Roll No.

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Total No. of Questions : **5** No. of Printed Pages : **11**

M1112010

MECHANICAL ENGINEERING

First Paper

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

Instructions to the candidates :

1. There are *five* questions in this question paper. *All* the five questions have to be answered. Each question has internal choice, except Q. No. **1**.
2. The total number of marks is **300** and the time allotted is **3** hours. *All* questions carry equal marks, unless specifically stated.
3. The first question will be of short answer type consisting of **20** questions, each one is to be answered in **3** or **4** lines.
4. Questions should be answered exactly in order in which they appear in the question paper. Answers to the various parts of the same question should be written together compulsorily and no answers of other questions should be inserted between them.
5. Assume suitable data wherever required.
6. All symbols have their usual meanings.
7. Give neat sketches or diagrams wherever necessary.
8. Where word limit has been given it must be adhered to.

1. Answer all of the following questions in brief (in **3** or **4** lines each) : 20×3=60

(*a*) Define the continuous beam and draw the figure.

(*b*) Who developed the Simplex method in linear programming model ?

(*c*) Define quality control.

(*d*) What is interferometer ? Where is it used ?

(*e*) What do you mean by tool signature ? Write the tool signature under ASA system.

(*f*) The ratio of inside to outside diameter of a hollow shaft is 0.6. If there is a solid shaft with same torsional strength, what is the ratio of the outside diameter of hollow shaft to the diameter of the equivalent solid shaft ?

(*g*) What do you mean by redundant constraint in LPP model ?

(*h*) If two cantilever beams of identical dimensions, but made of mild steel and gray cast iron are subjected to same point load at the free end, with in the elastic limit, which one will deflect more and why ?

(*i*) Differentiate clearly between 'Screw' and 'Bolt'.

(*j*) Write the full form of PERT and CPM.

(*k*) Where the worm and worm wheel is useful ? What is speciality in the worm and worm wheel that is not in the other gear systems ?

(*l*) What is whirling of shaft ? Why is study of the whirling of shaft required ?

(*m*) Why are the lathe machine spindles made hollow ?

(*n*) What is stress concentration ? From the stress concentration point of view, show the safe design of a bolt, with suitable diagrams.

(*o*) What is meant by break-even point ? Draw a figure to illustrate your answer.

(*p*) Why is taper provided in a cotter ? What is the range of taper generally provided in cotter for cotter joint ?

(*q*) Write the Miner's equation and its application in machine design.

(*r*) What is dross in metal casting ?

(*s*) What is the difference between dispatching and routing ?

(*t*) What is the difference between qualitative and quantitative forecasting ?

2. (*a*) Prove that in a bar uniformly tapering from a diameter d_1 to diameter d_2 and length L, subjected to a tensile force P, the elongation is given by :

$$\Delta = \frac{4PL}{\pi E d_1 d_2}.$$ 20

(*b*) In a mechanism as shown in Fig. 1, the angular velocity of the crank OA is 600 r.p.m. Determine the linear velocity of the slider D and the angular velocity of the link BD, when the crank is inclined at an angle of 75° to the vertical. The dimensions of various links are : OA = 28 mm, AB = 44 mm, BC = 49 mm and BD = 46 mm. The centre distance between the centres of rotation O and C is 65 mm. The path of travel of the slider is 11 mm below the fixed point C. The slider moves along a horizontal path and OC is vertical. 20

