Reg No.:_____ Name:_____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019

**Course Code: ME304**

**Course Name: DYNAMICS OF MACHINERY**

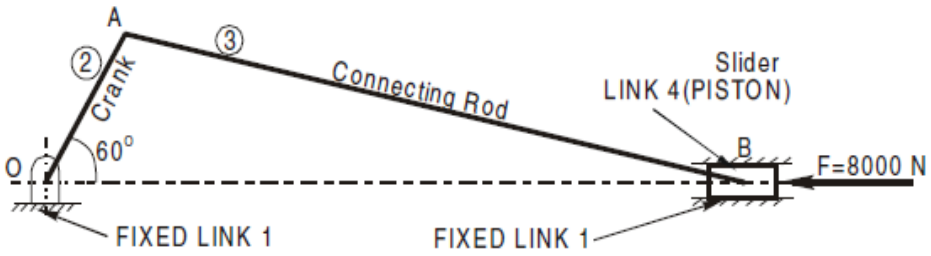
Max. Marks: 100 Duration: 3 Hours

**PART A**

***Answer any three full questions, each carries 10 marks.*** Marks

1 The dimensions of a four-link mechanism are: AB = 400mm, BC = 600mm, CD = 500mm, AD = 900 mm and ∠DAB = 60º. AD is the fixed link. E is a point on the link BC such that BE = 400mm and CE = 300mm (BEC clockwise). A force of 150 ∠45º N acts on DC at a distance of 250mm from D. Find the required input torque on the link AB for static equilibrium of the mechanism. (10)

2 A Slider-crank mechanism as shown in figure is given below. The force acting on slider is 8000 N. Calculate the driving torque. The dimensions of links are: OA = 200 mm ; AB = 800 mm and ∠BOA = 60º (10)




3 Derive an expression for the velocity and acceleration of a piston of a slider crank mechanism and the inertia force due to reciprocating mass. (10)

4 In a vertical IC engine, the connecting rod is 4.5 times the crank. The mass of the reciprocating parts is 1.20kg and the stroke of the piston is 140mm. The engine runs at 2000 rpm. If the net load on the piston due to gas pressure is 2kN when the crank has turned through an angle of 60º from the top dead centre, determine the (10)

(i) Thrust in the connecting rod, (ii)Thrust on the piston walls, (iii)Tangential force on the crank pin, (iv)Torque on the crankshaft

## PART B

***Answer any three full questions, each carries 10 marks.***

5 A shaft carries four masses A, B , C and D of magnitude 250kg, 350kg, 480kg and 250kg respectively and revolving at radii 64mm, 60mm, 50mm, and 64mm in planes measured from A at 300mm, 400mm, and 700mm. The angles between the cranks measured anticlockwise are A to B 45º, B to C 70º, C to D 120º. The balancing masses are placed in planes P and Q. The distance between the planes A and P is 100mm, between P and Q is 400mm and between Q and D is 200mm. If the balancing mass Q revolve at a radius of 100 mm, and balance mass P revolve at a radius of 150mm, find their magnitudes and angular positions. (10)

6 A single cylinder engine is producing 25hP at 4000rpm with 2000 explosions per minute. The fluctuation of speed not to exceed 1% on either side. Find the dimensions of a solid flywheel so that the hoop stress does not exceed 10MPa. Assume that the work done during the power stroke is 1.4 times work done during the cycle. Density of flywheel material is 7200kg/$m^3$. (10)

7 The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: **1.** when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. **2.** when the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees. (10)

8 A racing car weighs 20kN. It has a wheel base of 2m, track width 1m and height of C.G. 300 mm above the ground level and lies midway between the front and rear axle. The engine flywheel rotates at 3000 r.p.m. clockwise when viewed from the front. The moment of inertia of the flywheel is 4 $kgm^2$ and moment of inertia of each wheel is 3 $kgm^2$. Find the reactions between the wheels and the ground when the car takes a curve of 60m radius towards right at 60km/h, taking into consideration the gyroscopic and the centrifugal effects. Each wheel radius is 300mm. (10)

## PART C

***Answer any four full questions, each carries 10 marks.***

9 From fundamentals derive the expression for logarithmic decrement for a free damped longitudinal vibration system. (10)

