Roll No.

Candidate should write his/her Roll No. here.

Total No. of Questions : **9** No. of Printed Pages : **7**

SEM-2014(03)
MECHANICAL ENGINEERING
Paper – I

Time : **3** Hours] [Total Marks : **300**

Instructions to the candidates :

Please read each of the following instructions carefully before attempting questions.

*Candidates should attempt **FIVE** questions in all.*

*Question No. **1** is **compulsory**. The remaining FOUR questions are to be attempted by selecting **ONE** question from each four Sections – A, B, C & D.*

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

*Answer must be written in **ENGLISH** only.*

Assume suitable data, if necessary.

All parts and sub-parts of a question are to be attempted together in the answer book.

Any pages left blank in the answer book must be clearly struck out.

1. Each part carries **6** marks : **$10 \times 6 = 60$**

(A) State the assumptions made in Euler's theory of column.

(B) State Lame's equation for thick cylinder.

(C) What are different types of vibrations ? What do you understand by degrees of freedom of vibrating systems ?

(D) What is whirling speed of a shaft ? Is it same as the natural frequency of transverse vibration ?

(E) What is the relationship between the number of instantaneous centres and number of links in a mechanism ?

(F) What are hammer blow and where are they used ?

(G) What is the relationship between cutting speed and tool life in minutes ?

(H) Calculate the control limits for control chart for variables from given data :

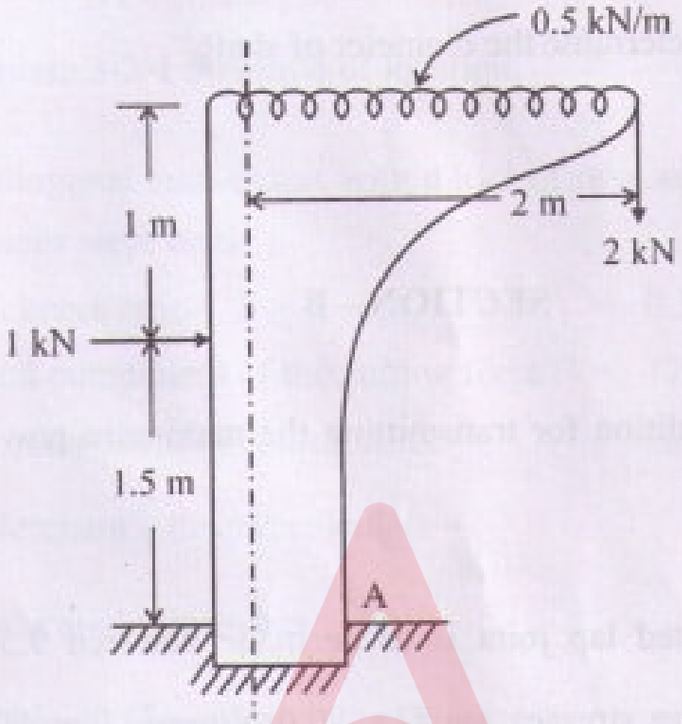
$\overline{\overline{X}} = 431$, $\overline{R} = 41$, $A_2 = 1.023$, $D_4 = 2.574$ & $D_3 = 0$.

(I) Show diagrammatically the different types of fits.

(J) What are the time estimates used for an activity in PERT ? How the expected time is calculated for the activity ?

SECTION – A

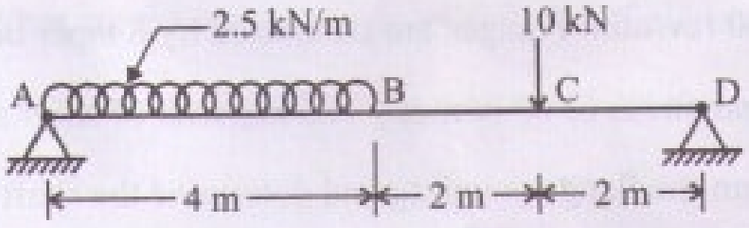
2. (a) Determine the reactions at fixed support A for the loaded bent shown below : 20



(b) A simple epicyclic gear train has a fixed sun gear with 100 teeth and a planet gear with 50 teeth. If the arm is revolved once, how many times does the planet gear revolve ? 20

