

ENGINEERING SERVICES  
EXAMINATION-2016

0063468

Sl. No.

A-HUF-P-OEB

**MECHANICAL ENGINEERING**

**Paper II**  
**(Conventional)**

Time Allowed : Three Hours

Maximum Marks : 200

**INSTRUCTIONS**

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

*There are SEVEN questions divided under THREE sections.*

*Candidates are required to attempt FIVE questions in all.*

*In Section A, Question No.1 is compulsory.*

*In Section B, TWO out of THREE questions are to be attempted.*

*In Section C, TWO out of THREE questions are to be attempted.*

*The number of marks carried by a question/part is indicated against it.*

*Unless otherwise mentioned, symbols and notations have their usual standard meanings.*

*Assume suitable data, if necessary and indicate the same clearly.*

*Neat sketches are to be drawn to illustrate answers, wherever required.*

*All parts and sub-parts of a question are to be attempted together in the answer book.*

*Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.*

*Answers must be written in ENGLISH only.*

*Any page or portion of the page left blank in the answer book must be clearly struck off.*

## Section – A

(Answer *all* of the following parts)

(Each part carries 4 marks)  $4 \times 10 = 40$

1. (a) The crank of a crank and slotted lever quick return mechanism is driven at 120 rpm clockwise. The vertical distance between the centres of rotation of the crank and slotted lever is 50 cm. What should be the length of the crank if the quick return ratio is 1 : 2 ? Determine the angular velocity of the slotted lever, when the tool-post attains maximum velocity during cutting stroke.
- (b) Square key of side  $d/4$  and length  $l$  is used to transmit torque  $T$  from the shaft of diameter  $d$  to the hub of a pulley. Assuming the length of the key to be equal to the thickness of the pulley, find the average shear stress and crushing stress developed in the key.
- (c) A tapering bar having  $d_1$  and  $d_2$  as diameters of end sections and another bar of uniform cross-section  $d$  are of same length  $l$ . Both are subjected to the same axial pull  $P$ . What should be the value of  $d$  in terms of  $d_1$  and  $d_2$  so that both the bars of same material will have same extension ? Evaluate maximum stresses in both the bars.

- (d) In a cam-follower mechanism the follower needs to rise through 20 mm during  $60^\circ$  of cam rotation, the first  $30^\circ$  with a constant acceleration and then retardation of equal magnitude for next  $30^\circ$ . The cam rotates at uniform speed of 300 rpm. Find out the maximum velocity and acceleration of the follower during the rise period.
- (e) Through the temperature vrs carbon percentage diagram of steel, show the microstructures of various phases of steel.
- (f) In reference to primary processes of Powder Metallurgy, explain the following :
- (i) Blending
  - (ii) Compacting
  - (iii) Pre-sintering
  - (iv) Sintering
- (g) What is centreless grinding ? Explain with sketch. What is the difference w.r.t. cylindrical grinding ?
- (h) Illustrate the difference between
- (i) open die forging and
  - (ii) closed die forging with appropriate sketches.
- (i) Show in a figure location of the surface texture details when used with machining symbols.
- (j) With sketches describe any four types of point defects in metallic materials.

## Section – B

(Answer any two questions)

2. (a) A machine is driven by a motor, which delivers a constant torque. The resisting torque of the machine increases uniformly from 500 Nm to 1500 Nm through one revolution of the driving shaft and drops suddenly to 500 Nm again at the beginning of the next revolution. The mean speed of the machine shaft is 300 rpm. In order to maintain coefficient fluctuation of speed of the machine as 0.2, a solid circular steel disc of 25 mm thick is used as a flywheel. The mass density of steel is  $7800 \text{ kg/m}^3$ . Evaluate the diameter of the flywheel disc. 10

(b) A solid shaft of diameter  $d$  is used for power transmission. Due to modification of the existing transmission system, it is required to replace the solid shaft by a hollow shaft of the same material and equally strong in torsion. Further the weight of the hollow shaft per metre length should be half that of the solid shaft. Determine the outer and inner diameters of the hollow shaft if diameter of solid shaft,  $d = 40 \text{ mm}$ . 20