10 Derive the formula for natural frequency of free undamped longitudinal vibration using any 2 methods. Also derive formula for natural frequency of free transverse vibration. (10)

11 a) A machine of mass 75kg is mounted on springs and is fitted with a dashpot to damp out vibrations. There are three springs each of stiffness 10N/mm and it is found that the amplitude of vibration diminishes from 38.4 mm to 6.4 mm in two complete oscillations. Assuming that the damping force varies as the velocity, determine : **1.** The resistance of the dashpot at unit velocity. **2.** The ratio of the frequency of the damped vibration to the frequency of the undamped vibration. **3.** The periodic time of the damped vibration. (10)

12 A shaft 1.5 m long, supported in flexible bearings at the ends carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7700 kg/$m^3$ and its modulus of elasticity is 200 GN/$m^2$. Find the lowest whirling speed of the shaft, taking into account the mass of the shaft. (10)

13 A steel shaft 1.5m long is 95 mm in diameter for the first 0.6 m of its length, 60mm in diameter for the next 0.5n of the length and 50 mm in diameter for the remaining 0.4m of its length. The shaft carries two flywheels at two ends, the first having mass of 900kg and 0.85 m radius of gyration located at the 95mm diameter end and the second having a mass of 700kg and 0.55m radius of gyration located at the end. Determine the location of the node and the natural frequency of free torsional vibration of the system. The modulus of rigidity of shaft material may be taken as 80GN/$m^2$ (10)

14 What do you understand by vibration pickups? With neat diagram explain the working of a seismometer. (10)

****

Reg No.:_____ Name:_____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019

**Course Code: ME304**

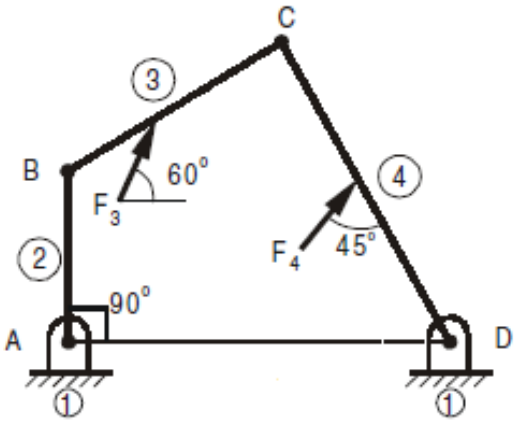
**Course Name: DYNAMICS OF MACHINERY**

Max. Marks: 100 Duration: 3 Hours

**PART A**

***Answer any three full questions, each carries 10 marks.*** Marks

1 A four bar mechanism as shown in Figure, is subjected to two forces, $F_3$ = 2000N at 60º from horizontal at midpoint of link 3 and $F_4$ = 4000 N at 45º from link 4 at midpoint of link 4. The dimensions of links are as under: AB = 0.3 m, BC = 0.4 m, CD = 0.45 m and AD = 0.6 m. Perform static force analysis and determine resisting torque on link 2 using superposition method. (10)




2 A slider crank mechanism of crank radius 60mm and connecting rod length 240mm is acted upon by 2kN gas force at its piston. Calculate the torque to be applied on the crank to make the mechanism in static equilibrium, when the crank makes $60^0$ with the line of stroke. (4)

3 The piston diameter of an internal combustion engine is 125 mm and the stroke is 220 mm. The connecting rod is 4.5 times the crank length and has a mass of 50kg. The mass of the reciprocating parts is 30kg. The centre of mass of the connecting rod is 170mm from the crank pin centre and the radius of gyration (10)

about an axis through the centre of mass is 148mm. The engine runs at 320 rpm. Find the magnitude and the direction of the inertia forces and the corresponding torque on the crankshaft when the angle turned by the crank is 140º from the inner dead centre.

