING QUESTIONS)				
1	Determine the axial force required to engage a cone clutch transmitting 20kW of power at 750 rpm. Average friction diameter of the cone is 400mm and average pressure intensity 60 kN/m^2. Semi cone angle is 100 and coefficient of friction is 0.25.Also Estimate the width of the friction cone.	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 4
2	A band brake acts on 3/4th of a circumference of a brake drum of 450 mm diameter which is keyed to a shaft. The band brake provides a braking torque of 225 Nm. One end of the lever is attached to a fulcrum pin of the lever and the other end is attached to a pin 100 mm from the fulcrum. If the operating force is applied at 500 mm from the fulcrum and coefficient of friction is 0.25, Estimate the operating force when the drum rotates in Clock-wise direction and anti- clockwise direction.	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 4
3	In a vertical belt transmission dynamometer, the diameter of the driving pulley rotating at 1500 rpm is 80 mm. The centre distance of the intermediate pulley from the fulcrum is also 80 mm each. The weighing pan on the lever is at a distance of 250 mm. Estimate the power transmitted when a mass of 20kg is required on the pan including its own mass.	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 4
4	The following data refer to a rope brake dynamometer in a laboratory experiment. Diameter of the flywheel=1m, Diameter of the rope=10 mm, Dead weight on the brake=50 kg, Speed of the engine =180 rpm, Spring balance reading=120 N, Estimate the power of the engine.	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 4

5	A conical pivot supports a load of 20kN, cone angle is 120^0 and intensity of pressure normal to the cone is $0.3N/mm^2$. The outer diameter is twice the inner diameter. Estimate the outer and inner radii of bearing surface if the shaft rotates at 200 rpm and μ= 0.1. Estimate the power absorbed in friction assuming uniform wear.	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 4
6	A bicycle and rider , travelling at 12 kmph on a level road have a mass of 105 kg. A brake is applied to the rear wheel which is 800 mm in diameter. The pressure on the brake is 80 N and the coefficient of friction is 0.06. Estimate the distance covered by the bicycle and number of turns of its wheel before coming to rest.	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 4
7	A simple band brake is applied to a drum of 560 mm diameter which rotates at 240 rpm. The angle of contact of the band is 270 degree. One end of the band is fastened to a fixed pin and the other end to the brake lever, 140 mm from the fixed pin. The brake lever is 800 mm long and is spaced perpendicular to the diameter that bisects the angle of contact. Assuming the coefficient of friction is 0.3, determine the necessary pull at the end of the lever to stop the drum if 40 kW of power is being absorbed. Also Estimate the width of the band if its thickness is 3 mm and the maximum tensile stress is 40 N/mm^2.	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 4
8	A band and block brake has 14 blocks. Each block subtends an angle of 14 degree at the center of the rotating drum. The diameter of the drum is 750 mm and the thickness of the blocks is 65 mm. The two ends of the band are fixed to the pins on the lever at distances of 50 mm and 210 mm from the fulcrum on the opposite sides. Determine the least force required to be applied at the lever at a distance of 600 mm from the fulcrum if the power absorbed by the blocks is 180 kW at 175 rpm. Coefficient of friction between the blocks and the drum is 0.35.	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 4
9	A simple band brake is applied to a drum of 500 mm diameter which rotates at 200 rpm. The angle of contact of the band is 260 degree. One end of the band is fastened to a fixed pin and the other end to the brake lever, 130 mm from the fixed pin. The	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 4

	brake lever is 700 mm long and is spaced perpendicular to the diameter that bisects the angle of contact. Assuming the coefficient of friction is 0.3, determine the necessary pull at the end of the lever to stop the drum if 30 kW of power is being absorbed. Also Estimate the width of the band if its thickness is 4 mm and the maximum tensile stress is 40 N/mm^2.			
10	A band and block brake has 14 blocks. Each block subtends an angle of 14 degree at the center of the rotating drum. The diameter of the drum is 700 mm and the thickness of the blocks is 60 mm. The two ends of the band are fixed to the pins on the lever at distances of 50 mm and 210 mm from the fulcrum on the opposite sides. Determine the least force required to be applied at the lever at a distance of 600 mm from the fulcrum if the power absorbed by the blocks is 180 kW at 175 rpm. Coefficient of friction between the blocks and the drum is 0.35.	Apply	This would require the learner to **recall** the formula of coefficient of friction and torque and its parameters, then **assigning** correct values for the parameters and solving the asked parameters.	CO 4
MODULE –III				
TURNING MOMENT AND GOVERNORS				
PART - A (SHORT ANSWER QUESTIONS)				
1	Explain the turning moment diagram with a neat sketch of an engine.	Understand	This would require the learner to **recall** the concepts of torque and then **describe** the relation between torque and angle of rotation	CO 5
2	Explain a spring loaded governor and give its application.	Understand	This would require the learner to **recall** the concepts of working of governor and then describe the spring loaded governors with applications.	CO 6
3	Explain the various types of governors used for regulating speed?	Understand	This would require the learner to recall the concepts of torque and then describe the various types for regulating speed.	CO 6
4	Explain the fluctuation of energy for a multi-cylinder engine.	Understand	This would require the learner to recall the angular velocities and kinetic energy then describe the fluctuation of energy of various cylinder engines	CO 6
5	Explain the coefficient of fluctuation of speed for an engine.	Understand	This would require the learner to recall the angular velocities and kinetic energy then describe the coefficient of fluctuation of energy of various cylinder engines	CO 5
6	Explain the function of a fly wheel in a rock crusher.	Understand	This would require the learner to recall the angular velocities and kinetic energy then describe the	CO 5

