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Question Paper Code : 80319

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fourth Semester

Robotics and Automation Engineering

RO 8403 – KINEMATICS AND DYNAMICS OF MACHINES

(Regulation 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Why inversion of higher pair links is not possible?
2. In a quick return mechanism the crank turns through 120° during the return stroke for one complete rotation of the crank at 60 rpm. Determine the ratio of time for forward and return stroke.
3. Define law of gearing.
4. Why is involute profile preferred over cycloid profile on the gear tooth?
5. A body of mass 5 kg is lying on a rough ground. The coefficient of friction between the body and ground is 0.3. A force of 12 N is acted on the body along the horizontal surface passing though the centroid to the body. Determine the friction force acting on the body.
6. Define the condition for the constant wear losses power transmission give example where constant wear is consider for design of systems.
7. Describe the type of motion exhibited by an unconstrained link when to a force acting away from the center of mass.
8. Define the condition for dynamic equivalent two mass system.
9. Why balancing of masses due to masses in different planes cannot be performed in a single plane?
10. Define the term frequency ratio and also indicate how it induces resonance in vibrating system.

PART B — (5 × 13 = 65 marks)

11. (a) Draw the Displacement, Velocity and Acceleration Diagrams when the Follower Moves with Simple Harmonic Motion and derive the expression for the maximum velocity and acceleration during lift and the return stroke. (13)

Or

(b) (i) Derive the expression for velocity and acceleration of the slider of a simple slider crank mechanism. (7)

(ii) Derive the expression and discuss the significance of Coriolis component of acceleration. (6)

12. (a) (i) Derive the expression for the minimum teeth required in a spur gear to avoid interference. (6)

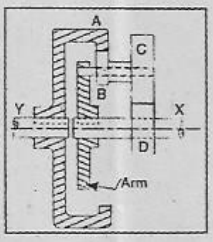
(ii) A compound train consists of six gears. The number of teeth on the gears are as follows : (7)

Gear :	A	B	C	D	E	F
No. of teeth :	60	40	50	25	30	24

The gear B and C are on one shaft while the gears D and E are on another shaft. The gear A drives gear B. gear C drives gear D and gear E drives gear F. If the gear A transmits 1.5 kW at 100 r.p.m. and the gear train has an efficiency of 80 per cent, draw the line diagram of the arrangement and determine the torque on gear F.

Or

(b) (i) An over drive for a vehicle consists of an epicyclic gear train, as shown in Figure, ,with compound planets B-C. B has 15 teeth and meshes with an annulus A which has 60 teeth. C has 20 teeth and meshes with the sun wheel D which is fixed. The annulus is keyed to the propeller shaft Y which rotates at 740 rad/s. The spider which carries the pins upon which the planets revolve, is driven directly from main gear box by shaft X, this shaft being relatively free to rotate with respect to wheel D. Find the speed of shaft X, when all the teeth have the same module. When the engine develops 130 kW, what is the holding torque on the wheel D? Assume 100 per cent efficiency throughout. (7)



(ii) A pair of gears, having 40 and 20 teeth respectively, are rotating in mesh, the speed of the smaller being 2000 r.p.m. Determine the velocity of sliding between the gear teeth faces at the point of engagement, at the pitch point, and at the point of disengagement if the smaller gear is the driver. Assume that the gear teeth are 20° involute form, addendum length is 5 mm and the module is 5 mm. Also find the angle through which the pinion turns while any pairs of teeth are in contact. (6)

13. (a) (i) Derive from first principles an expression for the effort required to raise a load with a screw jack taking friction into consideration. (6)

(ii) An open belt drive connects two pulleys 1.2 m and 0.5 m diameter on parallel shafts 3.6 m apart. The vee belt has a mass of 1 kg/m length and the maximum tension in it is not to exceed 2 kN. The 1.2 m pulley, which is the driver, runs at 200 r.p.m. Due to the belt slip on one of the pulleys, the velocity of the driven shaft is only 450 r.p.m. If the coefficient of friction between the belt and the pulley is 0.3, determine the Torque on each of the two shafts, Power transmitted, Power lost in friction, and Efficiency of the drive. (7)