(c) The following data relate to two meshing gears velocity ratio = $\frac{1}{3}$, Module = 4 mm, Pressure angle = 20°, Centre distance = 200 mm. Determine the number of teeth and base circle radius of the gear wheel. 20

3. (a) Draw SFD and BMD for a beam loaded as shown below : 20



(b) A solid shaft is subjected to a bending moment of 3.46 kN-m and a torsional moment of 11.5 kN-m. The shaft is made of C-45 steel for which allowable tensile stress and shear stress are 115 MPa & 86 MPa respectively. Determine the diameter of shaft. **40**

SECTION – B

4. (a) Derive the condition for transmitting the maximum power in a flat-belt drive. **20**

(b) A double rivetted lap joint is to be made between 9.5 mm plates. If the safe working stresses are f_t = 80.0 N/mm^2, f_s = 60.0 N/mm^2 and f_c = 1.5 f_t, calculate the rivet pitch and distance between rows of rivets for the joint. State how the joint will fail. **40**

5. (a) Draw schematically the displacement, velocity and acceleration diagram when a cam follower moves with uniform acceleration and retardation. **20**

(b) A marine type flange coupling is required to transmit 2900 kW power at a speed of 100 rev/min. Flanges are connected by 8 taper bolts having an allowable shear stress of 60 N/mm^2. The material of shaft and bolts used is same. Design the flange coupling and determine the shaft diameter. **40**

SECTION – C

6. (a) (i) What is the basic difference between jig and fixtures ? 5

(ii) List the types of jigs commonly used. 5

(iii) Explain 3-2-1 principle of location. 10

(b) In an orthogonal cutting test with a tool of rake angle 10°, the following observations were made :

Chip-thickness ratio = 0.3

Horizontal component of the cutting force = 1290 N

Vertical component of cutting force = 1650 N.

Using Merchant's theory, calculate –

(i) Shear angle from data 8

(ii) Frictional force along rake face. 8

(iii) Normal force on the rake face. 8

(iv) Coefficient of friction μ at chip-tool interface. 8

(v) Shear angle from merchant relationship. 8

7. (a) What are the functions served by the electrolyte in ECM ? State the properties for selection of electrolyte. 20

(b) (i) Explain the basic principle of EDM. 10

(ii) What are the requirements of dielectric fluid in EDM ? 10

(iii) List the process parameters which affects the metal removal rate in EDM. 10

(iv) What are the advantages and disadvantages of EDM process ? 10

SECTION – D

8. (a) ABC company has the requirement of 10000 units per year. The unit cost is ₹ 2.00 and overall ordering & processing cost is ₹ 36.00. The inventory carrying cost is estimated at 9% of average inventory investment. 20

Determine :

(i) EOQ

(ii) Optimum number of orders

(iii) Minimum cost of inventory per annum.

(b) Four different jobs are to be done on 4 different machines. The matrix below shows the cost (₹) of producing each job *i* on each one of the machine j. How should the jobs be assigned to the machine, so that the total cost is minimum ? 40

Jobs	Machines			
	A	B	C	D
J_1	5	7	11	6
J_2	8	5	9	6
J_3	4	7	10	7
J_4	10	4	8	3

9. (a) Customers arrive at a sales counter manned by a single person according to a poisson process with a mean rate of 20 per hour. The time required to serve a customer has an exponential distribution with a mean of 100 seconds. Find the average waiting time of a customer. **20**

(b) Explain Routing, Loading & Scheduling in PPC. **20**

(c) What is MRP ? State its objectives. **20**

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Total No. of Questions : 7

No. of Printed Pages : 7

SEM-2014(03)
MECHANICAL ENGINEERING
Paper – II

Time : 3 Hours]

[Total Marks : 300

Instructions to the candidates :

Please read each of the following instructions carefully before attempting questions.

*Candidate should attempt **FIVE** questions in all.*

*Question No. 1 is **compulsory**. The remaining **FOUR** questions are to be attempted by selecting any four out of these six questions Q2 to Q7.*

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

*Answer must be written in **ENGLISH** only. Unless otherwise mentioned, symbols and notations have their usual standard meanings. Assume suitable data, if necessary and indicate the same clearly.*

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer book.

