I.F.S. EXAM-(M)2017

FSI-P-MCHE

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.*

*Questions 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

Q1. (a) A slider-crank reciprocating mechanism has the following data :

Radius of the crank = 480 mm

Length of the connecting rod = 1600 mm

Angular velocity of the crank = 20 rad/s

Find the velocity and acceleration of the piston for the crank position of $\theta = 45°$ from the inner dead centre. *8*

(b) Two pulleys having diameters 640 mm and 480 mm, are used to connect two parallel shafts by a crossed belt drive. The distance between the centre lines of the shafts is 3 m. Determine how much the length of the belt should be changed, if it is desired to alter the direction of rotation of the driven shaft. *8*

(c) A rod of 1 m length is kept at a temperature of 30°C. Find the expansion of the rod when the temperature is raised to 80°C. If this expansion is prevented, find the stress induced in the material of the rod. Take E = 100 GPa and $\alpha = 0{\cdot}000012/°C$. *8*

(d) The state of stress at a point in a loaded piece of material is given by

$\sigma_x = 85$ kPa, $\sigma_y = -40$ kPa and $\tau_{xy} = \pm 50$ kPa.

Find the magnitudes of the principal stresses. Also find the magnitude of the maximum shear stress and the plane on which this acts. *8*

(e) In a simple cubic crystal, draw the following planes : *8*

(i) (110)

(ii) (111)

Q2. (a) (i) State the law of gearing. Also state the condition to meet the above requirement. Name the forms of teeth profiles normally used to avoid interference between the mating gears.

(ii) A pair of pinion and gear of 20° pressure angle involute profiles mesh externally and provide a velocity ratio of 3. The addendum is equal to 1·12 of module. Determine the minimum number of teeth on each to avoid interference. *5+10*

(b) A thick cylinder is made of 6 cm internal diameter. It is subjected to an internal pressure of 50 MPa. If the maximum tensile stress is limited to 100 MPa, find the thickness required. Also, show the variations of hoop and radial stresses across the thickness of the cylinder. *15*

(c) Draw a neat and clean iron-carbon equilibrium diagram and label its various features. *10*

Q3. (a) A single cylinder reciprocating engine has the following data :

Mass of reciprocating parts = 40 kg

Mass of revolving parts = 36 kg at crank radius

Speed of crank = 150 rpm

Stroke length of reciprocating parts = 350 mm

All the revolving parts and 60% of the reciprocating parts need to be balanced. Determine :

(i) Balancing mass required at a radius of 340 mm

(ii) Unbalanced force when the crank has turned 45° from the top dead centre *10*

(b) A machine mounted on 4 springs and fitted with a dashpot has a mass of 120 kg. The stiffness of each spring is 18 N/mm. The amplitude of vibrations reduces from 33·75 mm to 6 mm in two complete oscillations. Assuming that the damping force varies as the velocity, determine

(i) damping coefficient, and

(ii) ratio of frequencies of damped and undamped vibrations. *10*

(c) A uniform beam ($I = 7{,}800\ cm^4$) is 6 m long and carries a central concentrated load of 60 kN. Taking E = 210 GPa, calculate the deflection under the load if the beam is built-in at one end and simply supported at the other end. *10*

(d) Draw the heating cycle on Temperature – Time scale of the following processes : *10*

(i) Process annealing or Subcritical annealing

(ii) Spheroidize annealing

(iii) Austempering

Q4. (a) Each arm of a Porter governor is 200 mm long and is pivoted on the axis of the governor. The radii of rotation of the balls at the maximum and minimum speeds are 160 mm and 120 mm respectively. The mass of each ball is 4 kg and the mass of sleeve is 24 kg. Determine the range of speed of this governor. Also find the range of speed, if the friction at the sleeve is 18 N. *10*

(b) A shaft is required to transmit 40 kW at 300 r.p.m. The maximum torque may be 1·5 times the mean torque. The allowable twist is 1° per m length of the shaft. Determine the diameter of the solid shaft. *10*

(c) A column of 6 m length is fixed at both ends. It is of rectangular cross-section of 20 cm × 10 cm. Determine the Euler's crippling load on the column, if E = 200 GPa. *10*

(d) Determine the composition, in atom percent, of an alloy that consists of 97 wt% aluminium and 3 wt% copper. *10*

SECTION B

Q5. (a) Explain the variables influencing machinability. How is machinability assessed ? *8*

(b) Determine the material removal rate and the electrode feed rate in the electrochemical machining of an iron surface that is 10 mm × 10 mm in cross-section, using NaCl in water as electrolyte. The gap between the tool and workpiece is 0·25 mm. The supply voltage is 12 V DC. The specific resistance of the electrolyte is 4 Ω cm. For iron, atomic weight = 55·85, valency z = 2 and density ρ_a = 7860 kg/m^3. *8*

