2006

MECHANICAL ENGINEERING- I (Optional)

000064

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 will be penalised.*

Marks

1. *Answer any Four of the following :*

(a) A cantilever 3 m long is acted upon by two download transverse forces each equal to 3kN. One force acts at 1mm away from the fixed end and the other acts at 1m from the free end. Find deflection of the free end. The cross section of the beam is a rectangle of size 100 mm deep × 30 mm wide. Modulus of elasticity for the material of the beam is 210 MPa. — **10**

(b) State the law of gearing. Prove that the involute profile for gear teeth satisfy the law of gearing. — **10**

(c) (i) Describe the pre-design consideration in the design of casting. — **5**

(ii) Two solid work pieces *(i)* sphere with radius R *(ii)* a cylinder with diameter equal to its height, have to be sand cast. Both work pieces have the same volume. Show that the cylindrical work pieces will solidity faster than spherical work pieces. — **5**

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(d)   What is the difference between analytic and synthetic curves ? Explain Bezier   **10**
curve in detail with neat sketch.

(e)   (i)   A company has one surplus truck in each of the cities, A, B, C, D and E and   **5**
one deficit truck in each of the cities 1, 2, 3, 4, 5 and 6. The distance between
the cities in kilometers is shown in the matrix below. Find the assignment
of trucks from cities in surplus to cities in deficit so that the total distance
covered by vehicles is minimum.

	1	2	3	4	5	6
A	12	10	15	22	18	8
B	10	18	25	15	16	12
C	11	10	3	8	5	9
D	6	14	10	13	13	12
E	8	12	11	7	13	10

(ii)   Determine the optimal replacement policy for the data given below.   **5**
(1)   Group replacement cost Rs. 20 per unit
(2)   Cost of individual replacement of failure = Rs. 90 per unit
(3)   Total number of units in a system = 1000 units
(4)   Mortality data of units to be used in the system.

Sl. No.	Interval of time period	Probability of failure
1	0 - 200	0
2	200.01 - 400	0.06
3	400.01 - 600	0.30
4	600.01 - 800	0.48
5	800.01 - 1000	0.16

SECTION - A

2.   *Answer the following sub-questions :*

(a)   A mass M kg drops down from a height of 'h' m on the free end of a cantilever of   **15**
span 'l' m. Obtain an expression for maximum deflection of the free end using
strain energy consideration. Let I be the required moment of inertia of the cross
section, E be the Modulus of elasticity. Assume that the KE of the mass is
instantaneously absorbed by the cantilever on impact.

Marks

(b) (i)   A 100 mm wide and 10 mm thick belt transmits 5 kW between two parallel   9
           shafts. The distance between the shaft centres is 1.5 m and the diameter of
           the smaller pulley is 400 mm. The driving and driven shafts rotate at
           60 rpm and 150 rpm, respectively. Find the stress in the belt, if the two
           pulleys are connected by an open belt.

     (ii) Explain the gyroscopic effect of rotor of a ship during steering on rolling   6
           and pitching.

(c) (i)   Compare the maximum bending moments that can be carried by a solid   5
           square section of side d and a solid circular section of diameter d made of
           same material.

     (ii) What is Martensite ? Describe martensite with its micro structure. What   5
           are the favourable conditions needed to get martensitic structure in steels ?

3.   *Answer the following sub-questions :*

(a) (i)   Explain the significance of assumptions of uniform pressure and uniform   6
           wear while computing the frictional torque in a collar or pivot bearing.
           Under what practical conditions are these assumptions valid ? Explain by
           giving reasons.

     (ii) A thin disc made of steel having diameter 400 mm and thickness 50 mm is   9
           rolling without slip on a horizontal surface with its centre having a linear
           velocity of 10 m/s. It starts climbing up an inclined plane, with angle of
           inclination of 30° with respect to horizontal. Calculate the maximum height
           the disc will attain before coming to rest. Take density of steel as
           7800 kg/m^3.

(b) (i)   Draw neat sketches of all the inversions of four bar chain. Name them.   6
           State one application of each of them.

