

2007

MECHANICAL ENGINEERING-I (Optional)

100032

Standard : Degree

Total Marks : 200

Nature : Conventional

Duration : 3 Hours

Note :

- (i) Answers must be written in **English**.
- (ii) Question No. 1 is **Compulsory**. Of the remaining questions, attempt **any four** selecting one question from **each section**.
- (iii) Figures to the **RIGHT** indicate marks of the respective question.
- (iv) Use of log table, Non-programmable calculator is permitted, but any other Table / Code / Reference book are not permitted.
- (v) Make suitable assumptions, wherever be necessary and state the same.
- (vi) Number of optional questions upto the prescribed number in the order in which they have been solved will only be assessed. Excess answers will not be assessed.
- (vii) Credit will be given for orderly, concise and effective writing.
- (viii) Candidate should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer book otherwise he/she will be penalised.

Marks

1. Answer **any four** of the following :

- (a) A helical spring with mean coil diameter  $D$ , wire diameter  $d$  and number of active coils  $N$  is subjected to axial force  $P$ . Write the equations for (i) torsional stress (ii) direct shear stress and (iii) combined torsional and direct shear stress. Show the stress pattern of these stresses on cross section of wire. Give the significance of Wahl factor. 10
- (b) A single plate clutch consists of two pairs of contacting surfaces. The outer diameter of the friction disk is  $D$  and inner diameter is  $d$ . If the coefficient of friction between mating surfaces is  $\mu$  and the maximum intensity of pressure is  $p$ , derive the expression for torque transmitting capacity of the clutch considering uniform wear theory. Show that the torque transmitting capacity is maximum when  $(d/D)$  is equal to 0.577. 10

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- Marks**
- (c) (i) Discuss briefly the influence of water content on moulding sand properties. 5  
(ii) What is forgeability ? What are the factors influenced on forgeability and explain the one test for evaluating forgeability ? 5
- (d) Compare wire-frame and surface modelling. Explain parametric representation of 2D entities - Line and Circle. 10
- (e) Two products  $P_1$  and  $P_2$  are to be manufactured by a firm. Profit on  $P_1$  and  $P_2$  are Rs. 30 and 20 respectively. The products are to be processed on two machines, i.e. first on milling machine and then on surface grinder. The capacities and time required to produce a unit are as follows : 10

	$P_1$	$P_2$	Capacity
Milling Machine	3 hours	1 hour	1500 Man hrs/month
Surface Grinder	1 hour	1 hour	1000 Man hrs/month

How many products of type  $P_1$  and  $P_2$  should be manufactured to get maximum profit ? Use Simplex method.

### SECTION - A

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2. Answer the following sub-questions :

- (a) Find the least force required to drag a body of weight  $W$  placed on a rough inclined plane having inclination  $\alpha$  to the horizontal. The force is applied to the body in such way that it makes an angle  $\theta$  to the inclined plane. Consider that body is on the point of motion up the plane. Write the expressions for efficiency of plane when motion is (i) up the plane (ii) down the inclined plane. 15
- (b) A 280 cm long shaft carries three pulleys, two at its ends and third at mid length. Pulleys at two ends have masses 48 kg and 20 kg and their centre of gravities are at 1.5 cm and 1.25 cm respectively from the axis of the shaft. The middle pulley has mass 55 kg and its centre of gravity is 1.5 cm from the shaft axis. Each pulley is keyed to the shaft by means of woodruff key such that rotor assembly is in static balancing. The shaft rotates at 350 rpm. in two bearings 180 cm apart with equal overhung on either side. Determine relative angular positions of centre of gravities of two pulleys at both the ends with respect to centre of gravity of middle pulley. Use analytical method only. 15

## Marks

- (c) (i) For a simply supported beam of length  $l$  the load intensity varies uniformly from zero at each end to  $W/m$  at the mid span. Determine maximum bending moment and shear force. Show these values on S.F. and B.M. diagrams. 5
- (ii) List the factors those are affecting the strength of fiber reinforced composites. Define aspect ratio of the composite material. What is effect of aspect ratio on the strength of composite ? What is the range of diameters of the fibers used in composite material ? 5

## 3. Answer the following sub-questions :

- (a) An automobile vehicle of total mass 1000 kg is moving down on a straight inclined road at a speed of 36 km/hr. When the brakes are applied it stops after traveling braking distance of 10 m. The moment of inertia of each wheel about its rotating axis is  $0.5 \text{ kg-m}^2$ . The rolling radius of each wheel is 0.4 m. There are brakes on all four wheels. Calculate (i) energy absorbed by each brake (ii) torque capacity of each brake. Neglect M.I. of engine parts. Consider C.G. of vehicle in the plane passing through the axis of front and rear wheels. Consider angle of deep of the road as  $30^\circ$ . 15
- (b) State six essential characteristics of sliding contact bearing materials. When does the boundary lubrication exist in the journal bearing. What are the oils recommended to reduce coefficient of friction for boundary lubricated surfaces ? 15
- (c) (i) For a tapered circular shaft having diameters  $d_1$  and  $d_2$  at two ends respectively, show that total angle of twist for the length  $l$  is equal to
- $$\frac{32 T l (d_1^2 + d_2^2 + d_1 d_2)}{3\pi G d_1^3 d_2^3}$$
- where T=Applied Torque
- G=Modulus of rigidity
- (ii) State the kinetics of Martensite formation from austenite. Compare any three characteristics of martensite transformation with Bainite transformation. 5

