Code No: R1631031 **R16** SET - 1

III B. Tech I Semester Regular Examinations, October/November - 2018

DYNAMICS OF MACHINERY

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1. a) What is the effect of gyroscopic couple when a ship is rolling? [2M]
b) Define the terms: Coefficient of friction and Limiting angle of friction. [2M]
c) Explain clearly how the functions of fly wheel and governor differ from each other. [2M]
d) What is Controlling Force? [3M]
e) Explain dynamic balancing. [3M]
f) What is meant by critical speed of a shaft? [2M]

PART -B

2. A four wheeled trolley car has a total mass of 3000 kg. Each axle with its two wheels and gears has a total moment of inertia of 32 kg.m^2.Each wheel is 500 mm radius. The center distance between the two wheels on an axle is 1.5 m. Each axle is driven by a motor with a speed ratio of 1.3 each motor along with its gear has a moment of inertia of 20 kg.m^2 and rotates in the opposite direction to that of the axle. The center of mass of the car is 1.2 m above rails. Calculate the limiting speed of the car when it has to travel around a curve of 275 m radius without the wheels leaving rails. [14M]

3. a) A band brake shown in Fig.1 uses a V-belt. The pitch diameter of the V-grooved pulley is 400mm. The groove angle is 45° and the coefficient of friction is 0.3. Determine the power rating. [10M]

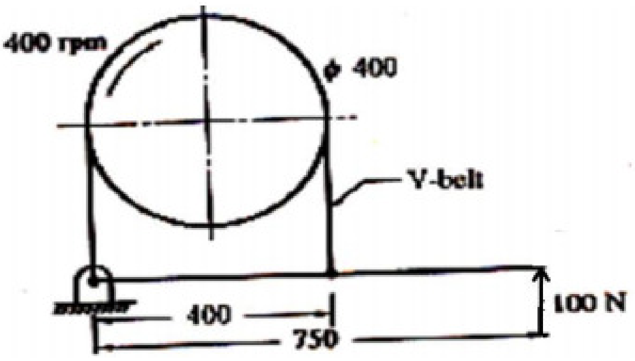

Fig.1

b) Explain uniform pressure theory for a single plate clutch. [4M]

4. The mass of flywheel of an engine is 6.5tonnes and the radius of gyration is 1.8m. It is found from the turning moment diagram that the fluctuation of energy is 56kN-m. If the mean speed of the engine is 120rpm, find the maximum and minimum speeds. [14M]
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5. A porter governor has equal arms each 250mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of central load on the sleeve is 25kg. The radius of rotation of the ball is 150mm. The governor begins to lift and raises to 200mm when the governor is at maximum speed. Find the range of speed when the friction at the sleeve is equivalent to 10N. [14M]

6. Four masses A, B, C and D are attached to a shaft and revolve in the same plane. The masses are 12kg, 10kg, 18kg and 15kg respectively and their radii of rotations are 40mm, 50mm, 60mm and 30mm. The angular position of the masses B, C and D are 60^0 , 135^0 and 270^0 from mass A. Find the magnitude and position of the balancing mass at a radius of 100mm. [14M]

7. a) With neat sketches, explain the different types of vibrations. [7M]

   b) Determine the frequency of torsional vibrations of the disc shown in Fig.2 if both the ends of the shaft are fixed and the diameter of the shaft is 50mm. The disc has a mass of 100kg and a radius of gyration of 0.5m. Take modulus of rigidity for the shaft material as $80GN/m^2$. I_1=1m and I_2=0.8m. [7M]

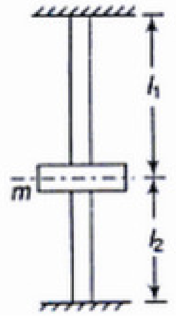

Fig.2

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PART –A

1. a) What is gyroscope? [2M]
b) List the characteristics of brakes. [2M]
c) Define the terms: [3M]
i) Coefficient of fluctuation of energy and
ii) Coefficient of fluctuation of speed related to the flywheels.
d) Define sensitiveness of a governor. [2M]
e) What do you mean by primary and secondary balance in reciprocating engines? [3M]
f) What is "Critical Damping Coefficient" (C_C) [2M]

PART -B

2. A ship is propelled by a rotor of mass 2000kg rotates at a speed of 2400rpm. The radius of gyration of rotor is 0.4m and spins clockwise direction when viewed from bow (front) end. Find the gyroscopic couple and its effect when: [14M]
i) The ship takes left turn at a radius of 350 m with a speed of 35kmph
ii) The ship pitches with the bow rising at an angular velocity of 1rad/s
iii) The ship rolls at an angular velocity of 0.15rad/s