			function of flywheel of rock crusher.	
7	Explain the function of a governor.	Understand	This would require the learner to recall the basics of engineering mechanics then describe the function of governor.	CO 6
8	Explain the equilibrium speed of a Porter governor?	Understand	This would require the learner to recall the basics of engineering mechanics then describe the equilibrium speed of a porter governor.	CO 6
9	Explain governor differ from that of flywheel.	Understand	This would require the learner to recall the function of governor and flywheel then describe the difference between them.	CO 5
10	Explain the function of flywheel in a punching press.	Understand	This would require the learner to recall the principle of working of flywheel then describe the function in punching press.	CO 5
11	Explain the function of a Watt governor.	Understand	This would require the learner to recall the equilibrium equations then describe the function of watt governor.	CO 6
12	Explain the isochronism of a Porter governor.	Understand	This would require the learner to recall the equilibrium equations then describe the function of watt governor.	CO 6
13	Explain the effort and power of a Proell governor.	Understand	This would require the learner to recall the equilibrium equations then describe the function of proell governor.	CO 6
14	Explain a Hartnell governor with a neat sketch.	Understand	This would require the learner to recall the equilibrium equations then describe the function of Hartnell governor.	CO 6
15	Describe Hartung governor with a neat sketch?	Understand	This would require the learner to recall the equilibrium equations then describe the function of Hartung governor.	CO 6
16	Explain the function of a Porter governor?	Understand	This would require the learner to recall the equilibrium equations then describe the function of Porter governor.	CO 6
17	Explain Proell governor with a neat sketch.	Understand	This would require the learner to recall the equilibrium equations then describe the function of Proell governor.	CO 6
18	Explain the equation for calculating the equilibrium speed of a Porter governor	Understand	This would require the learner to recall the equilibrium equations then describe the function of Porter governor.	CO 6
19	Explain the term hunting in the case of governors.	Understand	This would require the learner to recall the equilibrium equations then describe the hunting of governor.	CO 6
20	Explain the terms stability and insensitiveness in governors.	Understand	This would require the learner to recall the equilibrium equations	CO 6

			then describe the stability and insensitiveness of governor.	
PART - B (LONG ANSWER QUESTIONS)				
1	Explain the D'Alembert's principle with the concepts of mechanics.	Understand	This would require the learner to recall the basics of engineering mechanics and then describe the D Aleberts principle.	CO 6
2	Explain the necessary of torque in the case of four wheelers?	Understand	This would require the learner to recall the basics of engineering mechanics and then describe the torque for four wheels	CO 6
3	Derive a relation for the turning moment at the crankshaft in terms of the piston effort and the angle turned by the crank.	Apply	This would require the learner to recall the basics of engineering mechanics and then derive the mathematical relation of torque and angle turned by the crank shaft.	CO 6
4	Explain the terms coefficient of fluctuation of energy and coefficient of fluctuation of speed.	Understand	This would require the learner to recall the basics of engineering mechanics and then describe function of fluctuation of speed.	CO 5
5	Explain the function of a flywheel in a punching press?	Understand	This would require the learner to recall the basics of engineering mechanics and then describe function of flywheel in a punching press.	CO 5
6	Derive the relation for the coefficient of fluctuation of speed in terms of maximum fluctuation of energy and the kinetic energy of the flywheel at mean speed.	Apply	This would require the learner to recall and the basics of engineering mechanics and then derive the mathematical relations between the fluctuation of speed.	CO 5
7	Describe the graphical method of determining the inertia of the connecting rod of a reciprocating engine.	Understand	This would require the learner to recall the inertia of various parts for explaining the effect of inertia in a engine.	CO 6
8	Explain the dynamically equivalent system?	Understand	This would require the learner to recall the concepts of equilibrium equations for describing the dynamically equivalent systems.	CO 5
9	Derive an expression for the angular acceleration of the connecting rod of a reciprocating engine.	Apply	This would require the learner to recall the concepts of kinematics for deriving the mathematical relation of angular acceleration of connecting rod of reciprocating engine.	CO 6
10	Explain the equivalent offset inertia force of various governors.	Understand	This would require the learner to recall the concepts of equilibrium equations for describing the equivalent offset inertia of various governors.	CO 5
11	Explain the difference between the functions of a governor and flywheel.	Understand	This would require the learner to recall the concepts of equilibrium equations for describing the difference between the governor and flywheel..	CO 6
12	Explain centrifugal governors and the differ from inertia governors with other governors.	Understand	This would require the learner to recall the concepts of equilibrium	CO 6

