4th Semester Regular/ Back Examination: 2022-23
SUBJECT: Kinematics & Dynamics of Machines
BRANCH(S): AUTO, MMEAM, MECH
Time : 3 Hour
Max Marks : 100
Q.Code : M222
Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1   **Answer the following questions:**   **(2 x 10)**

   a) What is a machine? Differentiate between a machine and a structure with example.

   b) Explain Grubler's criterion for determining degree of freedom for mechanisms.

   c) Define limiting friction.

   d) What do you understand by 'gear train'? What are the various types of gear trains?

   e) Define D-Alembert's Principle.

   f) Define Brake. Write down the classification of brakes.

   g) Explain the term module and pitch circle diameter.

   h) Explain slip of belt.

   i) Define dynamometer. What are the types of dynamometers?

   j) What are the different forms of teeth used in gear system?

Part-II

Q2   **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)**   **(6 × 8)**

   a) Derive the condition for transmitting maximum power in a flat belt drive.

   b) In a screw jack, the helix angle of thread is α and the angle of friction is ϕ. Show that its efficiency is maximum, when $2\alpha = (90º - \phi)$.

   c) Obtain an expression for the length of an open belt drive.

   d) State and prove the law of gearing.

   e) Write down the characteristics of materials used for brake lining.

   f) Write down the difference between self-energizing and self-locking brake.

   g) Describe the construction and operation of a prony brake or rope brake absorption dynamometer.

   h) Derive an expression for the correction torque or couple to be applied to a crankshaft if the connecting rod of a reciprocating engine is replaced by two lumped masses at the piston pin and the crank pin respectively.

   i) Sketch and explain any one inversion of a double slider crank chain.

   j) Derive an expression for the friction moment for a flat collar bearing in terms of the inner radius r1, outer radius r2, axial thrust W and coefficient of friction μ. Assume uniform intensity of pressure.

k) Explain briefly the differences between simple, compound, and epicyclic gear trains. What are the special advantages of epicyclic gear trains?

l) State and Prove the Aronhold Kennedy's Theorem of three instantaneous centres.

Part-III
Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 A reverted epicyclic gear train for a hoist block is shown in figure. The arm E is keyed to the same shaft as the load drum and the wheel A is keyed to a second shaft which carries a chain wheel, the chain being operated by hand. The two shafts have common axis but can rotate independently. The wheels B and C are compound and rotate together on a pin carried at the end of arm E. The wheel D has internal teeth and is fixed to the outer casing of the block so that it does not rotate.   **(16)**

The wheels A and B have 16 and 36 teeth respectively with a module of 3 mm. The wheels C and D have a module of 4 mm. Find : 1. the number of teeth on wheels C and D when the speed of A is ten times the speed of arm E, both rotating in the same sense, and 2. the speed of wheel D when the wheel A is fixed and the arm E rotates at 450 r.p.m. anticlockwise.
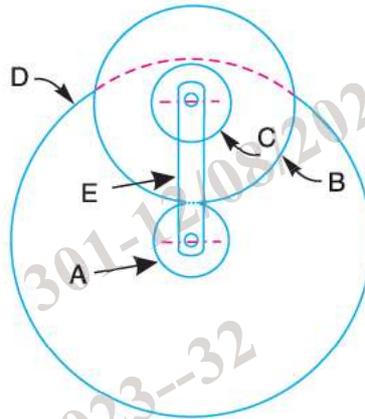
Q4 Derive an expression for the minimum number of teeth required on the wheel and pinion in order to avoid interference in involute gear teeth.   **(16)**

Q5 a) How are velocity and acceleration of the slider of a single slider crank chain determined analytically?   **(8)**

b) Power is transmitted using a V-belt drive. The included angle of V-groove is 30°. The belt is 20 mm deep and maximum width is 20 mm. If the mass of the belt is 0.35 kg per metre length and maximum allowable stress is 1.4 MPa, determine the maximum power transmitted when the angle of lap is 140°. $\mu = 0.15$.   **(8)**

Q6 a) A cone clutch is to transmit 7.5 kW at 900 r.p.m. The cone has a face angle of 12º. The width of the face is half of the mean radius and the normal pressure between the contact faces is not to exceed 0.09N/mm^2. Assuming uniform wear and the coefficient of friction between contact faces as 0.2, find the main dimensions of the clutch and the axial force required to engage the clutch.   **(8)**

b) Sketch and explain the various inversions of a slider crank chain.   **(8)**