THEORY OF MACHINES-II (18MEC312)

Class: III year I Semester **Branch:** Mechanical Engg.

QUESTION BANK

Prepared by

Mr. N. SATHISH KUMAR
Assistant Professor
Department of Mechanical Engineering,
SITAMS, Chittoor

INSTITUTE VISION

To emerge as a Centre of Excellence for Learning and Research in the domains of engineering, computing and management.

INSTITUTE MISSION

- Provide congenial academic ambience with state -of -art of resources for learning andresearch.
- Ignite the students to acquire self-reliance in the latesttechnologies.
- Unleash and encourage the innate potential and creativity ofstudents.
- Inculcate confidence to face and experience newchallenges.
- Foster enterprising spirit amongstudents.
- Work collaboratively with technical Institutes / Universities / Industries of National and Internationalrepute

DEPARTMENT VISION

To become a Centre of excellence in Mechanical Engineering studies and research.

DEPARTMENT MISSION

- Provide congenial academic ambience with necessary infrastructure and learning resources
- Inculcate confidence to face and experience new challenges from industry and society.
- Ignite the students to acquire self reliancein the latestTechnologies
- Foster Enterprising spirit amongstudents

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

Graduates of Mechanical Engineeringshall

PEO1: Have Professional competency through the application of knowledge gained from subjects like Mathematics, Physics, Chemistry, Inter-Disciplinary and core subjects like Manufacturing Engineering, Thermal Sciences, CAD/CAM and Design & Development. **(ProfessionalCompetency)**.

PEO2: Excel in one's career by critical thinking towards successful services and growth of the organization or as an entrepreneur or through higher studies. **(Successful Career Goals).**

PEO3: Enhance knowledge by updating advanced technological concepts for facing the rapidly changing world and contribute to society through innovation and creativity. **(Continuing Education and Contribution to Society).**

PROGRAM SPECIFIC OUTCOMES (PSO'S)

Students shall

PSO1: Apply the knowledge obtained in core areas for the design, analysis and manufacturing of mechanical systems and processes.

PSO2: Exhibit novel concepts on product development with the help of modern CAD/CAM integration, while ensuring best manufacturing practices.

III B.Tech I Semester

L	T	P	C
3	1	0	3

18MEC312 THEORY OF MACHINES-II

Course Educational Objectives:

- To understand the effects of gyroscopic couple and friction between two surfaces.
- To understand how the clutches brakes and dynamometers work in automobile
- To understand the inertia forces on reciprocating parts in engines and Turning moment diagrams for I.C.Engine.
- To understand the method of static force analysis and dynamic force analysis of mechanism, undesirable effects of unbalance in rotors and engines.
- To understand the concept of governors.

UNIT – 1: GYROSCOPIC EFFECTS AND FRICTION

Precession: Gyroscopes – Effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aero planes and ships. **Friction: -** Introduction- Principles -Inclined plane – Friction of screw and nuts, pivot and collar – Uniform pressure, uniform wear, friction circle and friction axis – Lubricated surfaces – Boundary friction – Film lubrication.

UNIT – 2: CLUTCHES, BRAKES AND DYNAMOMETER

Clutches: Friction clutches – Single disc or plate clutch, multiple disc clutch, cone clutch and centrifugal clutch.**Brakes:**Simple block brakes – Internal expanding brake and band brake of vehicle. **Dynamometers:** Absorption and transmission types – General description and methods of operation.

UNIT – 3: INERTIA FORCES AND TURNING MOMENT DIAGRAMS

Inertia Forces: Introduction – D-Alembert’s principle – Velocity and acceleration of the reciprocating parts in engines – Velocity and acceleration of the piston – Analytical method for inertia torque. **Turning Moment Diagrams:** Turning moment diagrams for steam engine, I.C. Engine and multi cylinder engine – Crank effort – Coefficient of fluctuation of energy – Coefficient of fluctuation of speed – Fly wheels and their design.

UNIT – 4: BALANCING OF ROTATING AND RECIPROCATING MASSES

Rotating Masses: Balancing of rotating masses – Single and multiple planes, single and different planes. **Reciprocating Masses**:Primary, secondary and higher balancing of reciprocating masses – Analytical and graphical methods – Unbalanced forces and couples – V, multi cylinder, in-line and radial engines for primary and secondary balancing – Locomotive balancing – Hammer blow, swaying couple – Variation of tractive force.