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## SECTION - B

4. Answer the following sub-questions :

- (a) A vertical cylindrical pressure vessel of inside diameter  $D_i$  and thickness  $t$  is simultaneously subjected to internal pressure  $p$ , bending moment  $M$  and torque about axis  $T$ . If weight of the vessel and its content is  $W$ , write equations for stresses due to individual loads, torque. On the basis of shear strain energy theory write equation for equivalent stress. For satisfactory design of vessel what are the conditions that must be satisfied under such combined loading. **15**
- (b) Explain the role of flow control valve in hydraulic system. What is meter in and meter out type flow control. Draw hydraulic circuits for meter in and meter out flow control. Use standard symbols. **10**
- (c) State the law of gearing. Explain the phenomenon of interference in involute gear. State three methods to reduce the interference. Two mating gears have 50 and 13 involute teeth of module 10 mm and  $20^\circ$  pressure angle. The addendum is one module. Pinion is driver. Does interference occur ? **15**

5. Answer the following sub-questions :

- (a) Two identical square keys having size  $h$  and length  $l$  are used in two separate power transmitting systems having equal torque. In first system square key is used as sunk key with half portion in the shaft and half in the hub of coupling. In second system square key is used as Kennedy key. Show that ratio of shear stress in Kennedy key to the shear stress in sunk key is  $\frac{1}{\sqrt{2}}$ . Find the ratio for crushing stresses. **15**
- (b) State five objectives of material handling system. State five principles that are used in design of material handling system to make the system effective and efficient. **10**
- (c) Define the terms vibration isolation and transmissibility. Prove that transmissibility **15**

at resonance is given by expression  $T_r = \frac{\sqrt{1+(2\xi)^2}}{2\xi}$

where  $T_r$  = Transmissibility,  $\xi$  = damping factor

Use appropriate notations for stiffness, mass, damping coefficient and external force.

## SECTION - C

6. Answer the following sub-questions :

- (a) (i) Explain the term Machinability. What are the criteria that may be considered while evaluating machinability. 9  
 Illustrate machinability properties of material.
- (ii) The following observations were made during an orthogonal cutting operation : 6  
 Tool rake angle -  $10^\circ$   
 Coefficient of friction - 0.85  
 Chip thickness - 2.5 mm  
 Width of cut - 15 mm  
 Cutting speed - 40 m/min  
 Feed - 1.5 mm/rev  
 Shear strength -  $650 \text{ N/mm}^2$   
 Determine the following :  
 (1) chip thickness ratio  
 (2) shear angle  
 (3) shearing force  
 (4) friction angle  
 (5) cutting force  
 (6) power consumed at cutting tool
- (b) Explain the following : 10  
 (i) Operating characteristics curve in single sampling fraction defective plan.  
 (ii) Acceptable Quality Level (AQL)  
 (iii) Lot Tolerance Fraction Defective (LTFD)  
 (iv) Producer risk and consumer risk
- (c) (i) Differentiate between CPM and PERT. 3  
 Explain the following terms related to PERT and CPM. 4  
 (1) Dummy activity  
 (2) Event  
 (3) Float  
 (4) Critical path
- (ii) Define queue with suitable example and state the characteristics of waiting line. 8  
 Explain the notation (M/M/1) : (FCFS/ $\infty$ / $\infty$ )

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7. Answer the following sub-questions :

- (a) (i) Explain principles and working of LASER BEAM Machining with neat sketch. Discuss various characteristics of LBM with Applications and advantages and disadvantages. **10**
- (ii) Explain the process of crater formation on cutting tools. Why crater is formed at some distance above the tool tip ? **5**
- (b) (i) Explain the difference between double sampling plan and multiple sampling with suitable illustration. **5**
- (ii) A manufacturer of hand drills sells a drill for Rs. 2000. The various annual expenses are as follows : **5**
- (1) Material cost - Rs. 50,000
  - (2) Labour cost - Rs. 25,000
  - (3) Cost of motor for each drill Rs. 1000
  - (4) The factory overhead - 40% of prime cost
  - (5) Total office expenses 10% of factory cost
- Calculate the profit on each drill if annual production is 5000 units.
- (c) (i) The following table gives the activities in a construction project and other related information. **9**
- (1) Draw a PERT diagram
  - (2) Calculate total project duration
  - (3) Make critical path
  - (4) Find the probability that project will be completed in 50 days

Activity	$f_o$	$f_m$	$f_p$
1-2	20	30	46
1-3	9	12	21
2-3	3	5	07
2-4	2	3	04
3-4	1	2	03
4-5	12	18	24

- (ii) Define value engineering. **2**
- Discuss the various fields of application of value engineering. **2**
- Explain the type of value. **2**

## SECTION - D

8. Answer the following sub-questions :
- (a) Explain the process of developing QFD matrix in detail with its basic ingredients. 10
- (b) Design a feed base for feed range  $s=0.1 - 1.11$  mm/rev. in  $u=2$  stages with geometric progression ratio  $\phi = 1.41$ . 15
- (c) (i) What do you understand by FMS ? Describe various systems in FMS. 6  
(ii) Define CIM. What are the various benefits of CIM ? Explain importance of DBMS in CIM. 9
9. Answer the following sub-questions :
- (a) Explain various DFM guidelines for good design practice in detail. 10
- (b) (i) Explain the importance of aesthetic and ergonomic considerations in machine tool design. 8  
(ii) Write short notes on machine tool vibration and chatter. 7
- (c) (i) What is the difference between manual part programming and computer aided part programming ? Explain various statements used in APT. 8  
(ii) Define Computer Aided Process Planning (CAPP). Explain variant and generative approach in brief. 7

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