# Code : 021408

## B.Tech 4th Semester Exam., 2018

### KINEMATICS OF MACHINERY

*Time* : 3 hours *Full Marks* : 70

*Instructions* :

*(i) The marks are indicated in the right-hand margin.*

*(ii) There are* ***NINE*** *questions in this paper.*

*(iii) Attempt* ***FIVE*** *questions in all.*

*(iv) Question No.* ***1*** *is compulsory.*

**1.** Choose the correct option (any *seven*) : 2×7=14

*(a)* The ratio of maximum fluctuation of energy to the work done per cycle is called

*(i)* fluctuation of energy

*(ii)* maximum fluctuation of energy

*(iii)* coefficient of fluctuation of energy

*(iv)* None of the above

*(b)* A rigid body, under the action of external forces, can be replaced by two masses placed at a fixed distance apart. The two masses form an equivalent dynamical system, if

*(i)* the sum of the two masses is equal to the total mass of the body





*(ii)* the center of gravity of the two masses coincides with that of the body

*(iii)* the sum of mass moment of inertia of the masses about their center of gravity is equal to the mass moment of inertia of the body

*(iv)* All of the above

*(c)* Angle of ascent of cam is defined as the angle

*(i)* during which the follower returns to its initial position

*(ii)* of rotation of the cam for a definite displacement of the follower

*(iii)* through which the cam rotates during the period in which the follower remains in highest position

*(iv)* moved by the cam from the instant the follower begins to rise, till it reaches its highest position

*(d)* The centrifugal tension in belts

*(i)* increases power transmission

*(ii)* decreases power transmission

*(iii)* have no effect on power transmission

*(iv)* increases power transmission up to a certain speed and then decreases

(e) In a spring controlled governor, when the controlling force _____ as the radius of rotation increases, it is said to be a stable governor.

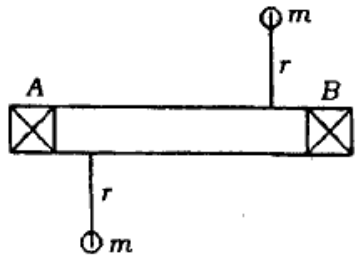
(i) remains constant

(ii) decreases

(iii) increases

(iv) None of the above

(f) A rotor supported at $A$ and $B$ carries two masses as shown in the figure given below :




The rotor is

(i) dynamically balanced

(ii) statically balanced

(iii) statically and dynamically balanced

(iv) not balanced





(g) Idler pulley is used

(i) for changing the direction of motion of the belt

(ii) for applying tension

(iii) for increasing velocity ratio

(iv) All of the above

(h) The primary unbalanced force due to inertia of reciprocating parts in a reciprocating engine is given by (where $m$ = mass of reciprocating parts, $\omega$ = angular speed of crank, $r$ = radius of crank, $\theta$ = angle of inclination of crank with the line of stroke, and $n$ = ratio of the length of connecting rod to radius of crank)

(i) $m \cdot \omega^2 \cdot r \sin\theta$

(ii) $m \cdot \omega^2 \cdot r \cos\theta$

(iii) $m \cdot \omega^2 \cdot r(\sin 2\theta / n)$

(iv) $m \cdot \omega^2 \cdot r(\cos 2\theta / n)$

(i) The height of a Watt governor is

(i) directly proportional to speed

(ii) directly proportional to $(\text{speed})^2$

(iii) inversely proportional to speed

(iv) inversely proportional to $(\text{speed})^2$

(j) 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

(i) maximum

(ii) minimum

(iii) zero

(iv) None of the above

**2.** (a) What are centripetal and tangential components of acceleration? When do they occur? How are they determined? 6

(b) Describe the procedure to draw velocity and acceleration diagrams of a four link mechanism. In what way are the angular accelerations of the output link and the coupler found? 8

**3.** (a) Define the following terms : 5

(i) Pitch circle

(ii) Pitch diameter

(iii) Pitch point

(iv) Circular pitch

(v) Module





(b) In an epicycle gear, the pitch cycle diameter of the annulus $A$ is to be approximately 324 mm and the module is to be 6 mm. When the annulus is stationary, the three armed spider makes one revolution for every five revolutions of the wheel $S$. Find the number of teeth for all the wheels and exact pitch circle diameter of the annulus. If the torque of 30 N.m is applied to the shaft carrying $S$, determine the fixing torque of the annulus. 9

**4.** In an epicyclic gear train, the internal wheels $A$ and $B$ and compound wheels $C$ and $D$ rotate independently about axis $O$. The wheels $E$ and $F$ rotate on pins fixed to the arm $G$. $E$ gears with $A$ and $C$ and $F$ gears with $B$ and $D$. All the wheels have the same module and the number of teeth are

$T_C = 28$, $T_D = 26$, $T_E = T_F = 18$

(a) Sketch the arrangement.