UNIT – 5: GOVERNORS

Governors: Watt, Porter and Pronell governors – Spring loaded governors – Hartnell, Hartung, Wilson-Hartnell and Pickering governors with auxiliary springs – Sensitiveness, isochronism and hunting – Effort and power of a governor.

Course Outcomes:

Upon completion of this course, the students will be able to:

- ✓ Estimate the gyroscopic couple and its effects in equipment like motor cars, motorcycles, aero planes and ships.
- ✓ Calculate the force required in friction based equipment like screw jacks, clutches, brakes, and rope brake dynamometer.
- ✓ Understand the inertia forces in reciprocating parts.
- ✓ Design a flywheel for a given application using the concept of turning moment diagram.
- ✓ Estimate the balancing mass and the location where it is to be added for balancing of rotating and reciprocating systems.
- ✓ Design various types of governors.

Course Outcomes		POs related to COs
CO1	Students can explain the theory behind gyroscopic couple and to predict the effect of gyroscopic couple in aircraft, ships and automobiles. Explain laws of friction. Calculate power loss due to friction in bearings.	PO1, PO2 ,PO3, PO4, PO12
CO2	List different types of clutches, brakes and dynamometers. Explain construction and operation of various braking mechanisms.	PO1, PO2, PO3, PO12
CO3	Analyze inertia forces acting on different links of simple planar mechanisms. Design suitable flywheel for simple mechanical systems.	PO1, PO2, PO3, PO4,
CO4	Students are capable of explaining how balancing of rotating and reciprocating masses are done and can calculate the unbalanced forces and couples in a system.	PO1, PO2, PO4
CO5	List different types of governors. Explain working principle of governors.	PO1, PO2

Text books:

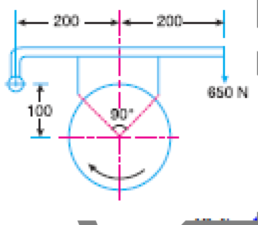
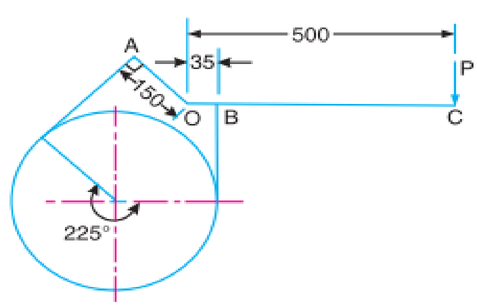
1. Theory of Machines and Mechanisms, S.S.Rattan, 3/e, 2009, Tata McGraw-Hill Education Pvt.Ltd., Noida.
2. Theory of Machines, R.K Bansal, 5/e, 2010, Lakshmi Publications, New Delhi.

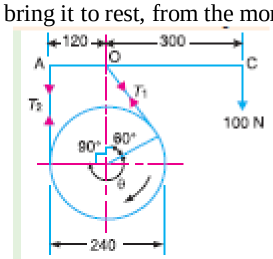
Reference books:

1. Theory of Machines, Thomas Bevan, 3/e, 2009, Pearson Education, New Delhi.
2. Theory of Machines, R.S Khurmi and J.K Gupta, 14/e, 2013, S.Chand& Company Pvt. Ltd. New Delhi.
3. Theory of Machines, Sadhu Singh, 3/e, 2011, Pearson Education, New Delhi.
4. The Theory of Machines, Shiegley, 3/e, 2009, Oxford University Press, New Delhi.
5. Theory of Machines, PL. Ballaney, 25/e, 2011, Khanna Publishers, New Delhi.