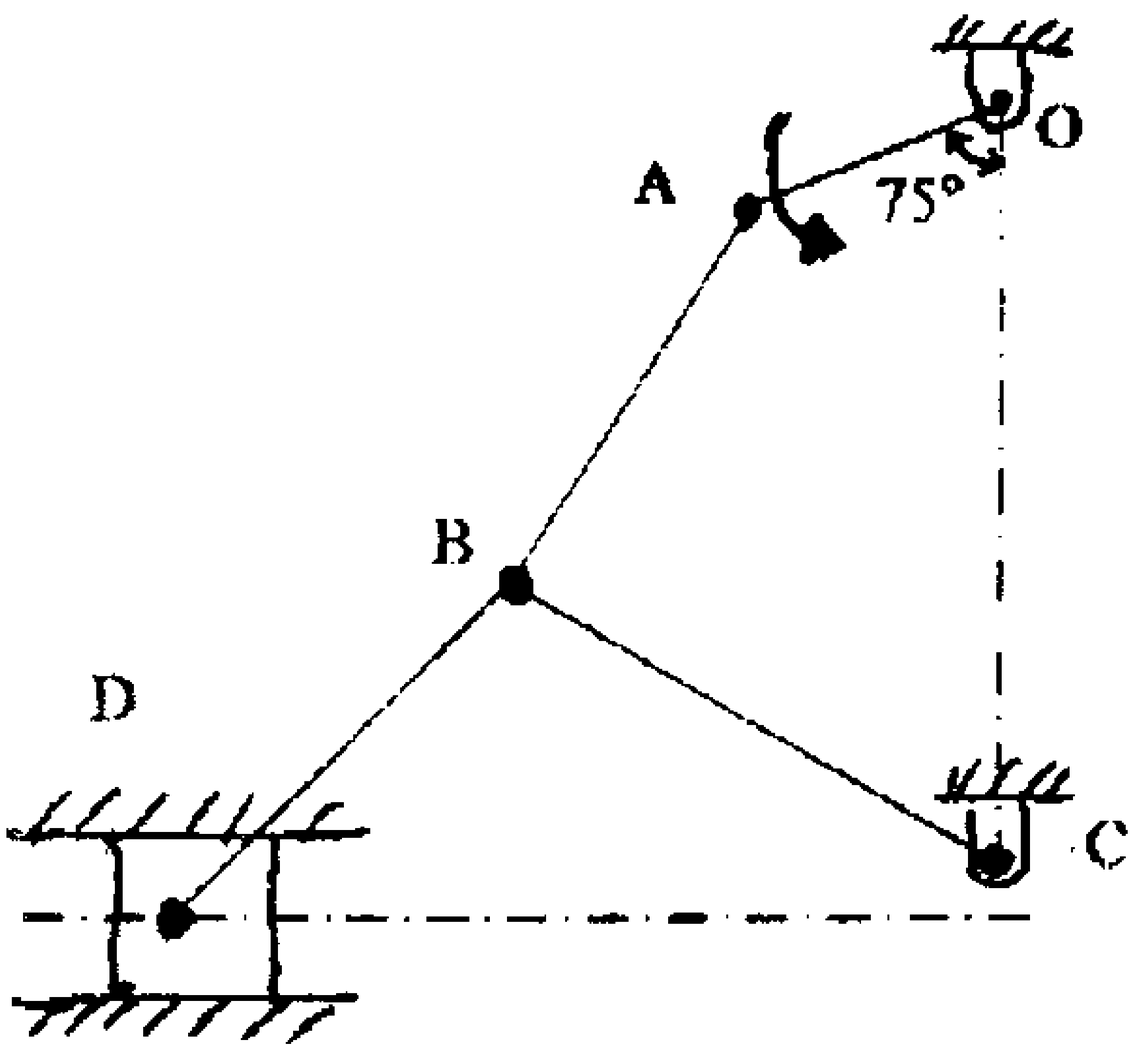

Fig. 1

(*c*) A horizontal beam, 30 m long, carries a uniformly distributed load of 10 kN/m over the whole length and a concentrated load of 30 kN at the right end. If the beam is freely supported at the left end, find the position of the second support so that bending moment on the beam should be as small as possible.

Draw the diagrams of shearing force and bending moment and insert the principal values. 20

Or

(*d*) A gun metal rod screw at the ends passes through a steel tube. The tube has 30 mm external diameter and 25 mm internal diameter. The diameter of the rod is 22 mm. The assembly is heated to 423 K and the nuts on the rod are then screwed tightly home on the ends of the tube. Find the intensity of stress in rod and in tube when the common temperature has fallen to 293 K.

Co-efficient of expansion per K of steel = 12×10^{-6}

Co-efficient of expansion per K of gun metal = 20×10^{-6}

Young's modulus for gun metal = 0.915×10^5 N/mm^2

Young's modulus for steel = 2.05×10^5 N/mm^2. 20

(*b*) In a manufacturing plant, one machine has a symmetrical tangent cam with a roller follower. The least radius of the cam is 25 mm and the roller radius is 18 mm. The angle for outward movement is 90° and total lift is 20 mm. The cam shaft runs at 900 rpm. Determine :

(*i*) Principal dimensions of the cam,

(*ii*) The acceleration of the follower at the beginning of the lift, where the straight flank merge into the circular nose.