(c) Enlist the areas of project monitoring. What are the steps for project monitoring ? *8*

(d) An analysis of a company reveals the following sales and cost information :

Current capacity = 1,00,000 units

At current level of operations, its margin of safety is 5% of its break-even point, whereas contribution margin P/V ratio is 25% and unutilised capacity is 10,000 units. For the sale price of ₹ 40 per unit, determine the following : *8*

(i) Break-even point in sales volume

(ii) Fixed costs

(iii) Variable costs per unit

(iv) Margin of safety in units

(e) Define ROM, PROM, EPROM, EEPROM and RAM. *8*

Q6. (a) During orthogonal turning operation of a medium carbon steel rod with a carbide tool having orthogonal rake angle 10°, the following observations were made :

Width of the chip = 6 mm

Uncut chip thickness = 0·1 mm

Chip thickness ratio = 0·4

Horizontal component of cutting force = 1300 N

Vertical component of cutting force = 1650 N

Determine the component of cutting force along the rake face and shear plane. Also find out coefficient of friction, resultant force and shear stress. *15*

(b) Explain the features and policy guidelines for ABC analysis. A manufacturer has to supply his customer 3600 units of his product per year. Shortages are not permitted. Inventory carrying cost amounts to ₹ 1·2 per unit per annum. The set-up cost per run is ₹ 80. Compute the following : *15*

(i) Economic order quantity

(ii) Optimum number of orders per annum

(iii) Average annual inventory cost (minimum)

(iv) Optimum period of supply per optimum order

(c) Draw a flow chart for computation of simple interest for 3 sets of p, n, r. *10*

Q7. (a) While turning a mild steel rod with a HSS cutting tool at a feed of 0·3 mm/rev. and depth of cut of 3 mm, the following observations were made :

Cutting velocity	V,	$\frac{m}{min}$	20	30
Tool life	T,	min	70	40

Determine the cutting velocity, if desired tool life is 60 minutes. *10*

(b) A cylindrical pipe of mild steel with inside diameter 60 mm and thickness 2·5 mm is to be reduced down to 48 mm and thickness 1·75 mm. Consider die angle as 40° and coefficient of friction is 0·1. Compare the pipe drawing force on cylindrical plug and movable mandrel. *10*

(c) A company intends to buy a machine having a capacity to produce 1,70,000 quality parts per annum. The machine constitutes a part of the total product line. The system efficiency of the product line is 85%.

(i) Find the system capacity per hour.

(ii) The time required to produce each part is 100 seconds and the machine works for 2000 hours per year. If the utilization of the machine is 60% and the efficiency of the machine is 90%, compute the output of the machine per hour.

(iii) Calculate the number of machines required. *10*

(d) A linear programming problem is given subjected to the constraints

$5x_1 + x_2 \geq 10$

$x_1 + x_2 \geq 6$

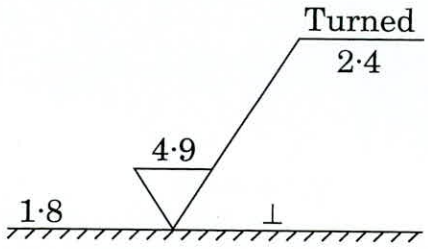
$x_1 + 4x_2 \geq 12$

$x_1, x_2 \geq 0$

For minimization of the function $z = 3x_1 + 2x_2$, plot each constraint on a graph paper and show the feasible region. *10*

Q8. (a) (i) Determine the dimensions of 'Go' and 'No Go' gauges of a plug gauge for checking 75 ± 0·05 mm diameter holes. Show the dimensions using Bilateral and Unilateral systems. Consider gauge maker's tolerance as 10% of work tolerance. *10*

(ii) What information can you obtain from the following surface roughness representation ? *5*



(b) A small project is composed of 7 activities whose time estimates are listed in the table below. Activities are identified by their beginning (i) and ending (j) node numbers.

Activity	Estimated duration (in weeks)		
(i – j)	Optimistic	Most likely	Pessimistic
1 – 2	1	1	7
1 – 3	1	4	7
1 – 4	2	2	8
2 – 5	1	1	1
3 – 5	2	5	14
4 – 6	2	5	8
5 – 6	3	6	15

(i) Draw the network diagram and critical path.

(ii) Find the expected duration and variance for each activity.

(iii) Find the expected project length. *15*

(c) Write a C-program using Array to find out the average marks obtained by a class of 50 students in a test conducted. *10*