I.F.S. EXAM-2015 वियोज्य *DETACHABLE*

0000100

MECHANICAL ENGINEERING

Paper I

Time Allowed : Three Hours | *Maximum Marks : 200*

QUESTION PAPER SPECIFIC INSTRUCTIONS

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

There are **EIGHT** questions in all, out of which **FIVE** are to be attempted.

Question No. **1** and **5** are compulsory. Out of the remaining **SIX** questions, **THREE** are to be attempted selecting at least **ONE** question from each of the two **Sections A** and **B**.

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 the Question-cum-Answer Booklet must be clearly struck off.

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

Answers 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.

SECTION 'A'

1.(a) What is contact ratio for a pair of gears. What is its importance ? Determine contact ratio for a pair of two (20°) involute gears of 8 mm module having 23 and 57 teeth. If the addenda on the gears are equal to module, find the contact ratio. 8

1.(b) What is critical speed of a shaft ? Determine critical speed of a shaft 24 mm dia carrying a mass 12 kg at its mid span measuring 1 m. The eccentricity of the mass is 0·11 mm. The material of the shaft is steel with E = 200 GN/m^2. Find the critical speed of the shaft. 8

1.(c) A circular steel rod tapers uniformly from 40 mm diameter to 150 mm diameter in a length of 400 mm. How much the bar will elongate under an axial pull of 40 kN ? Take E = 200 GPa. 8

1.(d) A square bar 20 mm × 20 mm in section, 1·5 m long, is freely supported at its ends in a horizontal position and is loaded with a central load of 200 N. The central deflection due to concentrated load is found to be 5 mm.

If the same bar is placed vertically (both ends hinged) and loaded centrally along its axis, what load is likely to cause the bar to buckle ? 8

1.(e) What are dual-phase steels ? Why are dual-phase steels named so ? Enlist important characteristics of dual-phase steels. 8

2.(a) Two pulleys of diameters 480 mm and 640 mm are connected by an open belt drive with distance between two pulleys set at 3 m. It was decided to change the direction of driven pulley (640 mm dia). How much extra length of the belt is required ? 10

2.(b) What is partial balancing of reciprocating masses ? What are its implications ? Determine the unbalanced force when the crank has turned by 45° from t.d.c., after the balancing is done by a mass at 320 mm radius. Only 60% of the reciprocating parts and all the revolving masses are balanced. Determine also the magnitude of balance mass. Single cylinder reciprocating engine data is as below :

Mass of reciprocating parts = 40 kg
Mass of revolving parts = 30 kg at crank radius
Speed of the crankshaft = 150 rpm
Stroke of the engine = 350 mm 10

2.(c) The torque delivered by a two-stroke engine is represented by

$$T = (1000 + 300\sin 2\theta - 500\cos 2\theta) \text{ N-m}$$

where θ is the angle turned by the crank from inner dead centre. The engine speed is 250 rpm. Mass of the flywheel is 400 kg and radius of gyration 400 mm. Determine

(i) power developed
(ii) total percentage fluctuation of speed
(iii) maximum and minimum torques
(iv) plot torque vs θ for significant points 20

3.(a) A cantilever of length L carries a uniformly distributed load ω/unit length over the entire length. The free end is supported from bottom by a rigid prop. Determine the reaction of the prop. 10

3.(b) A close coiled helical spring made of 8 mm diameter wire has 16 coils. Each coil is 80 mm mean diameter. If the maximum allowable stress in the spring is 150 MPa, determine (i) the maximum allowable load on the spring, (ii) the elongation of the spring and (iii) stiffness of the spring. Take G = Shearing modulus = 82 GPa. 10

3.(c) A thin cylindrical shell with hemispherical ends as thickness of cylindrical portion 't_1' and thickness of hemispherical portion 't_2'. The internal pressure for both is same. For no distortion of the junction under pressure what will be the value of ratio of thickness $\left(\frac{t_2}{t_1}\right)$ if the material has a Poisson's ratio $\nu = 0{\cdot}3$. 10

3.(d) A state of stress at a point are given by
$\sigma_x = 100$ MPa, $\sigma_y = 80$ MPa and $\tau_{xy} = \pm 50$ MPa.
Determine the principal stresses and the maximum shearing stress.
Take : $E = 200$ GPa, $\sigma_y = 200$ MPa and Poisson's ratio $\nu = 0{\cdot}3$.
Determine the factor of safety according to

(i) maximum principal stress theory
(ii) maximum strain theory and
(iii) maximum shearing stress theory 10

4.(a) Silver is face-centred cubic with lattice constant 4·086 A°. Calculate the planar density of atoms (a) on the (100) plane, (b) on the (111) plane and (c) the linear density of atoms along the [110] direction. 10

4.(b) Calculate percentage of vacant atomic sites in Cu (density = 8900 kg/m^3) at 20°C. Assume that vacancies in Cu at 400°C are $1{\cdot}62 \times 10^{22}$/m^3 and constants have following values :