     (ii) What is the purpose of a flywheel in a machine. Name any three machines   9
           that use flywheel. Define coefficient of fluctuation of speed and obtain
           expression for it in terms of maximum fluctuation of energy and KE of
           flywheel at normal speed.

(c) (i)   A simply supported beam of span 4 metres is loaded by two transverse   5
           forces, each 4 kN in magnitude, located at 1 metre from each end. The
           beam is made from hollow square tube 80 mm outer side and 8 mm uniform
           wall thickness. Calculate the maximum tensile stress developed in the beam
           due to bending.

     (ii) Explain the procedure, step to carry out full hardening and case hardening   5
           of steel.

P.T.O.

Marks

SECTION - B

4. *Answer the following sub-questions :*

    (a)   A thin spherical shell, 1 m in diameter and 10 mm wall thickness is subjected to   **15**
internal pressure of 2 MPa. Yield strength for material of the shell is 300 MPa.
According to Mises-Hencky theory, check whether the shell is safe or not.

    (b)   Design a refrigeration system of water cooler to cool 50 liters of water from 35°C   **10**
to 25°C in one hour. If the same quantity of water is to be cooled in two hours,
then how will it affect the selection of the components of the refrigeration system.

    (c)   Explain the phenomenon of whirling of shaft. Obtain expression for maximum   **15**
deflection of shaft which is vertical and considered hinged at two ends carrying
a rotor with an unbalance, located at centre of the shaft. Hence comment on the
safe speed of working of the shaft.

5. *Answer the following sub-questions :*

    (a)   Derive an expression for efficiency of a screw with square threads, neglecting   **15**
collar friction. What is a self locking screw. Comment on efficiency of a self
locking screw.

    (b)   An air conditioning system is to be designed for an auditorium with a seating   **10**
capacity of 1000 persons. Narrate the procedure to estimate the cooling load
based on various alternatives so as to reach an optimum solution, with minimum
energy consumption.

    (c)   Write a note on 'Vibration Isolation' and 'Transmissibility', defining the   **15**
transmissibility, its significance, typical plot of transmissibility against w/w_n for
different values of damping factor. How does this plot help in selecting a damping
material for isolation of vibration ?

SECTION - C

6.   *Answer the following sub-questions :*

(a) (i)   Explain briefly with neat diagram the working principle of plasma Arc   **7**
machining state also its advantages, disadvantages and application with
its characteristic also.

(ii) The following observations were made during turning (orthogonally) of a
mild steel tubing of 60 mm diameter on a lathe :

Cutting speed	—	24 m /min.
Toot rake angle	—	320
Feed rate	—	0.12 mm/Rev
Tangential cutting force	—	3000 N
Feed force	—	1200 N
Length of continuous chip in one revolution	—	96 mm

Determine :

(1)   Co-efficient of friction   **2**

(2)   Shear plane angle   **2**

(3)   Velocity of chip along tool force   **2**

(4)   Chip thickness   **2**

(b) (i)   A nursing home has one year moving average forecasting method to product   **5**
a particular medicine requirement. The actual demand for the item is shown
in table below. Using the 12 month moving average, find the exponential
smoothing forecast for 13th month.

Month	1	2	3	4	5	6	7	8	9	10	11	12
Demand	90	80	65	70	100	85	60	75	90	85	60	75

(ii) A factory requires 1500 units of an item/month, each costing Rs. 27, the   **5**
cost per order is Rs. 150 and the inventory carrying charges works out to be
20% of inventory cost. Find out economic order quantity and number of
order per year.

Would you accept a 2% price discount on a minimum supply quantity of
1200 numbers ? Compare the total cost, in both the cases.

