

This question paper contains 8+2 printed pages]

CODE : FRO-2017

MECHANICAL ENGINEERING

Roll No.

Time : 3 Hours

Maximum Marks : 200

- Note* :— (1) Question paper consists of *two* parts viz. Part I and Part II. Each part contains *four* questions. The paper as a whole carries *eight* questions. Question Nos. **1** and **5** are compulsory. The candidates are required to attempt *three* more questions out of the remaining six questions taking at least *one* question from each part i.e. this is in addition to the compulsory question of each part. Attempt *five* questions in all. *All* questions carry equal marks. The parts of a question are to be attempted at one place in continuation. Answers should be brief and to the point.
- (2) Parts of same question must be attempted together and not to be attempted in between the answers to other questions.

P.T.O.

Part I

1. (a) (i) Explain in brief Inversion of a mechanism ? Describe the inversions of a slider crank mechanism. 10
- (ii) Derive the equation of motion and find the natural frequency of vibration of the system as shown in Figure 1. Take $J_o = 7/48 * ml^2$. 10

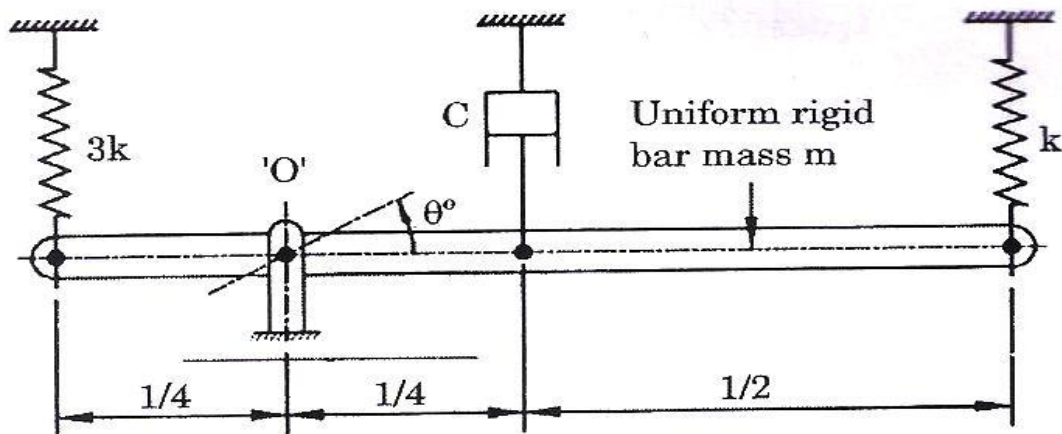


Figure 1

- (b) (i) Write a brief engineering note on various characteristics of a governor. 10
- (ii) The turning moment curve for an engine is represented by the equation, $T = (20000 + 9500 \sin 2\theta - 5700 \cos 2\theta)$ N-m, where θ is

the angle moved by the crank from inner dead centre. If the resisting torque is constant, determine : 10

- (a) Power developed by the engine.
- (b) Moment of inertia of flywheel in kg-m^2 , if the total fluctuation of speed is not exceed 1% of mean speed which is 180 rpm.
- (c) Angular acceleration of the flywheel when the crank has turned through 45° from the inner dead centre.

- (a) (i) Two parallel shafts connected by a crossed belt drive have the diameters of pulleys of 400 mm and 600 mm respectively. The direction of rotation of the driven shaft is required to be reversed, by changing over to an open belt drive. The centre distance between the shafts is fixed at 6 meters. Determine the value of length of belt required to be shortened. 10

- (ii) For the planetary gear train system as shown in Figure 2, the arm rotates at 200 rpm in a counter clockwise direction and the sun gear rotates 100 rpm clockwise. Find the speed and direction of rotation of internal gear 5. 10

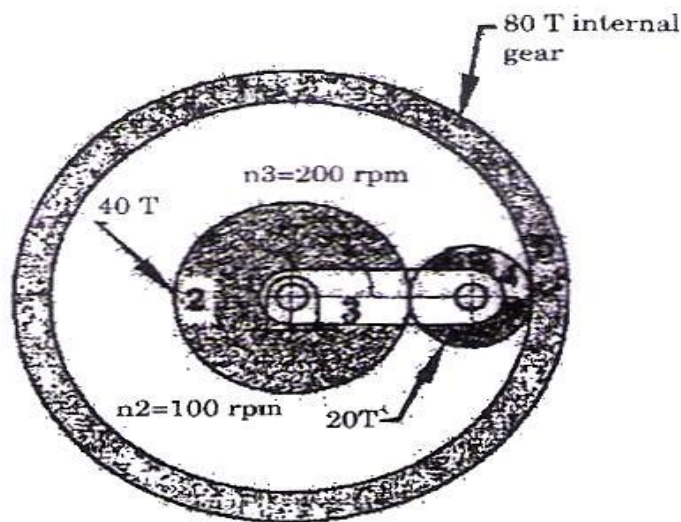


Figure 2

- (b) (i) Discuss the various theories of failure and establish their criterion of failure. 10
- (ii) At a point in a structural member subjected to plane stress there are normal and shearing stresses on horizontal and vertical planes through the point as shown in Figure 3 : 10

- (a) Determine the principal stresses and the maximum shearing stress at the point.
- (b) Locate the planes on which these stresses act and show the stresses on a complete sketch.