(*iii*) Acceleration of the follower at the apex of the circular nose i.e., when the angle turned by cam measured from the position when the roller is at the top of the nose, is zero. Assume there is no dwell between outward and inward travel of the follower. 20

(*c*) What is brake ? Explain the differential band brake with suitable diagram. Give the condition for self-locking. Differentiate between brake and dynamometer. What do you mean by absorption type dynamometer ? Give some examples. 20

3. (*a*) A close-coiled helical spring has mean coil diameter D, wire diameter *d* and number of active turns N. The spring material has modulus of rigidity G. Derive an expression for the deflection δ of the spring under axial load W. 20

(*b*) Design and draw a cast iron flange coupling for a mild steel shaft transmitting 80 kW at 200 rpm with the following specifications :

Allowable shear stress in the shaft = 40 MPa.

Permissible angle of twist < 1° in a length of 20 diameters.

Allowable shear stress in the coupling bolts = 30 MPa.

Rigidity modulus of the shaft material = 85 GPa.

Allowable shear stress for hub material = 15 MPa.

You may adopt, width of key = 25 mm and thickness of key = 14 mm.

You may also consider that the shaft and key are made of the same material.

Four numbers of bolts are to be used in the coupling. Find out the diameter of the shaft required and the main dimensions of the flange and the key. Adopt suitable dimensions. 20

(*c*) What is belt drive ? Classify the open belt drives. Prove that in V-belt drive ratio of the tensions in tight side and slack side is given by $\frac{T_1}{T_2} = e^{\mu\theta \operatorname{cosec} \alpha}$, where μ is coefficient of friction between belt and pulley and α is the groove angle of the V-belt pulley. 20

Or

(*a*) What is a sun and planet gear ? Give the procedure to analyse such a gear train. Also explain its working and differentiate its working with epicyclic gear train. 20

(*b*) What is stress concentration and stress concentration factor ? Explain various methods of reducing stress concentration with the help of suitable diagrams. What do you mean by endurance limit ? Explain the S-N curve for steel. 20

(*c*) A 200 mm long and 50 mm diameter solid shaft is welded to a flat plate. If the size of the weld is 15 mm and bending load 10 kN is applied at the other end of the shaft, find the maximum normal and shear stress in the weld. 20

4. (*a*) Define the terms tolerances, limits and fits with reference to dimensional measurement. What is the comparator ? How does it differ from a measuring instrument ? What do you understand by the terms hole basis and shaft basis in terms of assembly fit specifications ? Which is preferred and why is it preferred ? 20

(*b*) What is forecasting ? Classify the forecasting methods. Explain the Delphi method of forecasting. Give the various application areas of forecasting. 20

(*c*) In a turning process, tool life is given by $V.T^{0.13}.f^{0.77}.d^{0.37} = C$. A 60-minute tool life was obtained while cutting a V = 30 m/min, f = 0.3 mm/rev and d = 2.5 mm. Determine the change in tool life, if the cutting speed, feed and depth of cut are increased by 20% individually and also taken together. Which parameter gives maximum effects on the tool life ? 20

Or

(*a*) What is comparator ? Classify the comparators. Explain various comparators with advantages and limitations. Differentiate between comparators and measuring instrument. 20

(*b*) What is EDM ? Explain the working principle of EDM with suitable diagram. How is EDM different than ECM ? Write the advantages of EDM over ECM. 20

(*c*) A firm uses lathes, milling machines and grinding machines to produce two machine parts. Table 1 shows the machining times required for each part, the machining times available on different machines and the profit on each machine part.

Table 1

Type of Machine	**Machining time required for the machining part (minutes)**		**Maximum time available per week (minutes)**
	I	**II**	
Lathe machine	12	6	3,000
Milling machine	4	10	2.000
Grinding machine	2	3	900
Profit (Rs.)	40	100	

Find the number of parts I and II to be manufactured per week to maximize the profit. 20

5. Write short notes on the following (any *four*) : 4×15=60

(*a*) Laser beam machining

(*b*) Mohr's circle construction

(*c*) Theories of failures

(*d*) Statistical tools for quality control

(*e*) Whitworth quick return motion mechanism

(*f*) EOQ models.