3. a) Determine the axial force required to engage a cone clutch transmitting 25 kW of power at 750 rpm. Average friction diameter of the cone is 400 mm and average pressure intensity is 60 kN/m^2. Semi cone angle is 10^0 and coefficient of friction is 0.25. Also find the width of the friction cone. [8M]
b) What do you mean by friction axis and friction circle? Explain. [6M]

4. A multi-cylinder engine is to run at a speed of 600r.p.m. On drawing the turning moment diagram to a scale of 1mm = 250N-m and 1mm = 3^0, the areas above and below the mean torque line are : +160,-172,+168,-191,+197, -162. The speed is to be kept within + 1% of the mean speed of the engine. Calculate the necessary moment of inertia of the flywheel. Determine the suitable dimensions of a rectangular flywheel rim if the breadth is twice its thickness. The density of the cast iron is 7250 kg/m^3 and its hoop stress is 6MPa. Assume that the rim contributes 92 % of the flywheel effect. [14M]

5. The spring controlled governor of the Hartung type has two rotating masses each of 2.5 kg and the limits of their radius of rotation are 100 mm and 125 mm. The each mass is directly controlled by a spring attached to it and to the inner casing of the governor as shown in Fig.1. The stiffness of the 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 mass in order to allow for the dead weight of the mechanism. Neglecting friction, find the range of speed of the governor. [14M]
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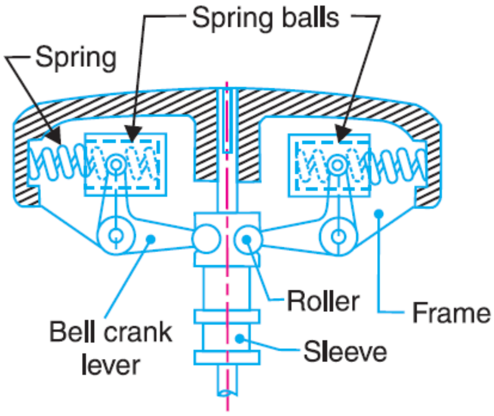

Fig.1

6. A four crank engine has two outer cranks set at 120^0 to each other, and their reciprocating masses are each 400 kg. The distance between the planes of rotation of adjacent cranks are 450 mm, 750 mm and 600 mm. If the engine is to be in complete primary balance, find the reciprocating mass and the relative angular position for each of the inner cranks. If the length of each crank is 300 mm, length of each connecting rod is 1.2 m and the speed of rotation is 240 rpm, what is maximum secondary unbalanced force? [14M]

7. a) What do you understand by whirling of shaft? Explain. [7M]

b) A gun is so designed that, on firing, the barrel recoil against a spring. A dashpot, at the end of the recoil, allows the barrel to come back to its initial position within the minimum time without any oscillation. The gun barrel has a mass of 500 kg and a recoil spring of 300 N/mm. The barrel recoil 1m on firing. Determine: [7M]
(i) The initial recoil velocity of the gun barrel
(ii) The critical damping coefficient of the dashpot engaged at the recoil stroke

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PART –A

1. a) Give the effect of gyroscopic couple on an aircraft when taking a left turn. [2M]
   b) Make a sketch of cone clutch. [2M]
   c) Differentiate between flywheel and governor. [2M]
   d) What are the limitations of a Watt governor? [3M]
   e) Write an expression for hammer blow in locomotive. [3M]
   f) Define Forced Vibrations. [2M]

PART –B

2. a) The moment of inertia of a rotating disc in aeroplane is 15kg-m^2 and the direction of rotation is clockwise when looking from front side of the aeroplane. The speed of the disc is 1600rpm. The speed of flight is 240km/hr. If the aeroplane makes a right turn on a curved path of 170m radius, find the gyroscopic couple on the aeroplane and discuss the effects on it. [10M]
   b) Derive an expression for gyroscopic couple. [4M]

3. a) In a belt transmission dynamometer, the driving pulley rotates at 300rpm. The distance between the centre of the driving pulley and the dead mass is 800mm. The diameter of each of the driving as well as the intermediate pulleys is equal to 360mm. Find the value of the dead mass require to maintain the lever in a horizontal position when the power transmitted is 3kW. Also find its value when the belt just begins to slip on the driving pulley. Coefficient of friction being 0.25 and the maximum tension in the belt 1200N. [7M]
   b) Explain the working of internal expanding shoe break with the help of neat sketch. [7M]

4. The turning moment diagram for a petrol engine is drawn to the following scales: Turning moment 1mm=5N-m; crank angle 1mm=1°. The turning moment diagram repeats itself at every half revolution of the engine and the areas above and below the mean turning moment line taken in order are 295, 685, 40, 340, 960, 270mm^2. The rotating parts are equivalent to a mass of 36 kg at a radius of gyration of 150mm. Determine the coefficient of fluctuation of speed when the engine runs at 1800r.p.m. [14M]

