महाराष्ट्र वनसेवा मुख्य परीक्षा - 2012 UOO

2012

MECHANICAL ENGINEERING (Optional) 100151

यंत्र अभियांत्रिकी (वैकल्पिक)

Time : 3 hours **Maximum Marks : 200**

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) *Figure to the* ***RIGHT*** *indicates marks of the respective question.*

(iv) *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.*

(v) *Candidates should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer book otherwise they will be penalised.*

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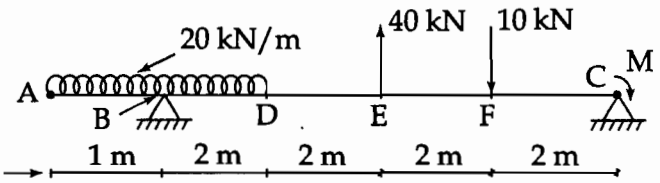
1. Answer ***any four*** of the following :

(a) A beam ABC is loaded and supported as shown in the fig. Find the magnitude of the clockwise moment M to be applied at C so that the reaction at B will be 30 kN upward and then draw the shear force and bending moment diagrams for the beam. **10**



(Fig. not to scale)

(b) Explain the working of universal dividing head. **10**

(c) Explain construction and working of hydroelectric power plant. State advantages of Hydroelectric power plant. **10**

(d) Describe the construction and working principle of Babcock and Wilcox water tube boiler with a neat sketch. Also list the different mountings and accessories on it. **10**

P.T.O.

(e) The power output of an adiabatic steam turbine is 5 MW, and the inlet condition of steam is having enthalpy = 3247.6 kJ/kg, velocity = 50 m/s, position of inlet = 10 m above the datum. While the exit condition of steam is having pressure = 15 kPa, dryness fraction = 0.9, velocity = 150 m/s, and position of exit = 6 m above the datum. Determine : **10**

(i) Change in enthalpy of the system

(ii) Change in kinetic energy of the system

(iii) Change in potential energy of the system

(iv) Work done per unit mass of the steam flowing through the turbine.

(v) Calculate the mass flow rate of the steam.

(Take enthalpy at 15 kPa as hf = 225.94 kJ/kg and latent heat, hfg = 2373.1 kJ/kg.)

SECTION - A

2. Answer the following sub-questions :

(a) A vibrating system consists of a mass of 50 kg, spring of stiffness 30 kN/m and a damper. The damping provided is only 20% of the critical value. Determine **15**

(i) the damping factor

(ii) the critical damping coefficient

(iii) the natural frequency of damped vibrations.

(iv) the logarithmic decrement

(v) the ratio of two consecutive amplitudes.

(b) A semi-elliptic leaf spring used for Automobile suspension consists of three extra full-length leaves and 15 graduated length leaves, including the master leaf. The centre to centre distance between two eyes of the spring is 1 m. The maximum force that can act on the spring is 75 kN. For each leaf, the ratio of width to thickness is 9 : 1. The modulus of elasticity of the leaf material is 207000 N/mm^2. The leaves are pre-stressed in such a way that when the force is maximum, the stresses induced in all leaves are same and equal to 450 N/mm^2. Determine : **15**

(i) the width and thickness of the leaves.

(ii) the initial nip ; and

(iii) the initial preload required to close the gap C between extra full-length leaves and graduated-length leaves.

(c) How a 3 D Geometric model may be represented and what is parametric modelling and when is it used ? **10**

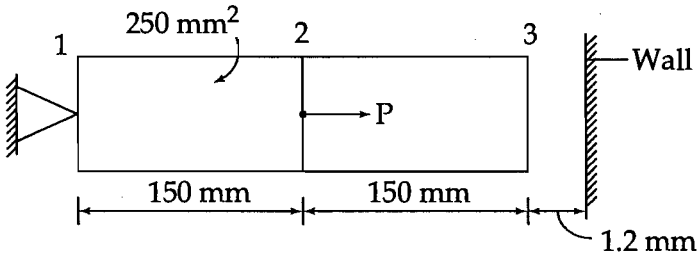
3. Answer the following sub-questions :

(a) State and derive the Law of gearing. Also make a comparison of cycloidal and Involute tooth forms. 15

(b) It is required to design a knuckle joint to connect two circular rods subjected to an axial tensile force of 50 kN. The rods are coaxial and a small amount of angular movement between their axes is permissible. Design the joint and specify the dimensions of its components. The permissible stresses in tension, crushing and shear are 80 MPa, 80 MPa and 40 MPa respectively. 15