			equations for describing the difference between the governors.	
13	Describe the function of a Watt governor with mathematical modeling.	Understand	This would require recalling of governors and explain the mathematical modeling of height of governors.	CO 6
14	Explain Porter governor differ from Watt governor?	Understand	This would require the learner to recall the concepts of equilibrium equations for describing the difference between the governors.	CO 6
15	Explain the effect of friction in a Porter governor And also the function of a Porter governor with a mathematical modeling.	Understand	This would require recalling of governors and explain the mathematical modeling of height of governors.	CO 6
16	Describe the function of a Proell governor with a neat sketch.	Understand	This would require recalling of governors and explain the mathematical modeling of height of governors.	CO 6
17	Describe the Governor and flywheel in relation to applications.	Understand	This would require recalling of governors and explain the mathematical modeling of height of governors.	CO 6
18	Describe the function of a Hartnell governor with a line diagram.	Understand	This would require recalling of governors and explain the mathematical modeling of height of governors.	CO 6
19	Explain the function of a Hartung governor with a neat sketch.	Understand	This would require recalling of governors and explain the function of governor.	CO 6
20	Derive the expressions for the effort and power of a Porter governor.	Apply	This would require recalling of governors and explain the mathematical modeling of the effort and power of a governor.	CO 6
PART - C (ANALYTICAL QUESTIONS)				
1	A machine shaft running at 200 rpm requires a torque increasing uniformly from 1200 Nm to 3600 Nm during180^0 of rotation. It is steady at 3600 Nm for subsequent one revolution and decreases uniformly to its original value of 1200 Nm in subsequent one revolution and is again steady at 1200 Nm for the next two revolutions. This completes the cycle. The motor has a constant torque which has a rotor of mass 450 kg and 250mm radius of gyration. In addition, if it has a flywheel of mass 2000kg and 600 mm radius of gyration fitted to the shaft. Determine the power required to drive the motor and percentage fluctuation in speed.	Apply	This would require the learner to **recall** the formulae of power and fluctuation of speed and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 5
2	The effective turning moment exerted by a two stroke engine at crank shaft is $T= 8000+ 1000\sin2\theta- 2000\cos2\theta$ where θ is the inclination of the crank to inner dead center. The mass of the	Apply	This would require the learner to **recall** the formulae of power and fluctuation of speed and its parameters, then **assigning** correct	CO 5

	flywheel is 500kg and radius of gyration is 750 mm. The engine speed is 300 rpm. Determine the power developed, the total percentage fluctuation of speed and maximum angular retardation.		values for the parameters and solving the asked parameters	
3	The turning moment diagram for a multi cylinder engine has been drawn to a scale of 1mm to 500 Nm of torque and 1mm to 60 of crank displacement The intercepted areas between the output torque curve and the mean resistance line taken in order from one end of the engine are -30, +410, -280+320, -330, +250, -360, +280, -260 mm2 when the engine runs at 800 rpm. The engine has a stroke of 300mm and the fluctuation of speed is not to exceed 2% of mean speed. Determine suitable diameter and cross section of the flywheel rim for a limiting value of safe centrifugal stress of 7 Mega Pascal. The material density is 720kg/m^3. Width of the rim is 5 times the thickness.	Apply	This would require the learner to **recall** the formulae of power and fluctuation of speed and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 5
4	The turning moment diagram for a multi cylinder engine has been drawn to a scale of 1cm= 5000Nm torque and 1cm= 600 respectively. The intercepted areas between output torque curve and mean resistance taken in order from one end are -0.3, +4.1, -2.8, +3.2, -3.3, +2.5, -3.6, +2.8, -2.6 square cm when the engine is running at 800rpm. The engine has a stroke of 300 mm and the fluctuation of speed is not to exceed 2% of mean speed. Determine a suitable diameter of cross section of the flywheel rim for limiting value of the shaft centrifugal stress of 280 X 103 N/m^2. The material density may be assumed as 7.2 g/cm^3. Assume the thickness of the rim to be ¼ th of the width.	Apply	This would require the learner to **recall** the formulae of power and fluctuation of speed and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 5
5	A single cylinder single acting four stroke gas engine develop 20kW at 300 rpm. The work done by the gases during the expansion stroke is three times the work done on the gases during the compression stroke, the work done during the suction and exhaust strokes is negligible. If the total fluctuation of speed is not to exceed ± 2 percent of the mean speed and the turning moment diagram during compression and expansion is assumed to be triangular in shape, Estimate the moment of inertia of the flywheel.	Apply	This would require the learner to **recall** the formulae of power and fluctuation of speed and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 5

