MIZORAM PUBLIC SERVICE COMMISSION

GENERAL COMPETITIVE EXAMINATIONS FOR RECRUITMENT TO THE POST OF JUNIOR GRADE OF MIZORAM FOREST SERVICE i.e. ASSISTANT CONSERVATION OF FOREST (ACF) UNDER ENVIRONMENT, FOREST & CLIMATE CHANGE DEPARTMENT, GOVERNMENT OF MIZORAM, 2018

MECHANICAL ENGINEERING

Time Allowed : 3 hours   Full Marks : 100

*The figures in the margin indicate
full marks for the questions.*

*Answer any <u>10 (ten)</u> questions
taking <u>5 (five)</u> questions from each section.*

SECTION - A

1. Define CNC system? How it is different from NC system? What are the different processes that can be performed using CNC system? Describe three types of N.C. motions with the neat sketch: (i) PTP, (ii) Straight cut and (iii) Contouring.   **(1+1+2+6=10)**

2. Explain with schematic diagram of different types of beams and types of loads acting on a beam. A simply supported beam of length 10m, carries the uniformly distributed load and two-point loads as shown in Figure 1 below. Draw the S.F. and B.M. diagram for the beam. Also calculate the maximum bending moment.   **(10)**
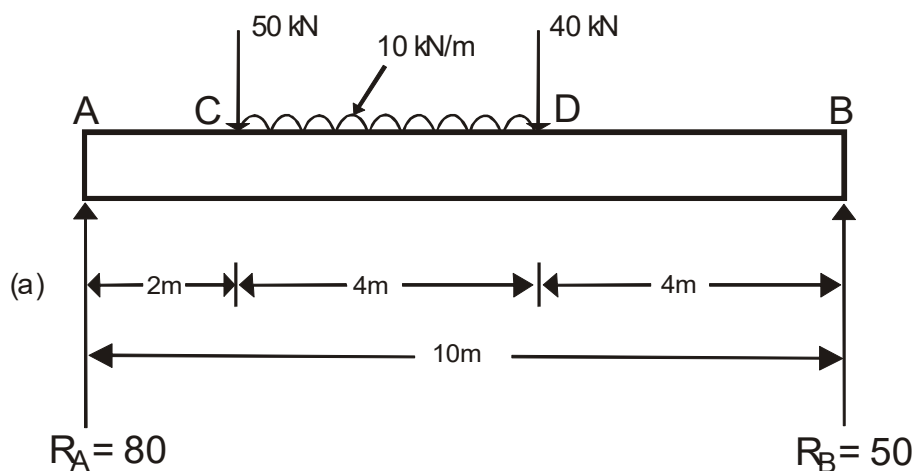

Figure 1

3. The gearing of a machine tool is shown in Figure 2. The motor shaft is connected to gear A and rotates at 975 r.p.m. The gear wheels B, C, D and E are fixed to parallel shafts rotating together. The final gear F is fixed on the output shaft. What is the speed of gear F? The number of teeth on each gear are as given below: **(10)**

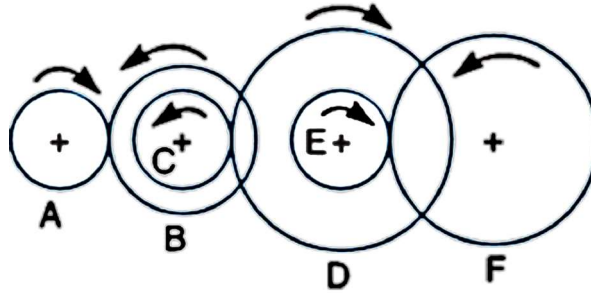| Gear	A	B	C	D	E	F
No. of teeth	20	50	25	75	26	65

Figure 2

4. A cylinder of internal diameter 2.5 m and of thickness 5 cm contains a gas. If the tensile stress in the material is not to exceed 80 N/mm², determine the internal pressure of the gas. **(10)**

5. (a) Draw net sketches of unit cells of simple cubic, BCC and FCC crystal structures. Calculate the number of atoms in each case. **(3+2=5)**

    (b) Why must water quenching be used to harden plain carbon steels, while some alloy steels can be hardened by air cooling? **(5)**

6. (a) What is Break-even analysis? **(2+8=10)**

    (b) A project has the following durations. Find the critical path.

Activity	Duration
1-2	3
2-3	2
4-3	3
1-4	3
2-5	2
3-5	2
4-5	4

7. What is Composite Material? How are Composite Materials classified? Explain in brief the different types of chip formed during metal cutting. Show that for orthogonal cutting $\dfrac{F_t}{F_c} = \tan(\tau - \alpha)$ where, F_t is the feed force or thrust force, F_c is the cutting force, τ is angle of friction and α is cutting rake angle. **(10)**

SECTION - B

8. (a) Compare four-stroke and two-stroke cycle engines by bringing out their relative merits and demerits. **(5)**

(b) In an engine working on ideal Otto cycle, the temperatures at the beginning and end of compression are 50°C and 373°C. Find the compression ratio and the air-standard efficiency of the engine. **(5)**

9. (a) What is the effect of high sulphur content on the performance of SI and CI engines? **(5)**

(b) The mechanical efficiency of a single-cylinder four-stroke engine is 80%. The frictional power is estimated to be 25 kW. Calculate the indicated power (ip) and brake power (bp) developed by the engine. **(5)**

10. (a) Describe with a suitable diagram the working principle of a centrifugal compressor. **(5)**

(b) Determine the expression for workdone by a reciprocating air compressor with clearance volume for rising the pressure of air from p_1 to p_2 with n as the polytropic index for compression and expansion. **(5)**

11. (a) What is a Steam Boiler? How are Steam Boiler classified? What are the main difference between Water Tube Boiler and Fire Tube Boiler? **(1+1+3=5)**

(b) The height of chimney is 28 m and it produces a draught of 16.5 mm of water gauge. The temperature of flue gas in the chimney is 320°C and the temperature of outside air is 28°C. Calculate the quantity of air used per kg of fuel burnt in the boiler. Take atmospheric pressure as 1.013 bar. **(5)**

12. Water (c_p = 4.187 kJ/kg K) is heated at the rate of 1.4 kg/s from 40°C to 70°C by an oil (c_p = 1.9kJ/kg K) entering at 110°C and leaving at 60°C in a counter flow heat exchanger. If U_o = 350 W/m² K, calculate the surface area required. Using the same entering fluid temperatures and the same oil flow rate, calculate the exit temperatures of oil and water and the rate of heat transfer, when the water flow rate is halved. **(10)**

13. (a) What do you mean by COP of Refrigerator? What is the difference between Refrigerator, Heat Pump and Heat Engine? **(1+4=5)**

(b) Describe with a suitable diagram the working principle of a Vapour Compression Refrigeration System. **(5)**

14. The inside and outside surfaces of a hollow sphere $a \le r \le b$ at $r = a$ and $r = b$ are maintained at temperatures T_1 and T_2 respectively. The thermal conductivity varies with temperature as $k(T) = k_o \left(1 + \alpha T + \beta T^2\right)$. Derive an expression for total heat flow rate, Q, through the sphere.

(10)

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