QUESTION BANK

Question No.	Questions	Blooms Taxonomy
	UNIT 1 - GYROSCOPIC EFFECTS AND FRICTION	
	PART-A (Two Marks Questions)	
1	Write a short note on gyroscope.	**BT4**
2	Explain the application of gyroscopic principles to aircrafts.	**BT2**
3	Describe the gyroscopic effect on sea going vessels.	**BT2**
4	Discuss the effect of the gyroscopic couple on a two wheeled vehicle when taking a turn.	**BT6**
5	Differentiate between pivot and collar bearing	**BT4**
6	What is meant by the expression 'friction circle'?	**BT2**
7	What is limiting angle of friction?	**BT2**
8	What is angle of Repose?	**BT2**
9	What is over hauling and self locking screws?	**BT2**
10	What is journal bearing?	**BT2**
	PART-B (Ten Marks Questions)	
1	A uniform disc of diameter 300 mm and of mass 5 kg is mounted on one end of an arm of length 600 mm. The other end of the arm is free to rotate in a universal bearing. If thedisc rotates about the arm with a speed of 300 r.p.m. clockwise, looking from the front, with what speed will it precess about the vertical axis?	**BT4, BT5**
2	An aeroplane makes a complete half circle of 50 metres radius, towards left, when flying at 200 km per hr. The rotary engine and the propeller of the plane has a mass of 400 kg and a radius of gyration of 0.3 m. The engine rotates at 2400 r.p.m. clockwise when viewed from therear. Find the gyroscopic couple on the aircraft and state its effect on it.	**BT4, BT5**
3	The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: **1.** when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. **2.** when the ship is pitching in a simple harmonic motion, the bow falling with its maximumvelocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees.	**BT4, BT5**
4	A four wheeled motor car of mass 2000 kg has a wheel base 2.5 m, track width 1.5 m and height of centre of gravity 500 mm above the ground level and lies at 1 metre from the front axle. Each wheel has an effective diameter of 0.8 m and a moment of inertia of 0.8 kg-m2. The drive shaft, engine flywheel and transmission are rotating at 4 times the speed of road wheel, in a clockwise direction when viewed from the front, and is equivalent to a mass of 75 kg having a radius of gyration of 100 mm. If the car is taking a right turn of 60 m radius at 60 km/h, find the load on each wheel.	**BT4, BT5**
5	Find the angle of inclination with respect to the vertical of a two wheeler negotiating a turn. Given : combined mass of the vehicle with its rider 250 kg ; moment of inertia of the engine flywheel 0.3 kg-m2 ; moment of inertia of each road wheel 1 kg-m2 ; speed of engine flywheel 5 times that of road wheels and in the same direction ; height of centre of gravity of riderwith vehicle 0.6 m ; two wheeler speed 90 km/h ; wheel radius 300 mm ; radius of turn 50 m.	**BT4, BT5**
6	An effort of 1500 N is required to just move a certain body up an inclined plane of angle 12º, force acting parallel to the plane. If the angle of inclination is increased to 15°, then the effort required is 1720 N. Find the weight of the body and the coefficient of friction.	**BT4, BT5**
7	A conical pivot supports a load of 20 kN, the cone angle is 120º and the intensity of normal pressure is not to exceed 0.3 N/mm2. 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. andthe coefficient of friction is 0.1, find the power absorbed in friction. Assume uniform pressure.	**BT4, BT5**
8	Derive from first principles an expression for the friction moment of a conical pivot assuming (*i*) Uniform pressure, and (*ii*) Uniform wear.	**BT5**
9	Derive from first principles an expression for the effort required to raise a load with a screw jacktaking friction into consideration.	**BT5**
10	The thrust of a propeller shaft in a marine engine is taken up by a number of collars integral with the shaft which is 300 mm in diameter. The thrust on the shaft is 200 kN and the speed is 75 r.p.m. Taking μ constant and equal to 0.05 and assuming intensity of pressure as uniform and equal to 0.3 N/mm2, find the external diameter of the collars and the number of collarsrequired, if the power lost in friction is not to exceed 16 kW.	**BT4, BT5**

