Enrollment No: _____ Exam Seat No:_____

C.U.SHAH UNIVERSITY
Winter Examination-2019

Subject Name: Theory of Machines

Subject Code: 4TE04TOM1 Branch: B.Tech (Mechanical)

Semester : 4 Date : 21/09/2019 Time : 02:30 To 05:30 Marks : 70

Instructions:
(1) Use of Programmable calculator & any other electronic instrument is prohibited.
(2) Instructions written on main answer book are strictly to be obeyed.
(3) Draw neat diagrams and figures (if necessary) at right places.
(4) Assume suitable data if needed.

Q-1 Attempt the following questions: (14)

a) When brakes are applied to all the four wheels of a moving car, the distance travelled by the car before it is brought to rest, will be
(a) maximum (b) minimum (c) zero (d) none of these

b) The brakes commonly used in railway trains is
(a) shoe brake (b) band brake
(c) band and block brake (d) internal expanding brake

c) In a spring controlled governor, when the controlling force _____ as the radius of rotation increases, it is said to be a stable governor.
(a) Remains constant (b) Decreases (c) Increases (d) None of these

d) The height of a Watt's governor is
(a) Directly proportional to speed (b) Directly proportional to (speed)^2
(c) Inversely proportional to speed (d) Inversely proportional to (speed)^2

e) The power of a Porter governor is equal to
(a) $[c^2/(1 + 2c)]\ (m + M)\ g.h$ (b) $[2c^2/(1 + 2c)]\ (m + M)\ g.h$
(c) $[3c^2/(1 + 2c)]\ (m + M)\ g.h$ (d) $[4c^2/(1 + 2c)]\ (m + M)\ g.h$

f) The steering of a ship means
(a) Movement of a complete ship up and down in vertical plane about transverse axis
(b) Turning of a complete ship in a curve towards right or left, while it moves forward
(c) Rolling of a complete ship sideways (d) None of the above

g) A disc is a spinning with an angular velocity ω rad/s about the axis of spin. The couple applied to the disc causing precession will be (where I = Mass moment of inertia of the disc, and ω_P = Angular velocity of precession of the axis of spin)
(a) $(1/2)I\omega^2$ (b) $I\omega^2$ (c) $(1/2)I\omega\omega_P$ (d) $I\omega\omega_P$

h) The ratio of maximum fluctuation of energy to the work-done per cycle is called
(a) Fluctuation of energy (b) Maximum fluctuation of energy
(c) Coefficient of fluctuation of energy (d) None of these

i) The coefficient of fluctuation of speed is _____ of maximum fluctuation of speed and the mean speed.
(a) Sum (b) Difference (c) Product (d) Ratio

j) The Bifilar suspension method is used to determine
(a) Natural frequency of vibration (b) Position of balancing weights
(c) Moment of inertia (d) Centripetal acceleration

k) The equivalent length of a simple pendulum which gives the same frequency as a compound pendulum is
(a) $h/(kG^2 + h^2)$ (b) $(kG^2 + h^2)/h$ (c) $h^2/(kG^2 + h^2)$ (d) $(kG^2 + h^2)/h^2$

l) The velocity of piston in a reciprocating steam engine is given by (where ω = Angular velocity of crank, r = Radius of crank pin circle, θ = Angle turned by crank from inner dead center, and n = Ratio of length of connecting rod to the radius of crank)
(a) $\omega r\ [\sin\theta + (\sin 2\theta/n)]$ (b) $\omega r\ [\cos\theta + (\cos 2\theta/n)]$
(c) $\omega^2 r\ [\sin\theta + (\sin 2\theta/n)]$ (d) $\omega^2 r\ [\cos\theta + (\cos 2\theta/n)]$

m) The synthesis of mechanism deals with
(a) the determination of input and output angles of a mechanism
(b) the determination of dimensions of the links in a mechanism
(c) the determination of displacement, velocity and acceleration of the links in a mechanism
(d) none of the above

n) The analysis of mechanism deals with
(a) the determination of input and output angles of a mechanism
(b) the determination of dimensions of the links in a mechanism
(c) the determination of displacement, velocity and acceleration of the links in a mechanism
(d) none of the above

Attempt any four questions from Q-2 to Q-8.

Q-2 Attempt all questions

(a) What is the difference between absorption and transmission dynamometers? Describe torsion dynamometer. **(07)**

(b) A Hartnell governor having a central sleeve spring and two right-angled bell crank levers moves between 290 r.p.m. and 310 r.p.m. for a sleeve lift of 15mm. The sleeve arms and the ball arms are 80 mm and 120 mm respectively. The levers are pivoted at 120 mm from the governor axis and mass of each ball is 2.5 kg. The ball arms are parallel to the governor axis at the lowest equilibrium speed. Determine: 1) loads on the spring at the lowest and the highest equilibrium speeds, and 2) stiffness of the spring. **(07)**

Q-3 Attempt all questions

(a) Explain the term height of the governor. Derive an expression for the height in the case of a Watt governor. **(07)**

(b) 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. **(07)**

Q-4 Attempt all questions

(a) What do you understand by gyroscopic couple? Derive a formula for its magnitude. **(07)**

(b) A single cylinder, single acting, four stroke gas engine develops 20 kW at 300 r.p.m. The work done by the gases during the expansion stroke is three times the work done on the gases during the compression stroke, the work done during the suction and exhaust strokes being negligible. If the total fluctuation of speed is not to exceed ± 2 per cent of the mean speed and the turning moment diagram during compression and expansion is assumed to be triangular in shape, find the moment of inertia of the flywheel. **(07)**

Q-5 **Attempt all questions**

(a) Prove that the maximum fluctuation of energy, $\Delta E = 2\ E\ C_S$ **(07)**

Where, E = Mean kinetic energy of the flywheel, and C_S = Coefficient of fluctuation of speed.

(b) The mass of the turbine rotor of a ship is 20 tonnes and has a radius of gyration of 0.60 m. Its speed is 2000 r.p.m. The ship pitches 6° above and 6° below the horizontal position. A complete oscillation takes 30 seconds and the motion is simple harmonic. Determine the following: **(07)**

1. Maximum gyroscopic couple, 2. Maximum angular acceleration of the ship during pitching, and 3. The direction in which the bow will tend to turn when rising, if the rotation of the rotor is clockwise when looking from the left.

Q-6 **Attempt all questions**

(a) Define (i) Hunting (ii) Sensitiveness (iii) Sleeve lift and (iv) Isochronisms for governor. **(07)**

(b) Derive an expression for angle of heel of a two wheeler taking turn. **(07)**

Q-7 **Attempt all questions**

(a) What is meant by dynamically equivalent system? State and prove conditions for it. **(07)**

(b) Determine the chebyshev spacing for function $y = 2x^3 - x$ for the range $0 \leq x \leq 4$, where four precession points are required. For these precision points, determine θ_2, θ_3, θ_4 and $\emptyset_2$, $\emptyset_3$, $\emptyset_4$ if $\Delta\theta = 45°$ and $\Delta\emptyset = 90°$. **(07)**

Q-8 **Attempt all questions**

(a) Explain: Function generation, path generation & motion generation. **(07)**

(b) A small connecting rod of mass 1.5 kg is suspended in a horizontal plane by two wires 1.25 m long. The wires are attached to the rod at points 120 mm on either side of the centre of gravity. If the rod makes 20 oscillations in 40 seconds, find the radius of gyration and the mass moment of inertia of the rod about a vertical axis through the centre of gravity. **(07)**