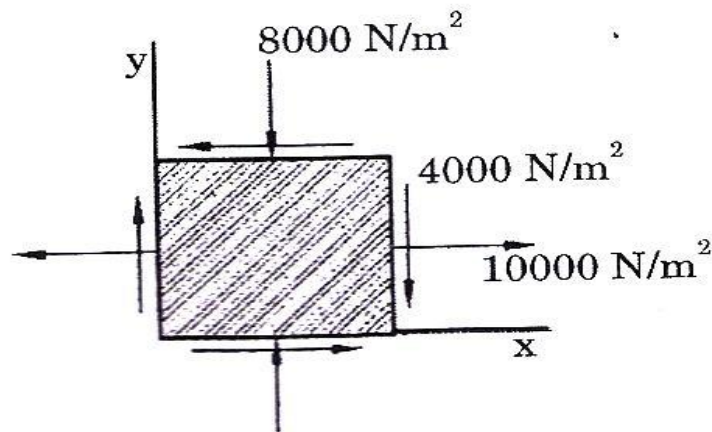


Figure 3

3. (a) (i) Explain, by drawing a neat diagram, the mechanism of material removal of Electro Discharge Machining. Also, list the advantages and disadvantages of machining by Electro Discharge Machining Process. 10
- (ii) A carbide tool with mild steel work piece was found to give life of 2 hours, while cutting

at 0.5 mpm. Compare the tool life, if the same tool is used at a speed of 25% higher than previous one. Also, determine the value of cutting speed, if the tool is required to have tool life of 3 hours. Assume Taylor's exponent as 0.27. 10

(b) (i) Draw Merchant's force diagram and state the assumptions made in its development. 10

(ii) Explain the mechanism of chip formation and also explain the conditions that promote formation of built up edge. Why a built up edge on a tool is undesirable ? 10

4. (a) (i) Annual demand of a product is 2,000. The cost of placing an order is Rs. 500. Purchase cost of the product is Rs. 50 each and selling cost is Rs. 95 each. Holding cost for the company is estimated to be 25% Rs/Rs held/year. Determine Economic Order Quantity (EOQ), Total cost at EOQ, Number of Order per year, and Order Interval. 10

- (ii) In a railway marshalling yard, goods trains arrive at a rate of 30 trains per day. Assuming that the inter-arrival time follows an exponential distribution and the service time (the time taken to hump a train) distribution is also exponential with an average 36 minutes. Calculate : 10
- (i) the mean queue size,
 - (ii) the probability that the queue size exceeds 10,
 - (iii) expected waiting time in the queue.
- (b) (i) What is the importance of the OC curve in the selection of sampling plans ? Describe the impact of the sample size and the acceptance number on the OC curve. What is the disadvantage of having an acceptance number of Zero ? 10
- (ii) The average time taken for an operation in a stop watch time study is 8 seconds. What

is the normal time of the operation if the average rating of the operator is 85% ? If 10% allowances are recommended by the management to cover the operator's personal needs and fatigue, what is the standard time of the operation ?

10

Part II

5. (a) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C . The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and -20°C . The heat transfer to the heat engine is 2000 kJ and the net work output of the combined heat engine-refrigerator plant is 360 kJ. Given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values :

6×5=30

- (a) Draw the schematic of the arrangement, and calculate
- (b) the work output from the engine,

- (c) the work required for the refrigerator,
- (d) the heat transfer to the refrigerator from low temperature reservoir, and
- (e) the net heat transfer to the reservoir at 40°C .
- (b) Explain the working of a simple carburettor by means of neat sketch. 10
6. (a) Represent the Otto cycle on P-V and T-s diagram. 10
- (b) Derive an expression for the thermal efficiency of the Otto cycle. 10
- (c) A cylindrical pipe (thermal conductivity k) of outer radius r at temperature T has to be insulated to reduce the heat transfer loss to an ambient at temperature T_0 . If the surface exposed to the ambient has convective heat transfer coefficient h , find out the critical radius of insulation. Show also the variation of heat transfer with radius. 20
7. (a) Explain ϵ -NTU method in designing of heat exchanger. 10
- (b) Draw the p-H and T-s diagram of ideal vapour compression refrigeration cycle. 10