[This question paper contains 05 printed pages]

Himachal Pradesh Administrative Service Combined Competitive (Main / Written) Examination, 2020

MECHANICAL ENGINEERING (PAPER-I)

Time allowed: Three Hours | Maximum Marks: 100

QUESTION PAPER SPECIFIC INSTRUCTIONS

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

1. There are EIGHT questions printed in English.
2. Candidate has to attempt FIVE questions in all.
3. Question No.1 is compulsory. Out of the remaining SEVEN questions, FOUR are to be attempted.
4. All questions carry equal marks. The number of marks carried by a question / part is indicated against it.
5. Write answers in legible handwriting.
6. Wherever any assumptions are made for answering a question, they must be clearly indicated.
7. Diagrams / Figures, wherever required, shall be drawn neatly. Unless otherwise mentioned, symbols and notations carry their usual standard meanings.
8. Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in answer book must be clearly struck off.
9. Re-evaluation / Re-checking of answer book of the candidate is not allowed.

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1. (a) A simply supported beam has a uniformly distributed load of 25kN/m and a central pointed load of 100kN. It is of 2m length. Find the reactions at the supports and draw the shear force and bending moment diagram of the beam. Also find the location of maximum bending moment. What is theory of pure bending? (10)

   (b) Mild steel has young's modulus of 210 GPa and yield strength of 370MPa. Find out the maximum elastic strain energy which can be stored per cubic meter of mild steel. Also find the true stress and true strain at the yield point. (10)

2. (a) A four-stroke engine develops 50 kW of power at 150 rpm. The work done during the power stroke is 1.4 times the work done during the cycle. Assume that the energy stored by the flywheel is 1.1 times the energy stored by the rim and density of rim material is 7200 kg/m^3. The turning moment diagram during power stroke may be assumed to be triangular in shape (Fig.1). If the speed variation is limited to 0.5% of the mean speed on either side and the hoop stress in the rim of flywheel is not to exceed 4 MPa, Find (i) the mass of the flywheel rim (kg), (ii) mean diameter of the flywheel (*m*), and (**c**) rim cross-sectional area (*m*^{2}). (10)

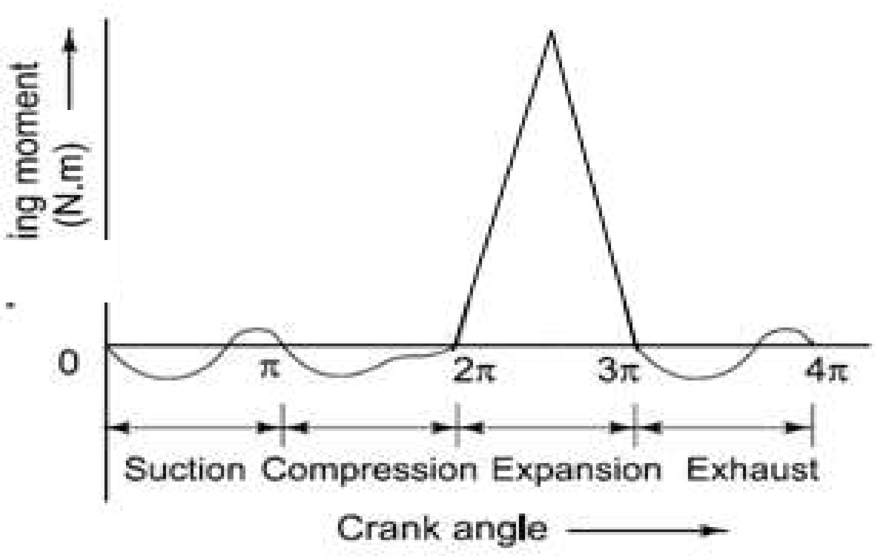

Fig.1

(b) Give the reasons for the following: (10)

(i) For the same capacity, size of flywheel of a two stroke engine is smaller than a four stroke engine.

(ii) Reciprocating masses can not be completely balanced.

(iii) Return stroke of quick return mechanism is faster than the forward stroke.

(iv) Natural frequency of a simple pendulum is independent of mass.