6	Each arm of a porter governor is 300 mm long and is pivoted on the axis of rotation. Each ball has a mass of 6 kg and the sleeve weighs 18kg. The radius of rotation of the ball is 200 mm when the governor begins to lift and250 mm when the speed is maximum. Determine the maximum and minimum speeds and the range of speed of the governor.	Apply	This would require the learner to **recall** the formulae of governors such as height, maximum and minimum speeds and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 6
7	The weight of each ball of a Proell governor is 90N. The central load is1500N and the arms are 250mm long. The arms are open and pivoted at a distance of 50 mm from the axis of rotation. The extension of the lower arms to which each ball is attached is 125 mm long and the radius of rotation of the balls is 250mm. When the arms are inclined at 40^0 to the axis of rotation, Estimate i) the equilibrium speed for the above configuration and the coefficient of insensitiveness if friction is equivalent to a force of 20N at the sleeve.	Apply	This would require the learner to **recall** the formulae of governors such as height, maximum and minimum speeds and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 6
8	A Hartnell governor having a central sleeve spring and two right angle bell crank levers moves between 290 rpm and 310 rpm 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 the mass of each ball is 2.5 kg. Determine the loads on the spring at the lowest and highest equilibrium speeds and the stiffness of the spring.	Apply	This would require the learner to **recall** the formulae of governors such as height, maximum and minimum speeds and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 6
9	Estimate the minimum speed of a Porter governor, which has equal arms each 200mm long and are pivoted on the axis of rotation. The mass of each ball is 5 kg and the minimum radius of rotation for the ball is 100mm.	Apply	This would require the learner to **recall** the formulae of governors such as height, maximum and minimum speeds and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 6
10	In a spring controlled governor of the Hartung type, the length of the ball and sleeve arms are 80mm and 120mm respectively. The total travel of the sleeve is 25 mm. In the mid position, each spring is compressed by 50mm and the radius of rotation of the mass center is 140mm. Each ball has a mass of 4 kg and the spring has a stiffness of 10kN/m. The equivalent mass at the sleeve is 16kg. Neglecting the moment due to the revolving masses, when the arms are inclined, determine the ratio of range of speed to the mean speed of	Apply	This would require the learner to **recall** the formulae of governors such as height, maximum and minimum speeds and its parameters, then **assigning** correct values for the parameters and solving the asked parameters.	CO 6

	the governor. Also Estimate the speed in mid position.			
MODULE –IV				
BALANCING OF ROTATORY AND RECIPROCATING MASSES				
PART - A (SHORT ANSWER QUESTIONS)				
1	Explain balancing of a single rotating mass?	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
2	What is static balancing of a rotating mass?	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
3	What is dynamic balancing in the case of rotation in a single plane?	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
4	Explain balancing of rotating masses in different planes.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
5	What is balancing of reciprocating masses?	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
6	Explain locomotive balancing with a neat sketch.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
7	Explain the tractive force in locomotive balancing.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing and tractive force of locomotives.	CO 7
8	Explain the effect of swaying couple in locomotives.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing and swaying couple of locomotives.	CO 7
9	Explain the hammer blow in the case of locomotives.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing and hammer blow of locomotives.	CO 7
10	Explain about multi cylinder engine?	Understand	This would require recalling of the fundamentals of functioning of single stroke engine and then describe the working principle of multi cylinder engine .	CO 7
11	Explain balancing of a V engine.	Understand	This would require recalling of the fundamentals of functioning of single stroke engine and then describe the working principle of v engine .	CO 7
12	Explain the primary balancing of reciprocating masses.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
13	Explain the secondary balancing of rotating masses.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
14	Explain about unbalanced forces balancing	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7