Or

(b) (i) Derive the expression for the difference in tension in a Vee belt. (7)

(ii) A centrifugal clutch is to transmit 15 kW at 900 r.p.m. The shoes are four in number. The speed at which the engagement begins is $3/4^{th}$ of the running speed. The inside radius of the pulley rim is 150 mm and the centre of gravity of the shoe lies at 120 mm from the centre of the spider. The shoes are lined with friction material for which the coefficient of friction may be taken as 0.25. Determine the Mass of the shoes, and size of the shoes, if angle subtended by the shoes at the centre of the spider is 60° and the pressure exerted on the shoes is 0.1 N/mm^2. (6)

14. (a) A vertical engine running at 1200 r.p.m. with a stroke of 110 mm, has a connecting rod 250 mm between centres and mass 1.25 kg. The mass centre of the connecting rod is 75 mm from the big end centre and when suspended as a pendulum from the gudgeon pin axis makes 21 complete oscillations in 20 seconds. (13)

(i) Calculate the radius of gyration of the connecting rod about an axis through its mass centre.

(ii) When the crank is at 40° from the top dead centre and the piston is moving downwards, find analytically, the acceleration of the piston and the angular acceleration of the connecting rod. Hence find the inertia torque exerted on the crankshaft. To make the two-mass system to be dynamically equivalent to the connecting rod, necessary correction torque has to be applied and since the engine is vertical, gravity effects are to be considered.

Or

(b) A petrol engine 90 mm in diameter and 120 mm stroke has a connecting rod of 240 mm length. The piston has a mass of 1 kg and the speed is 1800 r.p.m. On the explosion stroke with the crank at 30° from top dead centre, the gas pressure is 0.5 N/mm^2. Find: (13)

(i) The resultant load on the gudgeon pin,

(ii) The thrust on the cylinder walls,

(iii) The speed, above which other things remaining same, the gudgeon pin load would be reserved in direction. Also calculate the crank effort at the given position of the crank.

15. (a) A shaft is supported in bearings 1.8 m apart and projects 0.45 m beyond bearings at each end. The shaft carries three pulleys one at each end and one at the middle of its length. The mass of end pulleys is 48 kg and 20 kg and their centre of gravity are 15 mm and 12.5mm respectively from the shaft axis. The centre pulley has a mass of 56 kg and its centre of gravity is 15 mm from the shaft axis. If the pulleys are arranged so as to give static balance, determine : (i) relative angular positions of the pulleys, (ii) dynamic forces produced on the bearings when the shaft rotates at 300 r.p.m. (13)

Or

(b) (i) Derive the expression for the primary and secondary unbalanced forces in a vee engine. (7)

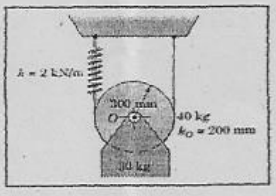
(ii) A two cylinder uncoupled locomotive has inside cylinders 0.6 m apart. The radius of each crank is 300 mm and is at right angles. The revolving mass per cylinder is 250 kg and the reciprocating mass per cylinder is 300 kg. The whole of the revolving and two-third of the reciprocating masses are to be balanced and the balanced masses are placed, in the planes of rotation of the driving wheels, at a radius of 0.8 m. The driving wheels are 2 m in diameter and 1.5 m apart. If the speed of the engine is 80 kmph; find hammer blow, maximum variation in tractive effort and maximum swaying couple. (6)

PART C — (1 × 15 = 15 marks)

16. (a) A 150-kg electric motor has a rotating unbalance of 0.5 kg, 0.2 m from the center of rotation. The motor is to be mounted at the end of a steel ($E = 210 \times 10^9$ N/m^2) cantilever beam of length 1 m. The operating range of the motor is from 500 to 1200 rpm. For what values of I, the beam's cross-sectional moment of inertia, will the steady-state amplitude of vibration be less than 1 mm? Assume the damping ratio is 0.1. (15)

Or

(b) (i) Calculate the frequency of vertical oscillation of the system shown. The pulley has a radius of gyration about its center O of 200 mm. (7)



(ii) Determine the value of the damping coefficient c for which the system is critically damped if k = 70 kN/m and m = 100 kg. (8)