4 a) State and explain D'Alembert's principle. (5)

b) What do you mean by dynamic equivalent .system? Explain (5)

## PART B

***Answer any three full questions, each carries 10 marks.***

5 a) A three cylinder single acting engine has its cranks set equally at 120° and it runs at 600 r.p.m. The torque-crank angle diagram for each cycle is a triangle for the power stroke with a maximum torque of 90 N-m at 60° from dead centre of corresponding crank. The torque on the return stroke is sensibly zero. Determine (10)

**1.** Power developed.

**2.** Coefficient of fluctuation of speed, if the mass of the flywheel is 12 kg and has a radius of gyration of 80 mm

**3.** Coefficient of fluctuation of energy

**4**. Maximum angular acceleration of the flywheel.

6 The firing order of a 6 cylinder 4 stroke inline engine is 1-4-2-6-3-5.The stroke is 120mm and the length of each connecting rod is 240mm. The pitch distance between the cylinders centrelines are 100mm each. The reciprocating mass per cylinder is 1kg and the engine runs at 2400rpm. Determine the out-of-balance primary and secondary forces and couples. (10)

7 Find the angle of heel of a two-wheeler negotiating a turn of radius 60m. Combined mass of the vehicle with the rider is 280kg, moment of inertia of engine rotating parts is 0.4kgm$^2$,taht of each road wheel is 1.2kgm$^2$, the overall gear ratio is 4, height of C.G. is 0.6m with the rider, vehicle speed is 90km/h (10)

8 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 (10)

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.

## PART C

***Answer any four full questions, each carries 10 marks.***

9 a) What is damping factor? (2)

b) In a single degree damped vibration system, a suspended mass of 8 Kg makes 30 oscillation in 18 second. The amplitude decreases to 0.25 of the initial value after 5 oscillations. Determine 1. The stiffness of the spring, 2. Logarithmic decrement, 3. Damping factor and 4. Damping coefficient (8)

10 The mass of an electric motor is 120 kg and it runs at 1500 r.p.m. The armature mass is 35 kg and its C.G. lies 0.5 mm from the axis of rotation. The motor is mounted on four springs of negligible damping so that the force transmitted is one-eleventh of the impressed force. Assume that the mass of the motor is equally distributed among the four springs. Determine: 1. stiffness of each spring; 2. dynamic force transmitted to the base at the operating speed and 3. natural frequency of the system. (10)

11 a) Explain the term 'dynamic magnifier'. What do you understand by transmissibility? (5)

b) A beam of length 10 m carries two loads of mass 200 kg at distances of 3 m from each end together with a central load of mass 1000 kg. Calculate the frequency of transverse vibrations. Neglect the mass of the beam and take I = 109 $mm^4$ and E = 205×103 $N/mm^2$. (5)

12 A steel shaft ABCD 1.5 m long has flywheel at its end A and D. The mass of the flywheel A is 600 Kg and has a radius of gyration of 0.6 m. The mass of the flywheel D is 800 Kg and has a radius of gyration of 0.9 m. The connecting shaft has a diameter of 50 mm for the portion AB which is 0.4 m long; and has a diameter of 60 mm for the portion BC which is 0.5 m long ; and has a diameter of 'd' mm for the portion CD which is 0.6 m long. Modulus of rigidity for the shaft material is 80$GN/m^2$ Determine (10)

1. The diameter 'd' of the portion CD so that the node of the torsional

vibration of the system will be at the centre of the length BC

2. The natural frequency of the torsional vibrations

13 What is whirling speed of a shaft. Prove that the whirling speed for a rotating shaft is the same as the frequency of natural transverse vibration. (5)

Calculate the whirling speed of a shaft 20 mm diameter and 0.6 m long carrying a mass of 1 kg at its mid-point. The density of the shaft material is 40 $Mg/m^3$, and Young's modulus is 200 $GN/m^2$. Assume the shaft to be freely supported (5)

14 A single cylinder diesel engine drives a centrifugal pump. The rotating mass of the engine, flywheel and the pump with the shaft is equivalent to a three rotor system. The mass moment of inertia of engine, flywheel and the pump are 0.15, 0.3,and 0.09$kgm^2$ respectively .The diameter of the shaft is 70mm and the centre distance between engine rotating masses, flywheel and the pump are 1.5m and 1m. Find the natural frequencies of the torsional vibrations, Take G=84$kN/mm^2$. (10)

****