15	Explain unbalanced couples in the case of radial engines.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of radial engines	CO 7
16	Explain balancing of radial engine.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of radial engines	CO 7
17	Explain about in-line engines.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of radial engines.	CO 7
18	Explain the conditions for static balancing.	Understand	This would require recalling of the fundamentals of mechanics and then describe the conditions for static balancing.	CO 7
19	Explain the conditions for dynamic balancing.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing dynamic balancing conditions.	CO 7
20	Explain about coupled locomotives.	Understand	This would require recalling of the fundamentals of mechanics and then describe the coupled locomotives.	CO 7
PART - B (LONG ANSWER QUESTIONS)				
1	Explain the static and dynamic unbalance in machinery.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
2	Explain the necessity of balancing in rotors of high speed engines	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing.	CO 7
3	Explain the balancing of rotating masses with a neat sketch.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of rotating masses.	CO 7
4	Explain the balancing of reciprocating masses with a neat sketch.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of reciprocating masses.	CO 7
5	Derive the expression for variation in tractive force in locomotive balancing.	Apply	This would require recalling of the fundamentals of mechanics and then express the mathematical relation for tractive force	CO 7
6	Derive the expression for swaying couple in locomotive balancing.	Apply	This would require recalling of the fundamentals of mechanics and then express the mathematical relation for swaying couple.	CO 7
7	Derive the expression for hammer blow i locomotive balancing.	Apply	This would require recalling of the fundamentals of mechanics and then express the mathematical relation for hammer blow.	CO 7
8	Describe the primary balancing in reciprocating engines.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of rotating masses	CO 7
9	Describe the secondary balancing in reciprocating engine.	Understand	This would require recalling of the fundamentals of mechanics and then	CO 7

			describe the balancing of rotating masses	
10	Derive the unbalanced forces and couples in case of two cylinder engines.	Apply	This would require recalling of the fundamentals of mechanics and balancing and then express the mathematical relation for unbalanced forces of various cylindered engines.	CO 7
11	Derive the magnitudes of unbalanced forces in V-engines	Apply	This would require recalling of the fundamentals of mechanics and balancing and then express the mathematical relation for unbalanced forces of various cylindered engines.	CO 7
12	Derive the magnitudes of unbalanced forces in radial engines	Apply	This would require recalling of the fundamentals of mechanics and balancing and then express the mathematical relation for unbalanced forces of various cylindered engines.	CO 7
13	Determine the magnitudes of unbalanced forces in in-line engines.	Apply	This would require recalling of the fundamentals of mechanics and balancing and then express the mathematical relation for unbalanced forces of various cylindered engines.	CO 7
14	Derive the magnitudes of unbalanced forces in multi-cylinder engines.	Apply	This would require recalling of the fundamentals of mechanics and balancing and then express the mathematical relation for unbalanced forces of various cylindered engines.	CO 7
15	Explain the method of direct and reverse cranks to observe the unbalance in radial engines.	Understand	This would require recalling of the fundamentals of balancing then describe the balancing of rotating masses	CO 7
16	Explain the effect of hammer blow reduced in coupled Locomotives.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of hammer blow effect.	CO 7
17	Explain the method of balancing different masses revolving in the same plane.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of rotating masses	CO 7
18	Explain different masses rotating in different planes balanced.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of rotating masses	CO 7
19	Explain how a single revolving mass is balanced by two masses revolving in different planes.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of rotating masses	CO 7
20	Explain the conditions for balancing several masses revolving in the same plane.	Understand	This would require recalling of the fundamentals of mechanics and then describe the balancing of rotating masses	CO 7