Question No.	Questions	Blooms Taxonomy
	UNIT 2 – CLUTCHES, BRAKES AND DYNAMOMETER	
	PART-A (Two Marks Questions)	
1	Explain different types of clutches.	**BT5**
2	Differentiate between bearing and clutch.	**BT4**
3	Differentiate between single plate and cone clutch.	**BT4**
4	Describe the construction and operation of a prony brake or rope brake absorption dynamometer.	**BT2**
5	Distinguish between brakes and dynamometers	**BT4**
6	What is the difference between absorption and transmission dynamometers ?	**BT2**
7	What are torsion dynamometers?	**BT2**
8	What are the types of dynamometers?	**BT2**
9	Differentiate between single shoe and band and block brake?	**BT4**
10	Differentiate between differential and simple band brake?	**BT4**
	PART-B (Ten Marks Questions)	
1	A single block brake, as shown in Fig. has the drum diameter 250 mm. The angle of contact is90° and the coefficient of friction between the drum and the lining is 0.35. If the operating force of650 N is applied at the end of the lever, determine the torque that may be transmitted by the block brake. 	**BT4, BT5**
2	Describe the construction and operation of a prony brake or rope brake absorption dynamometer.	**BT2**
3	Describe with sketches one form of torsion dynamometer and explain with detail the calculationsinvolved in finding the power transmitted.	**BT2**
4	A leather faced conical clutch has a cone angle of 30°. If the intensity of pressure between the contact surfaces is limited to 0.35 N/mm2 and the breadth of the conical surface is not to exceed one-third of the mean radius, find the dimensions of the contact surfaces to transmit22.5 kW at 2000 r.p.m. Assume uniform rate of wear and take coefficient of friction as 0.15.	**BT4, BT5**
5	Describe with a neat sketch the working of a single plate friction clutch.	**BT2**
6	A band brake acts on the 3/4th of circumference of a drum of 450 mm diameter which is keyed to the shaft. The band brake provides a braking torque of 225 N-m. One end of the band is attached to a fulcrum pin of the lever and the other end to a pin 100 mm from the fulcrum. If the operating force is applied at 500 mm from the fulcrum and the coefficient of friction is 0.25, find the operating force when the drum rotates in the (a) anticlockwise direction, and (b) clockwise direction.	
7	A differential band brake, as shown in Fig. 19.17, has an angle of contact of 225°. The band has a compressed woven lining and bears against a cast iron drum of 350 mm diameter. The brake is to sustain a torque of 350 N-m and the coefficient of friction between the band and the drum is 0.3. Find : 1. The necessary force (P) for the clockwise and anticlockwise rotation of the drum; and 2. The value of 'OA' for the brake to be self locking, when the drum rotates clockwise.  All dimensions in mm.	**BT2**

8	A band and block brake, having 14 blocks each of which subtends an angle of 15° at the centre, is applied to a drum of 1 m effective diameter. The drum and flywheel mounted on the same shaft has a mass of 2000 kg and a combined radius of gyration of 500 mm. The two ends of the band are attached to pins on opposite sides of the brake lever at distances of 30 mm and 120 mm from the fulcrum. If a force of 200 N is applied at a distance of 750 mm from the fulcrum, find:**1.** maximum braking torque, **2.** angular retardation of the drum, and **3.** time taken by the system to come to rest from the rated speed of 360 r.p.m. The coefficient of friction between blocks and drum may be taken as 0.25.	**BT4, BT5**
9	The simple band brake, as shown in Fig., is applied to a shaft carrying a flywheel of mass 400 kg. The radius of gyration of the flywheel is 450 mm and runs at 300 r.p.m. If the coefficient of friction is 0.2 and the brake drum diameter is 240 mm, find : 1. the torque applied due to a hand load of 100 N, **2.** the number of turns of the wheel before it is brought to rest, and **3.** the time required to bring it to rest, from the moment of the application of the brake.  All dimensions in mm	**BT4, BT5**
10	A conical friction clutch is used to transmit 90 kW at 1500 r.p.m. The semicone angle is 20º and the coefficient of friction is 0.2. If the mean diameter of the bearing surface is 375 mm and the intensity of normal pressure is not to exceed 0.25 N/mm2, find the dimensions of theconical bearing surface and the axial load required.	**BT4, BT5**

Question No.	Questions	Blooms Taxonomy
	UNIT 3 – INERTIA FORCES AND TURNING MOMENT DIAGRAMS	
	PART-A (Two Marks Questions)	
1	Define ‘inertia force’ and ‘inertia torque’.	**BT1**
2	What is the difference between piston effort, crank effort and crank-pin effort?	BT2
3	Draw the turning moment diagram of a single cylinder double acting steam engine.	**BT2**
4	What is the function of a flywheel?	BT2
5	Define the term ‘coefficient of fluctuation of energy’ in the case of flywheels.	**BT1**
6	Define the term ‘coefficient of fluctuation of speed’, in the case of flywheels.	**BT1**
7	Differentiate between flywheel and governor.	**BT4**
8	Define the term fluctuation of energy in turning moment diagram	BT1
9	Define the term maximum fluctuation of energy in turning moment diagram	BT1
10	State D’Alembert’s principle.	BT2
	PART-B (Ten Marks Questions)	
1	A vertical petrol engine 100 mm diameter and 120 mm stroke has a connecting rod 250 mm long. The mass of the piston is 1.1 kg. The speed is 2000 r.p.m. On the expansion stroke with a crank 20° from top dead centre, the gas pressure is 700 kN/m2. Determine: **1.** Net force on the piston, **2.** Resultant load on the gudgeon pin, **3.** Thrust on the cylinder walls, and **4.** Speed above which, other things remaining same, the gudgeon pin load would be reversed in direction.	**BT4, BT5**
2	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/mm2. The connecting rod length between centres 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.	**BT4, BT5**
3	The crank and connecting rod of a steam engine are 0.3 m and 1.5 m in length. The crank rotates at 180 r.p.m. clockwise. Determine the velocity and acceleration of the piston when the crank is at 40 degrees from the inner dead centre position. Also determine the position of the crank for zero acceleration of the piston.	**BT4, BT5**
4	In a slider crank mechanism, the length of the crank and connecting rod are 150 mm and 600 mm respectively. The crank position is 60° from inner dead centre. The crank shaft speed is 450 r.p.m.	**BT4, BT5**