(b) Find the number of teeth on $A$ and $B$.

(c) If the arm $G$ makes 100 r.p.m. clockwise and $A$ is fixed, find the speed of $B$.

(d) If the arm $G$ makes 100 r.p.m. clockwise and wheel $A$ makes 10 r.p.m. counter—clockwise, find the speed of wheel $B$. 14

5. *(a)* Derive the relation $T_1 / T_2 = e^{\mu\theta}$ for a flat-belt drive with usual notations. 6

*(b)* A belt drive transmits 8 kW of power from a shaft rotating at 240 r.p.m. to another shaft rotating at 160 r.p.m. The belt is 8 mm thick. The diameter of the smaller pulley is 600 mm and the two shafts are 5 m apart. The coefficient of friction is 0·25. If the maximum stress in the belt is limited to 3 $N/mm^2$, find the width of the belt for *(i)* an open belt drive and *(ii)* a cross-belt drive. 8

6. *(a)* Distinguish between brakes and dynamometer. 2

*(b)* Discuss the effect of applying the brakes to a vehicle when—

*(i)* brakes are applied to the rear wheels only;

*(ii)* brakes are applied to the front wheels only;

*(iii)* brakes are applied to all the four wheels. 4×3=12

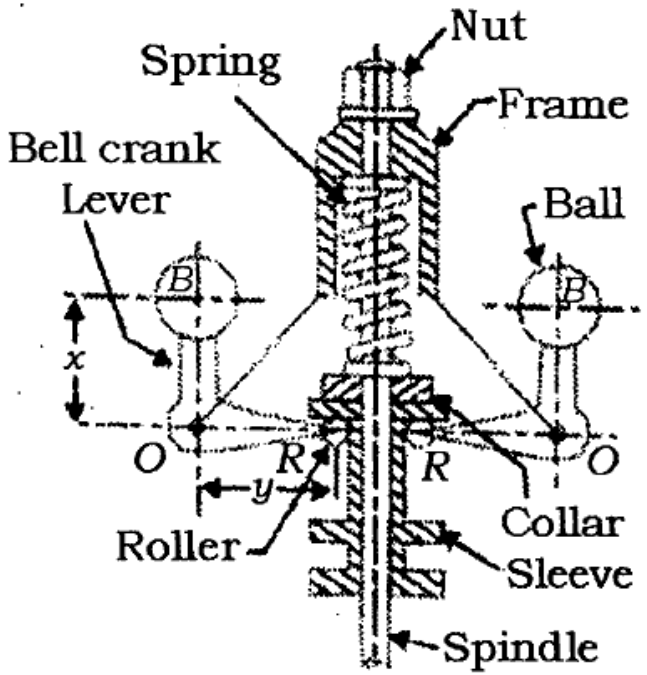




7. A rotating shaft carries three unbalanced masses of 4 kg, 3 kg and 2·5 kg at radial distance of 75 mm, 85 mm and 50 mm and at the angular position of 45°, 135° and 240° respectively. The second and third masses are in the planes at 200 mm and 375 mm from the plane of the first mass. The angular positions are measured counter-clockwise from the reference line along *x*-axis and viewing the shaft from the first mass end. The shaft length is 800 mm between bearings and the distance between the plane of the first mass and the bearing at that end is 225 mm. Determine the amount of the counter masses in planes at 75 mm from the bearings for the complete balance of the shaft. The first counter mass is to be in a plane between the first mass and the bearing and the second mass in a plane between the third mass and the bearing at the end. 14

8. The arms of a Hartnell governor are of equal length. When the sleeve is in the mid-position, the masses rotate in a circle with a diameter of 150 mm (the arms are vertical in the mid-position). Neglecting friction, the equilibrium speed for this

position is 360 r.p.m. Maximum variation of speed, taking friction into account, is to be 6% of the mid-position speed for a maximum sleeve movement of 30 mm. The sleeve mass is 5 kg and the friction at the sleeve is 35 N. Assuming that the power of the governor is sufficient to overcome the friction by 1% change of speed on each side of the mid-position, find (neglecting obliquity effect of arms) the *(i)* mass of each rotating ball, *(ii)* spring stiffness and *(iii)* initial compression of the spring. 14








**9.** The length of the ball and sleeve arms of the bell-crank lever of a Hartnell governor are 140 mm and 120 mm respectively. The mass of each governor ball is 5 kg. The fulcrum of the bell-crank lever is at a distance of 160 mm. At the mean speed of the governor which is 270 r.p.m., the ball arms are vertical and the sleeve arms are horizontal. The sleeve moves up by 12 mm for an increase of speed of 4% neglecting friction, determine the *(i)* spring stiffness, *(ii)* minimum equilibrium speed when the sleeve moves by 24 mm, *(iii)* sensitiveness of the governor and *(iv)* spring stiffness for the governor to be isochronous at the mean speed. 14

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