ΔE for vacancy formation = 0·90 eV per vacancy
Boltzman constant, K = $8{\cdot}62 \times 10^{-5}$ eV/K
Avogadro's number = $6{\cdot}02 \times 10^{23}$
Atomic mass of Cu = 63·54 g/mol. 10

4.(c) A tensile test specimen having a diameter of 12·7 mm was loaded up to a load of 76 kN and its diameter was measured as 12 mm. Compare true stress and strain with engineering stress and strain. 10

4.(d) What are the characteristics required for good bearing material ? Compare the properties of bearing bronzes, babbits materials and copper-lead alloys for bearings. 10

SECTION 'B'

5.(a) What is the function of MCU in NC machine ? A dc servomotor is coupled directly to a lead screw which drives the table of an NC machine tool. A digital encoder which emits 500 pulses per revolution is mounted on the other end of the lead screw. If the lead screw pitch is 5 mm and the motor rotates at 650 rpm, calculate

(i) The linear velocity of the table

(ii) The BLU of the NC system

(iii) The frequency of the pulses transmitted by the encoder 8

5.(b) Define a comparator. Write at least six desirable features it should possess. Also name four types of comparators. 8

5.(c) Write Taylor's tool-life equation. Draw tool-life curves for a variety of cutting tool materials like ceramic, high speed steel, cast alloy and carbide. Why the knowledge of the thrust force in cutting is important ? 8

5.(d) What is bill of material (BOM) ? Describe single level and multilevel bill of materials. 8

5.(e) The following information is available for a factory :

Daily working hours	8
Number of working days in week	6
Number of operators	20
Standard hours per unit production	4

During a particular week

Number of units produced	48
Absentee man-days	40
Idle time due to load shedding	30 man-days

Find :

(i) Absenteeism percentage

(ii) Labour utilisation percentage

(iii) Productive efficiency of labour

(iv) Overall productivity of labour in terms of units produced/week/employee. 8

6.(a) Write the design criteria of a jig, Draw a box-jig with open sides arranged for drilling two sides of a block. Name four types of clamping devices. 10

6.(b) Draw a figure to show the wire drawing process and name the process variables. What is recrystallization temperature ? Explain impact extrusion. 10

6.(c) Discuss with a figure ultrasonic machining and its applications. Write some characteristics of chemical machining. 10

6.(d) In economics of machining discuss with the help of figures the variation of machining cost and tool cost with cutting speed. The length of a machining element is 500 mm and the part diameter is 100 mm OD. Velocity and feed for this material are 6·9 m/min and 0·5 mm/rev. What is the time to machine ? 10

7.(a) Using LPP Graphical method, find the maximum value of

$$Z = 5x_1 + 3x_2$$

subject to constraints :

$$3x_1 + 5x_2 \leq 15$$
$$5x_1 + 2x_2 \leq 10$$
$$\text{and } x_1,\ x_2 \geq 0$$

Find the values of x_1 and x_2 for the condition for maximization. 10

7.(b) In queueing theory define the following terms :

(i) Queue time

(ii) Move time

(iii) Wait time

(iv) Queue length

10

7.(c) Draw the network diagram for the given data. Find critical path and the project time duration.

Activity	*Time*	*Activity*	*Time*
1–2	2	4–8	8
1–4	2	5–6	4
1–7	1	6–9	9
2–3	4	7–8	3
3–5	1	8–9	5
4–6	5		

10

7.(d) What are the advantages of exponential smoothing method of forecasting ? The demand for a wooden article in terms of units for last 8 prior months is given in the table. Compute exponentially smoothed forecast for the periods using $\alpha = 0{\cdot}1$ and $0{\cdot}3$.

Month	1	2	3	4	5	6	7	8
Demand (units)	10	18	29	15	30	12	16	8

10

8.(a) Discuss with a figure Plasma Arc cutting. Write some advantages of plasma arc torch. Also show with figure cost advantages of plasma over oxyfuel. 10

8.(b) What is QFD ? Describe the following two methods of implementing QFD :

(i) House of Quality

(ii) Quality Circles

10

8.(c) A company has demand of 12,000 units/year for an item and it can produce 2,000 such items per month. The cost of one setup is Rs. 400 and the holding cost/unit/month is Rs. 0·15. Find the optimum lot size and the total cost per year, assuming the cost of one unit as Rs. 4. Also find the maximum inventory manufacturing time and total time. 10

8.(d) Write a C-program to store the information of AC units in an electronic retail shop. Use bit fields to store the status information. Assume the AC object consists of the following :

(i) Company name : Samsung, LG, Voltas, Blue Star

(ii) Capacity : One ton, one and half ton

(iii) Power consumption : ★★, ★★★, ★★★★★
2 star, 3 star, 5 star

Assume appropriate number of bits for each field. 10