PART - C (ANALYTICAL QUESTIONS)				
1	The cranks of a three cylinder locomotive are set at 120^0. The stroke is 120 mm, the length of the connecting rod is 240 mm, the mass of the reciprocating parts per cylinder is 1 Kg and the speed of the crank shaft is 2400 rpm. Determine the magnitude of primary and secondary balancing.	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7
2	A rigid rotor has its unbalance in one plane and can be considered to consist of three masses m1 = 5 kg at an angle of 30^0 from mass m_1 in anti clockwise direction, m2 = 3 kg at an angle of 165^0 counter clockwise from m1 and m3 = 8 kg at angle 85^0 clockwise from m_1. The radii r1 = 200mm, r2 = 80mm and r3 = 140 mm. Determine the balancing mass required at a radius of 100 mm. Specify the location of this mass with respect to m1.	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7
3	An air compressor has four vertical cylinders 1,2,3 and 4 inline and the driving cranks at 90^0 intervals reach their uppermost positions in this order. The cranks are of 150 mm radius, the connecting rods 500 mm long and the cylinder centre lines 400 mm apart. The mass of the reciprocating parts of each cylinder is 22.5 kg and the speed of rotation is400 rpm. Show that there are no out of balance primary and secondary forces. Determine the corresponding couples indicating their positions for maximum values. The central plane of the machine may be taken as reference plane.	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7
4	The pistons of 60^0 twin V-Engine have strokes of 120 mm. The connecting rods driving a common crank and are of length 200 mm. The mass of the reciprocating parts per cylinder is 1.5 kg and the speed of the crankshaft is2500 rpm. Determine the magnitude of primary and secondary unbalanced forces.	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7
5	A single cylinder horizontal engine runs at 120 rpm. The length of stroke is 400mm. The mass of the revolving parts assumed concentrated at the crank pin, is 100kg and mass of reciprocating parts is 150kg. Determine the magnitude of the balancing mass required to be placed opposite to the crank at a radius of 150mm which is equivalent to all the revolving masses and 2/3 of the reciprocating masses. If	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7

	the crank turns 30^0 from the inner dead center, Estimate the magnitude of the unbalanced force due to the balancing mass.			
6	An inside cylinder locomotive has its cylinder center lines 0.7 m apart and has a stroke of 0.6 m. The rotating masses per cylinder are equivalent to150kg at the crank pin and the reciprocating masses per cylinder are 180kg. The wheel center lines are 1.5m apart. The cranks are at right angles. The whole of rotating parts and 2/3 of reciprocating masses are to be balanced by masses placed at a radius of 0.6m. Estimate the magnitude and direction of the balancing masses.	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7
7	Four masses P, Q, R and S are completely balanced. Masses R and S make angles of 90^0 and 210^0 respectively with Q in the same sense. The planes containing Q and R are 300 mm apart. Masses P, Q, R and S are supposed to be concentrated at radii of 360mm, 480mm, 240mm and 300mm respectively. The masses Q, R and S are 15kg, 25kg and 20kg respectively. Determine The mass P and its angular position, The planes in which the masses P and S are placed.	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7
8	The three cylinders of an air compressor have their axes120^0 to one another and their connecting rods are coupled to a single crank. The stroke is 100mm and the length of each connecting rod is 150mm. The mass of the reciprocating parts per cylinder is 1.5 kg. Estimate the maximum primary and secondary forces acting on the frame of the compressor when running at 3000 rpm.	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7
9	A V- twin engine has the cylinder axes at right angles and the connecting rods operate a common crank. The reciprocating masses per cylinder are11.5kg and the crank radius is 75mm. The length of connecting rod is 0.3m Show that the engine may be balanced for primary forces. If the engine speed is 500rpm, what is the maximum secondary unbalanced force?	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7
10	The three cylinders of an air compressor have their axes120^0 to one another and their connecting rods are coupled to a single crank. The stroke is 150mm and the length of each connecting rod is 160mm. The mass of the reciprocating parts per cylinder is 3	Apply	This would require the learner to **recall** the formulae of balancing and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 7

	kg. Estimate the maximum primary and secondary forces acting on the frame of the compressor when running at 2000 rpm.			
MODULE-V				
MECHANICAL VIBRATIONS				
PART - A (SHORT ANSWER QUESTIONS)				
1	Explain longitudinal vibration?	Understand	This would require the recalling of the fundamentals of SHM and describe the longitudinal vibrations	CO 8
2	Explain the causes of vibration?	Understand	This would require the recalling of the fundamentals of SHM and describe the causes of vibrations.	CO 8
3	Explain the effects of vibration?	Understand	This would require the recalling of the fundamentals of SHM and describe the effects of vibrations.	CO 8
4	Explain the free vibration of mass attached to a spring.	Understand	This would require the recalling of the fundamentals of mathematics and describe the free vibrations.	CO 8
5	Explain the forced vibration of a spring mass system.	Understand	This would require the recalling of the fundamentals of mathematics and describe the forced vibrations.	CO 8
6	Explain the damped vibration in spring mass damper system.	Understand	This would require the recalling of the fundamentals of mathematics and describe the damped vibrations.	CO 8
7	Explain the longitudinal vibration of mass attached to a vertical spring.	Understand	This would require the recalling of the fundamentals of mathematics and describe the longitudinal vibrations.	CO 8
8	Explain the transverse vibration of mass attached to a vertical spring.	Understand	This would require the recalling of the fundamentals of mathematics and describe the transverse vibrations.	CO 8
9	Explain the torsional vibration of a single rotor system.	Understand	This would require the recalling of the fundamentals of mathematics and describe the torsional vibrations.	CO 8
10	Explain the critical Speed of shaft supported horizontally.	Understand	This would require the recalling of the fundamentals of vibrations and describe the critical speed.	CO 8
11	Explain the term under damping of a vibrating system.	Understand	This would require the recalling of the fundamentals of mathematics and describe the damping of a vibrating system.	CO 8
12	What is meant by the term critical damping?	Understand	This would require the recalling of the fundamentals of mathematics and describe critical damping.	CO 8
13	Explain the term over damping of vibrating system.	Understand	This would require the recalling of the fundamentals of mathematics and describe the over damping of vibrating system.	CO 8