	(clockwise). Using analytical method, determine: 1. Velocity and acceleration ofthe slider, and 2. Angular velocity and angular acceleration of the connecting rod.	
5	The turning moment diagram for a petrol engine is drawn to the following scales :Turning moment, 1 mm = 5 N-m ; crank angle, 1 mm = 1°. The turning moment diagram repeats itself at every halfrevolution of the engine and the areas above and below the mean turning moment line taken in order are 295, 685, 40, 340, 960, 270 mm2. The rotating parts are equivalent to a mass of 36 kg at a radius of gyration of 150 mm. Determine the coefficient of fluctuation of speed when the engine runs at 1800r.p.m.	**BT4, BT5**
6	A shaft fitted with a flywheel rotates at 250 r.p.m. and drives a machine. The torque of 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 followingrevolution. 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.	**BT4, BT5**
7	The turning moment diagram for a four stroke gas engine may be assumed for simplicity to be represented by four triangles, the areas of which from the line of zero pressure are as follows :Suction stroke = 0.45 × 10–3 m2; Compression stroke = 1.7 × 10–3 m2; Expansion stroke= 6.8 × 10–3 m2; Exhaust stroke = 0.65 × 10–3 m2. Each m2 of area represents 3 MN-m of energy. Assuming the resisting torque to be uniform, find the mass of the rim of a flywheel required to keep the speed between 202 and 198 r.p.m. The mean radius of the rim is 1.2 m.	**BT4, BT5**
8	The turning moment curve for an engine is represented by the equation, T = (20 000 + 9500 sin 2Ө– 5700 cos 2 Ө) N-m, where Өis the angle moved by the crank from inner dead centre. If the resisting torque is constant, find: **1.** Power developed by the engine ;**2.** Moment of inertia of flywheel in kg-m2, if the total fluctuation of speed is not exceed 1% of mean speed which is 180 r.p.m; and **3.** Angular acceleration of the flywheel when the crank has turned through 45° from inner dead centre.	**BT4, BT5**
9	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/m3. The width of the rim is to be 5 times the thickness.	**BT4, BT5**
10	A machine punching 38 mm holes in 32 mm thick plate requires 7 N-m of energy per sq. mm of sheared area, and punches one hole in every 10 seconds. Calculate the power of the motor required. The mean speed of the flywheel is 25 metres per second. The punch has a stroke of 100 mm. Find the mass of the flywheel required, if the total fluctuation of speed is not to exceed 3% of the mean speed. Assume that the motor supplies energy to the machine at uniform rate.	**BT4, BT5**

Question No.	**Questions**	**Blooms Taxonomy**
	UNIT 4 – *BALANCING OF ROTATING AND RECIPROCATING MASSES*	
	PART-A (Two Marks Questions)	
1	Explain clearly the term ‘static balancing’.	**BT2**
2	Explain clearly the term ‘dynamic balancing’.	**BT2**
3	Define variation of Tractive force.	**BT1**
4	What are the balancing of locomotives?	BT2
5	What is Swaying Couple?	BT2
6	What is Hammer Blow?	BT2
7	Why radial engines are preferred?	BT6
8	Write the equation for balancing a single rotating mass by a single mass?	BT4
9	What are the effects of an unbalanced primary force along the line of stroke of two cylinder locomotive?	BT2
10	Write the different types of balancing?	BT4
	PART-B (Ten Marks Questions)	
1	Four masses m1, m2, m3 and m4 are 200 kg, 300 kg, 240 kg and 260 kgrespectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectivelyand the angles between successive masses are 45°, 75° and 135°. Find the position and magnitudeof the balance mass required, if its radius of rotation is 0.2 m.	**BT4, BT5**
2	A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively	**BT4, BT5**