Any pages left blank in the answer book must be clearly struck out.

1. All questions carry equal marks. $10 \times 6 = 60$

(a) State the equation which represents the application of first law of thermodynamics to a steady flow process. Identify the terms in the equation and explain how this equation can be applied to the slow metal extrusion through a die.

A metal extrudes slowly through a die under pressure of 2400 kg/cm^2. The metal is incompressible, weights 9500 kg/m^3 and has specific heat of 0.05 kcal/kg °K. Assume that during the process; there is no cooling, what would be the rise in the temperature of metal ? 6

(b) Prove that the approximate change of entropy during the polytropic process equals the quantity of heat transferred divided by the mean absolute temperature. 6

(c) Prove that Froud's Law of similarity holds good, while testing model geometrically similar of its prototype. 6

(d) A water turbine manufactured by BHEL for Hydroelectric Station is rated at 110 m and 62.5 m^3/sec. and develops 61740 kW. The alternator uses 12 pairs of poles and generates at a frequency of 50 Hz. Calculate the normal speed. If nominal runner diameter is 2.905 m. What will be the speed ratio ? What type of turbine is it ? Assuming a hydraulic efficiency of 95%. Calculate the degree of reaction. Determine also the overall efficiency. 6

(e) Calculate the critical radius of insulation for asbestos (k = 0.17 W/m °C) surrounding a pipe and exposed to room air at 20 °C with h = 3.0 W/m^2 °C. Calculate the heat loss from a 200 °C, 5.0 cm diameter pipe when covered with the critical radius of insulation and without insulation. 6

(f) What are the components of a cooling load for cooling load estimation ? 6

(g) An indicated diagram taken on a diesel engine shows that the compression curve follows the law $PV^{1.4}$ = constant. At points lying on the compression curve at $1/8^{th}$ and $7/8^{th}$ of the stroke, the pressures are respectively 1.5 bar and 15 bar. Find the compression ratio of the engine. If the cut-off occurs at $1/8^{th}$ of the stroke, calculate the ideal efficiency of the engine. Determine also the fuel consumption per kW-hr, if the efficiency ratio is 0.5, mechanical efficiency is 0.8 and the fuel used has a calorific value of 46000 kJ/kg. 6

(h) A reaction turbine having identical blading delivers dry saturated steam at 3 bar. The velocity of steam is 100 m/s. The mean blade height is 4 cm and the exit angle of the moving blade is 20°. At the mean radius the axial flow velocity equal 3/4 blade speed. For a steam flow rate of 10,000 kg/hour, 6

calculate :

(a) The rotor speed in rev/min

(b) The power output of stage

(c) The diagram efficiency

(d) The percentage increase in relative velocity in the moving blades due to expansion of these blades.

(e) The enthalpy drop of the steam in this stage.

Take at 3 bar with dry saturated steam v = 0.6055 m^3/kg.

(i) What are the principles of material handling ? Explain the equipments used in automated material handling system. 6

(j) What are the basic elements of a robot ? Write briefly about each element. 6

Attempt any **four** questions (Q2 to Q7) :

In a test on a four stroke six cylinder engine with 10.0 cm bore, 15 cm stroke and working on the dual combustion cycle, the fuel consumption was 0.17 kg/minute when running at 1500 rpm. The engine had a compression ratio of 10.5 and the calorific value of the fuel used was 450000 kJ/kg. At the commencement of compression, the pressure and temperature conditions were 0.92 bar and 49 °C. Both expansion and compression were carried according to polytropic law $PV^{1.33}$ = constant. If $2/3^{rd}$ of heat released by the combustion of fuel is at constant volume and the remainder $1/3^{rd}$ at constant pressure, estimate

(a) Heat supplied in kJ/kg of the cylinder charge

(b) Pressure and temperature at the corner point of the cycle

(c) Work output in kJ/kg of cylinder charge

(d) Cycle efficiency and power output of the engine

Assume that the working substance is air with $C_p = 1$ and $C_v = 0.715$ kJ/kg K. **60**