14	What is meant by transmissibility?	Understand	This would require the recalling of the fundamentals of mathematics and describe the transmissibility.	CO 8
15	Explain the Damping Factor of a vibrating system.	Understand	This would require the recalling of the fundamentals of mathematics and describe the Damping Factor.	CO 8
16	Explain logarithmic decrement.	Understand	This would require the recalling of the fundamentals of mathematics and describe the logarithmic decrement.	CO 8
17	What is a torsionally equivalent shaft?	Understand	This would require the recalling of the fundamentals of mathematics and describe torsionally equivalent shaft.	CO 8
18	What is meant by magnification factor?	Understand	This would require the recalling of the fundamentals of mathematics and describe the magnification factor.	CO 8
19	Explain Dunkerley's method of vibrating system.	Understand	This would require the recalling of the fundamentals of mathematics and describe the Dunkerley's method of vibrating system.	CO 8
20	What is Raleigh's method as applied to a spring mass system?	Understand	This would require the recalling of the fundamentals of mathematics and describe Raleigh's method.	CO 8
PART - B (LONG ANSWER QUESTIONS)				
1	Explain the causes of vibrations and mention their effect?	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then **describe** the causes of vibrations.	CO 8
2	Explain the effects of vibrations in simple vibrating system.	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then **describe** the effects of vibrations.	CO 8
3	Explain the free and forced vibrations of a vibrating system.	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then **describe** free and forced vibrations of a vibrating system.	CO 8
4	Explain the damped vibrations of vibrating system.	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then **describe** the damped vibrations of vibrating system.	CO 8
5	Describe with neat sketch the longitudinal free vibrations.	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then **describe** the longitudinal free vibrations.	CO 8
6	Describe with neat sketch the transverse free vibrations.	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then **describe** the transverse free vibrations.	CO 8
7	Derive an expression for the natural frequency of free longitudinal vibrations	Apply	This would require the learner to **recall** the concepts of vibrations and its principles, then **apply** to	CO 8

			develop the mathematical relation of natural frequency of free longitudinal vibrations.	
8	Derive an expression for the natural frequency of free transverse vibrations	Apply	This would require the learner to **recall** the concepts of vibrations and its principles, then **apply** to develop the mathematical relation of natural frequency of free transverse vibrations.	CO 8
9	Derive an expression for the natural frequency of free transverse vibrations for a simply supported shaft carrying uniformly distributed mass of m kg per meter length.	Apply	This would require the learner to **recall** the concepts of vibrations and its principles, then **apply** to develop the mathematical relation of natural frequency of free transverse vibrations.	CO 8
10	Derive an expression for the natural frequency of free transverse vibrations for a beam fixed at both ends and carrying uniformly distributed mass of m kg per meter length.	Apply	This would require the learner to **recall** the concepts of vibrations and its principles, then **apply** to develop the mathematical relation of natural frequency of free transverse vibrations.	CO 8
11	Establish an expression for the natural frequency of free transverse vibration for a simply supported beam carrying a number of point loads by energy method.	Apply	This would require the learner to **recall** the concepts of vibrations and its principles, then **apply** to develop the mathematical relation of natural frequency of free transverse vibrations.	CO 8
12	Establish an expression for the natural frequency of free transverse vibration for a simply supported beam carrying a number of point loads by Dunkerley's method	Apply	This would require the learner to **recall** the concepts of vibrations and its principles, then **apply** to develop the mathematical relation of natural frequency of free transverse vibrations.	CO 8
13	Explain the term whirling speed or critical speed of shaft.	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then describe critical speed of the shaft.	CO 8
14	Prove that the whirling speed of a rotating shaft is the same as the frequency of natural transverse vibration.	Apply	This would require the learner to recall the concepts of vibrations and its principles, then apply to develop the mathematical relation of natural frequency of free transverse vibrations.	CO 8
15	Explain the terms under damping, critical damping and over damping.	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then describe damping, critical damping and over damping.	CO 8
16	Explain the term logarithmic decrement as applied to damped vibrations.	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then describe logarithmic decrement as applied to damped vibrations.	CO 8
17	Explain the transmissibility in the case of a vibrating system?	Understand	This would require the learner to **recall** the concepts of vibrations and its principles, then describe transmissibility in the case of a vibrating system.	CO 8