(v) Helical gears are better than spur gears.

3. (a) A metal has a flow curve with strength coefficient = 850 MPa and strain-hardening exponent = 0.30. A tensile specimen of the metal with gage length = 100 mm is stretched to a length = 157 mm. Determine the flow stress at the new length and the average flow stress that the metal has been subjected to during the deformation. Also explain the effect of grain size on flow stress of a polycrystalline material.

(10)

(b) Explain the difference between: (10)

(i) Product layout and process layout

(ii) Free vibration and damped vibration

(iii) Drilling and reaming

(iv) Fine grain structure and coarse grain structure

(v) Steady state and transient creep

4. (a) (i) Bar stock of initial diameter = 90 mm is drawn with a draft = 15 mm. The draw die has an entrance angle = 18°, and the coefficient of friction at the work-die interface = 0.08. The metal behaves as a perfectly plastic material with yield stress = 105MPa. Determine area reduction. (05)

(ii) A brass billet is to be extruded from its initial diameter of 100 mm to a final diameter of 50 mm. The working temperature of 700ºC and the extrusion constant is 250 MPa. Calculate the force required for extrusion. (05)

(b) Suggest suitable for manufacturing processes to manufacture the following components with justification:- (10)

(i) Boiler Drum having thickness of 200mm.

(ii) Bell used in Temples.

(iii) Spanners

(iv) Nose of an aircraft.

(v) Seamless tubes used in boilers

(vi) Rope car wires

(vii) Stepped shafts used in machine tools.

(viii) Connecting rods of IC Engines.

(ix) Angular channels used in constructions

(x) Diesel filters used in engines.

5. (a) Fibrous makes products from rough tree fibers. Its product line consists of five items processed through one of five machines as per details in the table given below. The machines are not identical, and some products are better suited to some machines. Given the following production time in minutes per unit, determine an optimal assignment of product to machine. (10)

Product	Machine				
	A	B	C	D	E
1	17	10	15	16	20
2	12	9	16	9	14
3	11	16	14	15	12
4	14	10	10	18	17
5	13	12	9	15	11

(b) A Cab company has taxi waiting at each of four cab stands. Four customers have called and requested service. The distance in miles from the waiting taxis to the customers are given in the following table. Find the optimal assignment of taxis to customers so as to minimize total driving distances to the customers. (10)

Cab Site	Customer			
	A	B	C	D
Stand 1	7	3	4	8
Stand 2	5	4	6	5
Stand 3	6	7	9	6
Stand 4	8	6	7	4

6. (a) When the rake angle is zero during orthogonal cutting, show that $\frac{\tau_s}{U_c} = \frac{(1-\mu r)r}{1+r^2}$

Where τ_s= ultimate shear stress for work material. U_c= Specific energy, r= chip thickness ratio, μ=coefficient of friction. What is the effect of nose radius on surface finish of machined surface? (10)

(b) A low carbon steel bar of 147 mm diameter with a length of 630 mm is being turned with uncoated carbide insert. The observed tool lives are 24 min and 12 min for cutting velocities of 90 m/min and 120 m/min respectively. The feed and depth of cut are 0.2 mm/rev and 2 mm respectively. Using the unmachined diameter to calculate the cutting velocity, calculate the cutting velocity in m/min to have tool life of 20 min. What is the composition of HSS tool? (10)

7. (a) Draw the TTT diagram of an eutectoid steel and show the cooling curve of the following heat treatment processes and the type of microstructure obtained:- (10)

   (i) Annealing
   (ii) Normalising
   (iii) Quenching
   (iv) Austempering
   (v) Martempering

   (b) Draw a Typical S-N Curve of mild steel and Aluminium. Explain the method of predicting the fatigue life using these curves. Also explain the effect of following parameters of Fatigue life:- (10)

   (i) Shot peening
   (ii) Stress concentration
   (iii) Sand blasting
   (iv) Corrosion
   (v) Surface crack

8. Explain the following:- (5x4=20)

   (i) Toughness and Resilience
   (ii) PERT and time duration of a project
   (iii) Single piece flow
   (iv) Isomorphous system of phase diagram

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