5. In a Hartnell governor the radius of rotation is 7 cm when speed is 500 rpm. At this speed, ball arm is normal and sleeve is at mid position. The sleeve movement is 2 cm with $\pm$5% of change in speed. The mass of sleeve is 6 kg and friction is equivalent to 25 N at the sleeve. The mass of the ball is 2 kg. If ball arm and sleeve arms are equal, find, [14M]
   (i) Spring rate
   (ii) Initial compression in the spring, and
   (iii) Governor effort and power for 1% change in the speed if there is no friction.
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6. The following data refers to a two- cylinder uncoupled locomotive: [14M]
Rotating mass per cylinder = 280kg
Reciprocating mass per cylinder = 300kg
Distance between wheels = 1400mm
Distance between cylinder centres = 600mm
Diameter of treads of driving wheels =1800mm
Crank radius = 300mm
Radius of centre of balance mass = 620mm
Locomotive speed = 50Km/hr
Angle between cylinder cranks = 90^o
Dead load on each wheel = 3.5tonne
Determine the:
i) Balancing mass required in the planes of driving wheels if whole of the revolving and two-third of the reciprocating mass are to be balanced
ii) Swaying couple
iii) Variation in tractive force
iv) Maximum and minimum pressure on the rails
v) Maximum speed of locomotive without lifting the wheels from the rails

7. a) Derive the differential equation of motion for a free damped vibration. [6M]

b) A shaft of 40mm diameter and 2.5m length has a mass of 15kg per meter length. It is simply supported at the ends and carries three masses of 90kg, 140kg and 60kg at 0.8m, 1.5m and 2m respectively from the left support. Taking E=200GN/m^2 , find the frequency of the transverse vibrations and whirling speed. [8M]

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2. Answer **ALL** the question in **Part-A**
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PART –A

1. a) Define axis of spin and axis precession. [2M]
   b) What is Band brake? [2M]
   c) State the applications of Flywheel [2M]
   d) What is the function of a governor? How does it differ from that of a flywheel ? [3M]
   e) How do you balance several masses rotating in the same plane? [3M]
   f) What is whirling speed of the shaft? [2M]

PART -B

2. a) The motor of a marine ship having a mass of 1200kg and radius of gyration 350 mm rotates at 1500 rpm clockwise when looking from bow. Determine the gyroscopic couple and its effect on the ship in the following cases: [10M]
   i) When the ship pitches with an angular velocity of 1rad/sec when the bow Rising
   ii) When the ship is speeding at 50km/hr and takes a right turn in a circular path of 200m radius
   iii) When the ship rolls at certain instant, it has an angular velocity of 0.75 rad/sec when viewed from the stern.
   b) What do you meant by gyroscopic couple? Derive a relation for magnitude. [4M]

3. a) The mean diameter of a square threaded screw jack is 50 mm. The pitch of the thread is 10mm. The coefficient of friction is 0.15. What force must be applied at the end of a 0.7m long lever, which is perpendicular to the longitudinal axis of the screw to raise a load of 20kN and to lower it? [7M]
   b) With a neat sketch explain the working of Multi plate clutch. [7M]

4. a) The mass of fly wheel of an engine is 1800 kg and its radius of gyration is 0.7m. The starting torque of the engine is 1200 N-m which may be assumed to be constant. Determine the angular acceleration of the wheel, speed and energy stored by it.10 seconds after starting from rest. [8M]
   b) Write notes on following: [6M]
   i) Turning moment diagram ii) coefficient of fluctuation of speed.

5. 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. [14M]
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6. a) Four masses A, B, C & D are completely balanced. Masses C & D makes an angle of 90^0 and 195^0 respectively with that of mass B in the counterclockwise direction. The rotating masses have the following properties: masses at B, C & D are 25 Kg, 40 Kg and 35 Kg respectively with their radii of rotations are 200 mm, 100 mm & 180 mm respectively. The radius of rotation of mass A is 150 mm. Planes B & C are 250 mm apart. Determine the [10M]
i) mass A and its angular position with that of mass B,
ii) position of all the planes relative to plane of mass A.
b) Explain why the reciprocating masses are partially balanced. [4M]

7. a) Governing equation of motion of an under damped single degree of freedom system with a mass of 31 kg is given as $\mathbf{d^2x/dt^2 + (3c/7m)\ dx/dt + (27k/7m)x = 0}$.The amplitude of damped vibration reduces from 3mm to 2mm in successive vibrations in a duration of 0.1 seconds. Evaluate: [7M]
i) frequency of damped vibration, ii) logarithmic decrement iii) damping factor,
iv) natural frequency, v) stiffness and vi) damping coefficient
b) Write short note on following i) vibration isolation ii) Dunkerly's method. [7M]

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