3. Show that the pressure head rise in the impeller of a centrifugal pump when frictional and other losses in the impeller are neglected, is given by

$$\frac{1}{2}g[V_{fi}^2 + u_o^2 - V_{fo}^2 \operatorname{cosec}^2\beta_o']$$

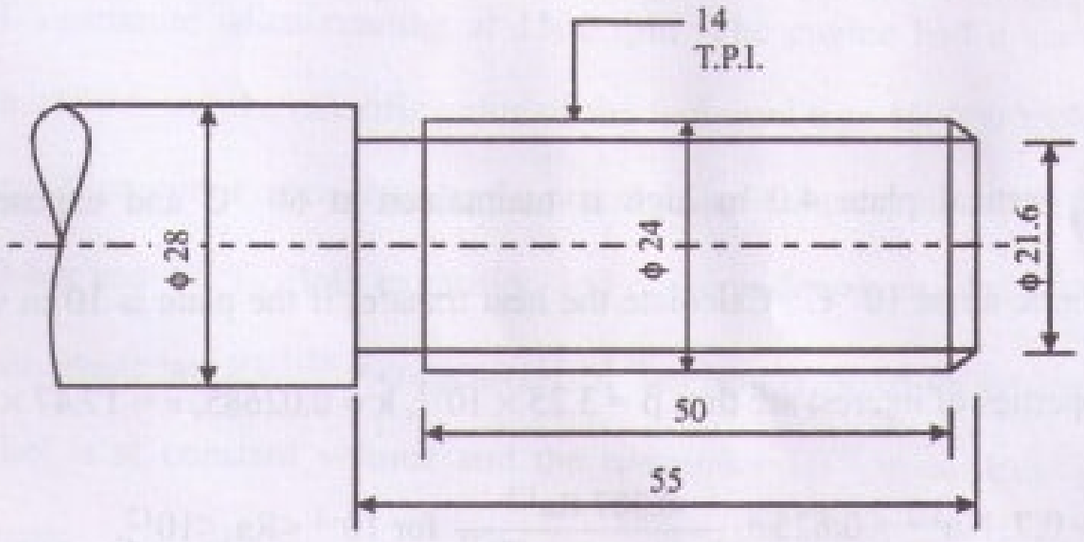
Where V_{fi} and V_{fo} are the velocities of flow at the inlet and the outlet respectively, u_o is the blade velocity at the outlet and β_o' is the blade angle at the outlet of the backward curved blades. **60**

4. A large vertical plate 4.0 m high is maintained at 60 °C and exposed to atmospheric air at 10 °C . Calculate the heat transfer if the plate is 10 m wide. The properties of interest are thus $\beta = 3.25 \times 10^{-3}$, $k = 0.02685$, $\nu = 17.47 \times 10^{-6}$ and $Pr = 0.7$, $Nu^{1/2} = 0.825 + \dfrac{0.387\, Ra^{1/6}}{\left[1 + \left(\frac{0492}{Pr}\right)^{9/16}\right]^{8/27}}$ for $10^{-1} < Ra_1 < 10^{12}$. **60**

5. The average i.h.p induced in C.I. engine is 17.25 per m^3 of free air induced per minute. The engine is a 3 litre, 4 stroke running at 3500 rev/min. and has a volumetric efficiency of 80% referred to free air condition of 1 kg_f/cm^3 and 15 °C. It is proposed to fit a blower driven mechanically from the engine. The blower has an isentropic efficiency of 75% and works through a pressure ratio of 1.7. Assume that at the end of induction, the cylinder contains a volume of charge equal to swept volume at a pressure and temperature of delivery from the blower. Estimate the increase in b.h.p. to be expected from the engine. Take all mechanical efficiencies as 80% and $\nu = 1.4$. **60**

6. (a) What is a Flexible Manufacturing System ? Write its components, applications and benefits. **30**

(b) Write the Part Program of the following figure for CNC lathe machine using 'G' codes. **30**



(All dimensions are in mm.)

7. The P-V diagram of 0.2 mol of a diatomic ideal gas is shown in the figure given below. Process BC is adiabatic. The value of γ for this gas is 1.4. **60**

(a) Find the pressure and volume at points A, B and C.

(b) Calculate ΔQ, ΔW and ΔU for each of the three processes.

(c) Find the thermal efficiency of the cycle.