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(c) (i)   For a network shown in figure normal time, crash time, normal cost, and   **8**
crash costs, are given in the Table. Contract the network by crashing it to
optimum value and calculate the optimum project cost indirect cost is given
as Rs. 100 per day.
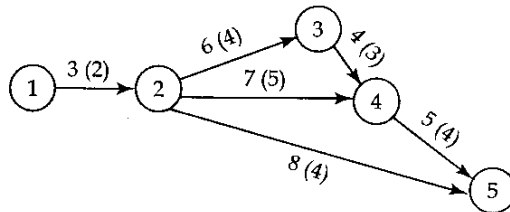
Network figure

|		Normal		Crash	
	Activity	Time (days)	Cost (Rs.)	Time (days)	Cost (Rs.)
1	1 - 2	3	300	2	400
2	2 - 3	6	480	4	520
3	2 - 4	7	2100	5	2500
4	2 - 5	8	400	6	600
5	3 - 4	4	320	3	360
6	4 - 5	5	500	4	520

(ii)   Patients at hospital clinic arrive for general checkup according to Poisson
input process at an average rate of 4 per hour. The medical check up is
carried out in three phases. Three minutes on the average is spend on each
phase of check-up, the distribution of the time on each being approximated
exponential.

(1)   Determine the average time spent by the patient in hospital clinic.   **2**

(2)   What is the average time of getting the service.   **3**

(3)   What is the most probable time to be spent in getting the service.   **2**

Marks

7. *Answer the following sub-questions :*

(a) (i) The following equation for tool life is given for a turning operation : 8
$VT^{0.14} \times f^{0.78} \times d^{0.38} = C$
One hour tool life was obtained while cutting at $V = 28$ m/min;
$f = 0.3$ mm/Rev and $d = 2.6$ mm.
Calculate the tool life if the cutting speed, feed and depth of cut are increased by 25% individually and also taken together.

(ii) Explain the term Degree of freedom along with Principles of location. 7

(b) (i) In a CI component having a 35 mm cored hole, and internal relief is to be 5
provided over a length of 150 mm. Determine the total time to machine the
bore (in two pieces) and turning the relief (in one cut) in the component.
Cutting speed is 15 mm/min. and a feed 0.10 mm/Rev. Enlarging boring
the diameter from 35 to 40 mm for length of 200 mm is first operation.
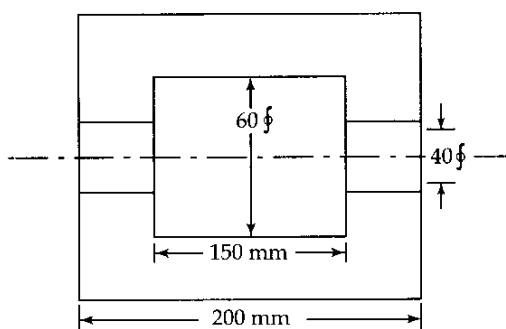
CI Component

(ii) Explain 5 (five "S") S Theory with reference to TPM. 5

(c) (i) The Cost of new machine is Rs. 4000. The maintenance cost of nth year is 8
given by $R_n = 500(n-1)$ $n = 1, 2\ldots\ldots\ldots$ suppose that the discount rate per
year is 0.05. After how many years will it be economical to replace the
machine by a new one ?

(ii) Explain the procedure of value analysis. 7

SECTION - D

8. *Answer the following sub-questions :*

(a) Explain product development process. What is DFM ? Explain strength and 10
weakness of DFM methodology.

(b) (i) Explain various laws of steeped regulations. 5

(ii) What are the functions of guideways ? Explain different requirements that 10
guideways satisfy. Compare slideways and antifriction ways.

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(c) (i) With the help of line diagram explain construction of horizontal and vertical machining centre. 8

(ii) What do you mean by robot programming ? Explain different ways of programming a robot. 7

9. *Answer the following sub-questions :*

(a) Explain following terms related to product development : 10

   (i) Product specifications

   (ii) Product architecture

   (iii) Concept generation and selection

(b) (i) Classify and explain speed box based 7

   — On basis of general layout

   — By method of changing speed

   (ii) Explain feed boxes with change gears and feed boxes with sliding gears in detail. 8

(c) (i) Define automation. Compare fixed, programmable and flexible automation. 7

   (ii) Explain different types of Automatic Tool Changers (ATC) used in Machining centre. 8

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