18	Establish an expression for the amplitude of forced vibrations.	Apply	This would require the learner to recall the concepts of vibrations and its principles, then apply to develop the mathematical relation of the amplitude of forced vibrations.	CO 8
19	Derive the differential equation for the motion of an oscillating system subjected to viscous damping without aperiodic excitation force.	Apply	This would require the learner to recall the concepts of vibrations and its principles, then apply to develop the mathematical relation of viscous damping without aperiodic excitation force.	CO 8
20	Derive the equation for natural frequency of free torsional vibration of three rotor system.	Apply	This would require the learner to recall the concepts of vibrations and its principles, then apply to develop the mathematical relation of natural frequency of free torsional vibration of three rotor system	CO 8
PART - C (ANALYTICAL QUESTIONS)				
1	A shaft 50 mm diameter and 3 m long is simply supported at its ends and carries three loads of 1000 N, 1500N and 750N at 1m, 2m and 2.5m from the left support. Modulus of elasticity is 200 GN/m2. Estimate the frequency of transverse vibrations.	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 8
2	A cantilever shaft of 50 mm diameter and 300 mm long has a disc of mass100 kg at its free end. The Young's modulus of the shaft material is 200 GN/m^2. Determine the frequency of longitudinal and transverse vibrations of the shaft.	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 8
3	A vibrating system consists of a mass of 50 kg, a spring of stiffness 30kN/m and a damper. The damping provided is only 20% of the critical value. Determine the damping factor, critical damping coefficient and logarithmic decrement.	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 8
4	Estimate the whirling speed of a shaft 20 mm diameter and 0.6 m long, carrying a mass of 1 kg at its mid point. Density of the shaft material is 40 Mg/m3 and E = 200 GN/m2. Assume freely supported shaft.	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 9
5	A 1.5 m long shaft AB has flywheels at its ends A and B. The mass of the flywheel at the end A is 600kg and its radius of gyration is 400mm. The corresponding values for the flywheel at the end B are300kg and 300 mm. The diameter of the shaft for the first 400mm starting from the end A is 50mm, 60 mm diameter for the next portion of 500 mm length and the	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 8

	remaining portion of 600mm length is unknown. Determine the diameter of the shaft for the portion B so that the node of the torsional vibration of the system will be at the center of 500 mm long segment. Also determine the frequency of vibration.			
6	A stepped shaft of 0.05 m in diameter for the first 0.6 m length, 0.08 m diameter for the next 1.8 m and 0.03 m diameter for the remaining 0.25 m length. While the 0.05 m diameter end is fixed, the 0.03 m diameter end of the shaft carries a rotor of mass moment of inertia 14.7 kg-m2. If the modulus of elasticity of the shaft material is 0.83 x 1011 N/m2, Estimate the natural frequency of torsional oscillations, neglecting the inertia effect of the shaft.	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 8
7	A shaft 100 mm diameter and 1000 mm long is fixed at one end and the other end carries a flywheel of mass 90 kg. The radius of gyration of the flywheel is 500mm. Estimate the frequency of torsional vibration, if the modulus of rigidity for the shaft material is $80GN/m^2$.	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 8
8	A single cylinder engine of total mass 200kg 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 simple harmonic motion with a stroke of 150mm. It is desired that the maximum vibratory force transmitted through the elastic support to the foundation shall be 600N when the engine speed is 800 rpm. Estimate the necessary stiffness of the elastic support and the amplitude of vibration at 800 rpm.	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 8
9	An instrument vibrates with a natural frequency of 1 Hz. when there is no damping. When the damping is provided, the frequency of damped vibration was observed to be 0.9 Hz. Estimate the damping factor and logarithmic decrement.	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the parameters and solving the asked parameters	CO 8
10	A body of mass 20kg is suspended from a spring which deflects 15mm under this load. Estimate the frequency of free vibrations and verify that a viscous damping force of 1000N at a	Apply	This would require the learner to **recall** the formulae of vibrations such as natural frequency, time period etc and its parameters, then **assigning** correct values for the	CO 8

	speed of 1 m/s is just sufficient to make the motion aperiodic.		parameters and solving the asked parameters	

Prepared by:
Dr. K Viswanath Allamraju, Professor **HOD, ME**