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M1122010

MECHANICAL ENGINEERING

Second Paper

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

Instructions to the candidates :

1. There are *five* questions in this question paper. *All* the five questions have to be answered. Each question has internal choice, except Q. No. **1**.
2. The total number of marks is **300** and the time allotted is **3** hours. *All* questions carry equal marks, unless specifically stated.
3. The first question will be of short answer type consisting of **20** questions, each one is to be answered in *two* or *three* lines.
4. Questions should be answered exactly in order in which they appear in the question paper. Answers to the various parts of the same question should be written together compulsorily and no answers of other questions should be inserted between them.
5. Assume suitable data wherever required.
6. All symbols have their usual meanings.
7. Give neat sketches or diagrams wherever necessary.
8. Wherever word limit has been given, it must be adhered to.
9. Use of I.S. codes is permitted.

1. Answer the *all* the following *twenty* questions briefly (**2-3** lines each), they *all* carry equal marks : 20×3=60

(A) Explain the conditions when the enthalpy of a fluid before throttling is equal to that after throttling.

(B) Narrate the conditions when there is difference between "steady flow energy equation" and "Bernoulli equations".

(C) Explain how the same plant can be used as a heat pump in winter and as a refrigerator in summer.

(D) Explain the term energy cascading.

(E) What are the assumptions made while deriving the momentum equation ?

(F) What is wall turbulence and how does it differ from free turbulence ?

(G) Under what conditions would a reaction turbine work as a pump ?

(H) What are the causes of occurrence of cavitation in turbines ?

(I) Explain why a throttle valve is preferred in vapour compression refrigerator over an expansion cylinder for reducing pressure between condenser and evaporator.

(J) What are the conditions of abnormal combustion ?

(K) What is fouling resistance ?

(L) What is the difference between "black" and "gray" surface with reference to heat exchange by radiation ?

(M) Explain the function of turbocharger in diesel engines.

(N) Why is gas turbine preferred over steam turbine ?

(O) What is the difference between a reaction and an impulse turbine ?

(P) What is condensation ? State the conditions of condensation.

(Q) Give the advantages of 3D modelling.

(R) Differentiate hard automation from soft automation.

(S) Explain "repeatability" as applied to CNC machines.

(T) Define stoichiometric air-fuel ratio for gasoline.

2. (*a*) A metallic resistance thermometer has a resistance of 2.7 ohms at 0°C and 3.6 at 100°C. Calculate the temperature when the metal resistance is 5.1 ohms.

20

(*b*) Calculate the decrease in available energy when 30 kg of water at 90°C is mixed with 40 kg of water at 40°C, the surrounding temperature being 20°C and the Mieing process is carried out at constant pressure. 20

(*c*) A rectangular aluminium fin 15 mm wide and 1.00 mm thickness is fitted along a 25 mm tube. The fin base temperature is 175°C and the ambient temperature being 25°C. Estimate the heat loss per fin when k for aluminium is 200 W/mK and the heat transfer coefficient is 130 W/m^2K. 20

Or

(*a*) Water at 20°C flows through a tube of 50 mm diameter. The tube is receiving a constant heat flux of 750 W/m length. If the Reynolds number is 1600, determine :

(*i*) the flow rate

(*ii*) the average heat transfer coefficient between water and tube wall, and

(*iii*) the length of the tube when the water temperature rises from 20°C to 60°C. 20

(*b*) A fluid at 0.5 MPa undergoes a reversible adiabatic compression from 0.2 m^3 to 0.05 m^3 following the law, $PV^{1.25}$ = constant. Determine the change in enthalpy, internal energy and entropy, and the heat transfer and work transfer during the process. 20

(*c*) What is "Fourier's Law of Conduction" ? State also the assumptions on which this law is based. 20

3. (*a*) In a study test the energy loss in pipeline of 1.0 m diameter used to transport 2500 lts/sec of a fluid with sp. gr. 0.80 and dynamic viscosity of 0.03 poise. The model tests were carried out on a 10 cm diameter pipe using water at 20°C. The head loss in 30 m long model is measured to be 45.0 cm of water. then calculate the following :

(*i*) flow rate in the model

(*ii*) head loss in the prototype, and

(*iii*) the friction factor for the prototype. 20

(*b*) A jet propelled boat, having velocity 5.56 m/s when the jet velocity is 10.5 m/s relative to the boat. The cross-sectional area of the jet is 0.016 m^2. Calculate :

(*i*) The power required to run the pump, if the water is drawn amidship.

(*ii*) State the assumptions made, if any. 20

(*c*) A Kaplan turbine having runner of 3.5 m diameter developing 600 kW at 800 rpm under a head at 2.2 m. Calculate the discharge and specific speed if the turbine has overall efficiency of 80%.