	and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, findtheir magnitudes and angular positions.	
3	A, B, C and D are four masses carried by a rotating shaft at radii 100, 125, 200 and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B, C and D are 10 kg, 5 kg, and 4 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance	**BT4, BT5**
4	A shaft carries four masses in parallel planes A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is 100° and that between the masses at B and A is 190°, both being measured in the same direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine : **1.** The magnitude of the masses at A and D ;**2.** the distance between planes A and D ; and **3.** the angular position of the mass at D.	**BT4, BT5**
5	Four masses *A*, *B*, *C* and *D* are attached to a shaft and revolve in the same plane. The masses are 12 kg, 10 kg, 18 kg and 15 kg respectively and their radii of rotations are 40 mm, 50 mm, 60 mm and 30 mm. The angular position of the masses *B*, *C* and *D* are 60°, 135° and 270° from the mass *A*. Find the magnitude and position of the balancing mass at a radius of 100 mm.	**BT4, BT5**
6	A rotating shaft carries four masses A, B, C and D which are radially attached to it. The mass centres are 30 mm, 38 mm, 40 mm and 35 mm respectively from the axis of rotation. The masses A, C and D are 7.5 kg, 5 kg and 4 kg respectively. The axial distances between the planes of rotation of A and B is 400 mm and between B and C is 500 mm. The masses A and C are at right angles to each other. Find for a complete balance, 1. the angles between the masses B and D from mass A, 2. the axial distance between the planes of rotation of C and D, 3. the magnitude of mass B.	**BT4, BT5**
7	An inside cylinder locomotive has its cylinder centre lines 0.7 m apart and has a stroke of 0.6 m. The rotating masses per cylinder are equivalent to 150 kg at the crank pin, and the reciprocating masses per cylinder to 180 kg. The wheel centre lines are 1.5 m apart. The cranks are at right angles. The whole of the rotating and 2/3 of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Find the magnitude and direction of thebalancing masses. Find the fluctuation in rail pressure under one wheel, variation of tractive effort and the magnitude of swaying couple at a crank speed of 300 r.p.m.	**BT4, BT5**
8	The three cranks of a three cylinder locomotive are all on the same axle and are set at 120°. The pitch of the cylinders is 1 metre and the stroke of each piston is 0.6 m. The reciprocating masses are 300 kg for inside cylinder and 260 kg for each outside cylinder and the planes of rotation of the balance masses are 0.8 m from the inside crank.If 40% of the reciprocating parts are to be balanced, find :**1.** the magnitude and the position of the balancing masses required at a radius of 0.6 m ;and **2.** the hammer blow per wheel when the axle makes 6 r.p.s.	**BT4, BT5**
9	The following data refer to two cylinder locomotive with cranks at 90° :Reciprocating mass per cylinder = 300 kg ; Crank radius = 0.3 m ; Driving wheel diameter = 1.8 m ; Distance between cylinder centre lines = 0.65 m ; Distance between the driving wheel central planes = 1.55 m. Determine : **1.** the fraction of the reciprocating masses to be balanced, if the hammer blow is not to exceed 46 kN at 96.5 km. p.h. ; **2.** the variation in tractive effort ; and **3.** the maximum swaying couple.	**BT4, BT5**
10	A single cylinder horizontal engine runs at 120 r.p.m. The length of stroke is 400 mm. The mass of the revolving parts assumed concentrated at the crank pin is 100 kg and mass of the reciprocating parts is 150 kg. 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 and 2/3rd of the reciprocating masses. If the crank turns 30° from the inner dead centre, find the magnitude of the unbalanced force due to the balancing mass.	**BT4, BT5**

Question No.	**Questions**	**Blooms Taxonomy**
	UNIT 5 - GOVERNORS	
	PART-A (Two Marks Questions)	
1	What is the function of a governor ? How does it differ from that of a flywheel ?	BT2
2	Define and explain the following terms relating to governors :1. Stability, 2. Sensitiveness	BT1
3	Define and explain the following terms relating to governors: 1. Isochronism, 2. Hunting.	BT1
4	State the different types of governors.	BT2