(c) Determine the displacement field and stress in the given body. 10

$P = 60$ kN, $E = 20$ kN/mm^2



SECTION - B

4. Answer the following sub-questions :

(a) What are different types of clamps used with jigs and fixtures ? Briefly discuss any four with sketches. 20

(b) (i) Explain point to point positioning control system and straight cut positioning system. 10

(ii) Explain the grinding wheel specifications. W – C – 60 – M – 7 – V – 28 10

5. Answer the following sub-questions :

(a) (i) Explain in brief die casting process with its merits and demerits. 10

(ii) Explain upmilling and downmilling process with sketches. 10

(b) A product is sold at the rate of 500 pieces/day and manufacturing at the rate of 2500 per day. Set up cost of the machines is ₹ 3000 and storage cost is found to be $4.5 \times 1_0{}^{-3}$ ₹/unit/day. Labour, material and overhead charges are ₹ 95, ₹ 65 and ₹ 120 respectively. If the interest charges are 16 percent, find the minimum cost batch size and cost of production run. 20

SECTION - C

6. Answer the following sub-questions :

(a) Define dynamic and kinematic viscosity. Determine the intensity of shear of an oil having viscosity one poise. The oil is used for lubricating the clearance between a shaft of diameter 10 cm and its journal bearing. The clearance is 1.5 mm and shaft rotates at 150 rpm. **15**

(b) Derive the equation for the Bernoulli's theorem. A pipe through which water is flowing is having diameters 20 cm and 10 cm at cross-sections 1 and 2 respectively. The velocity of water at section 1 is 4 m/sec. Find velocity head at sections 1 and 2. **15**

(c) Explain types of similarities used in model analysis. **10**

7. Answer the following sub-questions :

(a) A tank contains water up to height of 0.5 m above the base. An immiscible liquid of specific gravity 0.8 is filled on top of water upto 1 m height. Calculate **20**

(i) Total pressure on one side of tank

(ii) The position of centre of pressure for one side of tank which is 2 m wide. **10**

(b) State impulse momentum equation and derive equation of force exerted by flowing fluid on a pipe bend.

(c) In the model test of a spillway, the discharge and velocity of flow over the model were 2 m^3/sec and 1.5 m/sec respectively. Calculate velocity and discharge over the prototype which is 36 times the model size. **10**

SECTION - D

8. Answer the following sub-questions :

(a) A six cylinder, four stroke direct injection diesel engine is tested against a water brake dynamo meter with the brake power = WN/17280 in kW where, W is the brake load in Newton and N is the speed of engine in rpm. During the test following observations were taken and the air consumption was measured by means of orifice : Bore = 9 cm, stroke = 13 cm, speed = 2500 rpm, brake load = 270 N, barometer reading = 76 cm of Hg, orifice diameter = 3.2 cm, coefficient of discharge of orifice = 0.6, pressure drop across the orifice = 14 cm of Hg, room temperature = 21°C. Fuel consumption = 0.3 kg/min, ratio of carbon to hydrogen by mass of fuel = 84 : 16. **15**

Calculate :

(i) the volumetric efficiency

(ii) brake mean effective pressure

(iii) engine torque

(iv) Specific fuel consumption

(v) ratio of $\frac{(A/F)_{actual} - (A/F)_{stoichiometric}}{(A/F)_{stoichiometric}}$

(b) Derive the expression for minimum work input for 2-stage reciprocating air compressor with perfect intercooling. Draw the p-V diagram for 2-stage compressor with perfect intercooling. **10**

(c) Describe the working of vapour compression refrigeration system with a neat sketch. Compare the performance of it with reversed carnot cycle. **15**

9. Answer the following sub-questions :

(a) What is the necessity of providing cooling systems on I.C. Engine ? Describe the working of cooling system used in modern passenger cars with a neat sketch. **15**

(b) A single acting 14 cm (bore) × 10 cm (stroke) reciprocating air compressor having 4 percent clearance gives the following data obtained from a performance test, suction pressure = 0 bar gauge, suction temperature = 20°C, barometer reading = 76 cm of Hg, discharge pressure = 5 bar gauge, discharge temperature = 180°C, speed = 1200 rpm, shaft power = 6.247 kW, mass of air delivered = 1.7 kg/min. **10**

Calculate :

(i) the actual volumetric efficiency

(ii) indicated power

(iii) isothermal efficiency

(iv) mechanical efficiency

(v) overall efficiency

(c) Derive the expression for Log Mean Temperature Difference (LMTD) for parallel flow and counter flow heat exchanger. **15**

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