Also if a homogeneous turbine is to be tested at a head of 3.0 m, calculate its rotational speed, discharge and the power of the unit. 20

Or

(*a*) A double jet Pelton turbine develops 5500 kW at a specific speed of 18. The water 350 m above the nozzle is supplied from a source, through a pipeline 1.0 km long. Assume the coefficient of velocity for the nozzles as 0.97, $\phi = 0.46$, overall $\eta = 85\%$, Darcy's friction

factor = 0.024, and friction loss allowed in the penstock pipeline to be 5.0% of gross head. Determine the following :

(*i*) turbine speed in rpm;

(*ii*) diameter of the jets;

(*iii*) mean diameter of bucket circle; and

(*iv*) diameter of penstock pipeline. 20

(*b*) A centrifugal pump running at 100 rpm has an outlet vane angle of 60°. The velocity of flow through the impeller is constant at 3 m/s. The manometric head is 24 m and the manometric efficiency is 75%. The outlet diameter is twice the inlet diameter. Assuming that water enters without whirl, find :

(*i*) The inlet and outlet diameter of the impeller.

(*ii*) Inlet vane angle. 20

(*c*) Show that for the maximum efficiency the bucket speed of a Pelton wheel should be equal to one half of the jet speed. 20

4. (*a*) In an absorption refrigeration system, heating, cooling and refrigeration temperatures are 200°C, 30°C and –30°C. Find the theoretical COP of the system. **10**

(*b*) In an ammonia-absorption refrigeration system, the strong ammonia solution at 85°C is supplied to the generator at a rate of 8 kg/min. The pressure maintained in the generator is 12 bar. The rate of evaporation (dry NH_3 vapour) from the generator is 1.5 kg/min. The enthalpy of NH_3 vapour coming out of the generator is 1880 kJ/kg. The remaining weak solution leaves the generator at 105°C. Find the quantity of heat supplied per kg of NH_3 vapour generated. Assume the sp. heat of solution as 4.94 kJ/kg-°C and mean mass concentration is 0.35.

The NH_3 is reduced to liquid at 30°C before entering the evaporator and evaporated at 2 bar. Find the refrigerating effect and COP of the system. The relevant values of enthalpies at 2 bar are 558 kJ/kg and 1663 kJ/kg and those for 12 bar are 558 kJ/kg and 1924 kJ/kg.

Also compare the refrigerating effect with that obtained by vapour compression system working between same pressure limit. Assume compression is isentropic, suction is dry and saturated and there is no subcooling. The thermal coefficient is 20%. 40

(*c*) A four-cylinder engine running at 1200 rpm gave 25.3 B.H.P. The average torque when one cylinder was cut out was 10.5 mkgf. Determine the indicated thermal efficiency if the calorific value of the fuel is 10000 kcal/kg and the engine uses 0.25 kg of petrol per B.H.P. hour. 10

Or

(*a*) A petrol engine having a compression ratio of 7 has a brake thermal efficiency which is 40% of ideal air standard efficiency. The calorific value of the fuel used is 10000 kcal/kg. Calculate the fuel consumption in kg/hr if engine delivers 10 h.p. 10

(*b*) In an impulse turbine the steam enters at a velocity of 1000 m/sec and the nozzle angle is 20°. The mean peripheral velocity of blades is 450 m/sec and the blades are symmetrical. Determine the following :

(*i*) Blade angles if the steam enters without shock.

(*ii*) Estimate the diagram efficiency, axial thrust, diagram power and tangential force if the mass flow is 0.75 kg/sec. 40

(*c*) In a refrigerating machine using R-12 with efficiency of compressor 80% has refrigerant circulation rate of 2 kg/min and works between 37°C and −18°C. The liquid enthalpy at 37°C is 78 kJ/kg and enthalpies of R-12 entering and leaving compressor are 200 kJ/kg and 238 kJ/kg respectively. Determine the capacity and COP of the refrigeration plant. 10

5. Write any *four* from following parts of the question : 4×15=60

(*a*) Discuss the CNC, DNC and adaptive control system briefly.

(*b*) Discuss the elements of a robotic system briefly.

(*c*) (*i*) Discuss Group Technology briefly.

(*ii*) What are the advantages of FMS ?

(*d*) What are LMTD and NTU methods ? Explain them. Discuss briefly.

(*e*) Discuss Ozone friendly refrigerants.

(*f*) Discuss briefly the automated materials handling.