5	What is stability of a governor?	BT2
6	Explain the term 'effort' of a Porter governor.	BT5
7	Explain the term 'power' of a Porter governor.	BT5
8	Differentiate between porter and proell governor?	BT4
9	Differentiate between hartnell and hatung governor?	BT4
10	Differentiate between Wilson hartnell and pickering governor?	BT4
PART-B (Ten Marks Questions)		
1	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.	**BT4, BT5**
2	The upper arms of a Porter governor are pivoted on the axis of rotation and the lower arms are pivoted to the sleeve at a distance of 30 mm from the axis of rotation. The length of each arm is 300 mm andthe mass of each ball is 6 kg. If the equilibrium speed is 200 r.p.m. when the radius of rotation is 200mm, find the required mass on the sleeve. If the friction is equivalent to a force of 40 N at the sleeve,find the coefficient of insensitiveness at 200 mm radius	**BT4, BT5**
3	A Porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the minimum and maximum speeds and range of speed of the governor.	
4	The arms of a Porter governor are each 250 mm long and pivoted on the governor axis. The mass of each ball is 5 kg and the mass of the central sleeve is 30 kg. The radius of rotation of the balls is 150 mm when the sleeve begins to rise and reaches a value of 200 mm for maximum speed. Determine the speed range of the governor. If the friction at the sleeve is equivalent of 20 N of load at the sleeve, determine how the speed range is modified	**BT4, BT5**
5	Explain the term height of the governor. Derive an expression for the height in the case of a Watt governor. What are the limitations of a Watt governor ?	**BT5**
6	Derive an expression for the height in the case of a Hartnell governor. What are the limitations of a Hartnellgovernor ?	**BT4, BT5**
7	A Proell governor has equal arms of length 300 mm. The upper and lower ends of the arms are pivoted on the axis of the governor. The extension arms of the lower links are each 80 mm long and parallel to the axis when the radii of rotation of the balls are 150 mm and 200 mm. The mass of each ball is 10 kg and the mass of the central load is 100 kg. Determine the range of speed of the governor.	**BT4, BT5**
8	The spring controlled governor of the Hartung type has two rotating masses each of 2.5 kg and thelimits of their radius of rotation are 100 mm and 125 mm. The each mass is directly controlled by aspring attached to it and to the inner casing of the governor as shown in Fig 18.26 (*a*). The stiffness ofthe spring is 8 kN/m and the force on each spring, when the masses are in their mid-position, is 320 N.In addition, there is an equivalent constant inward radial force of 80 N acting on each revolving massin order to allow for the dead weight of the mechanism. Neglecting friction, find the range of speed ofthe governor.	**BT4, BT5**
9	A governor of the Proell type has each arm 250 mm long. The pivots of the upper and lower arms are 25 mm from the axis. The central load acting on the sleeve has a mass of 25 kg and the each rotating ball has a mass of 3.2 kg. When the governor sleeve is in mid-position, the extension link of the lower arm is vertical and the radius of the path of rotation of the masses is 175 mm. The vertical height of the governor is 200 mm. If the governor speed is 160 r.p.m. when in mid-position, find : 1. length of the extension link; and 2. tension in the upper arm.	**BT4, BT5**
10	A Hartnell governor has two rotating balls, of mass 2.7 kg each. The ball radius is 125 mm in the mean position when the ball arms are vertical and the speed is 150 r.p.m. with the sleeve rising. The lengthof the ball arms is 140 mm and the length of the sleeve arms 90 mm. The stiffness of the spring is7 kN/m and the total sleeve movement is 12 mm from the mean position. Allowing for a constantfriction force of 14 N acting at the sleeve, determine the speed range of the governor in the lowest andhighest sleeve positions. Neglect the obliquity of the ball arms.	**BT4, BT5**

Note:

Bloom's Taxonomy

Bloom's Level	Descriptions	Bloom's Level	Descriptions
BT 1	Remember	BT 2	Understand
BT 3	Apply	BT 4	Analyze
BT 5	Evaluate	BT 6	Create

Prepared by	Recommended by	Approved by
Mr.N.Sathish Kumar **Assistant Professor** Department of Mech. Engineering, Sreenivasa Institute of Technology& Management Studies, Chittoor.	**Dr. T.Chinna Pamulety** **HOD/Mechanical** Sreenivasa Institute of Technology& Management Studies, Chittoor.	**Principal** **SITAMS,** Chittoor.

ALL THE BEST