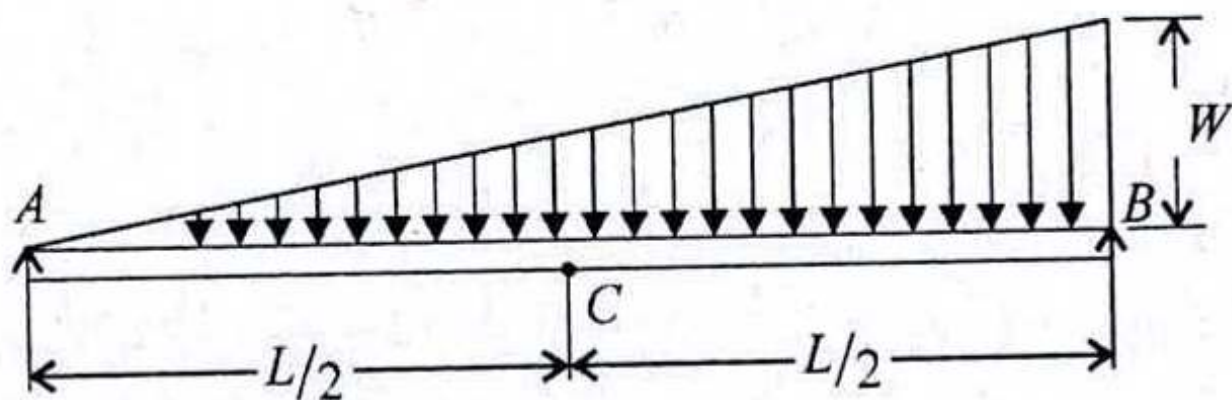
(c) A thin cylinder with closed ends has an internal pressure of  $6 \text{ MN/m}^2$ . The cylinder is of 50 mm internal diameter and 2.5 mm thick. It is also subjected to an axial pull of 10 kN and a torque of 500 Nm.

Determine the principal stresses in the cylinder and maximum shear stress. 10

3. (a) The cylinder axes of a V-engine are at  $90^\circ$  to each other. The mass of each piston is 2 kg and that of each connecting rod is 2.8 kg. The mass of rotating parts like crank webs and the crank pin is 1.8 kg. The connecting rod is 400 mm long and its centre of mass is 100 mm from crank pin centre. The stroke of the piston is 160 mm. Find the magnitude of the balancing mass for balancing primary unbalance force and its position, if its centre is placed at 100 mm from crank shaft centre. Whether secondary unbalance force is balanced or not? If not, what is the magnitude of resultant secondary unbalance force for the engine speed of 840 rpm? 10

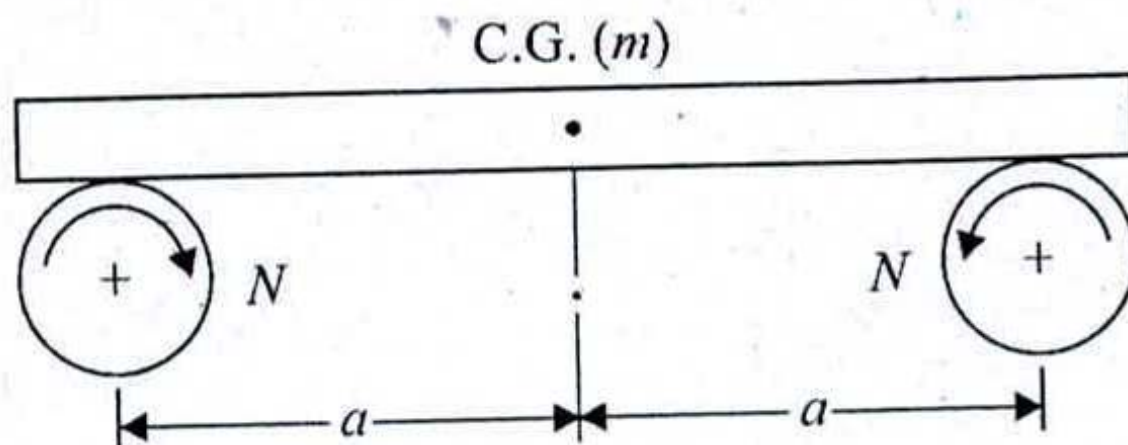
(b) Design a muff coupling to connect two steel shafts of same diameter in order to transmit 25 kW of power at 360 rpm. The shafts and keys are made of plain carbon steel 30C8 ( $S_{yt} = S_{yc} = 400 \text{ N/mm}^2$ ). The sleeve is made of grey cast iron FG 200 ( $S_{ut} = 200 \text{ N/mm}^2$ ). The factor of safety for the shafts and key is 4 and for the sleeve the same is 6 based on yield strengths and ultimate strengths respectively. The standard proportion for the sleeve of muff coupling is usually taken as external diameter =  $(2 \times \text{shaft diameter} + 13) \text{ mm}$ . Axial length of sleeve =  $(3.5 \times \text{shaft diameter})$ . Sketch the coupling showing all the dimensions of the shafts, sleeve and keys. Ensure safety of all components. 20

- (c) A simply supported beam  $AB$  of span  $L$  carries a distributed load of varying intensity as shown in figure below. Establish the equation for deflection curve for the beam at a distance  $x$  from the origin  $A$  of the beam. Determine the deflection of the beam at the mid-section  $C$  in terms of  $W$ ,  $L$ ,  $E$  and  $I$ , where  $EI$  is the flexural rigidity of the beam.



10

4. (a) A uniform plank of mass  $m$  is resting over two identical rollers rotating in the opposite directions as shown in figure below. The distance between the roller axes is  $2a$  and the rollers are spinning at same speed. The coefficient of friction between the plank and the rollers is  $\mu$ . Show that the plank will oscillate when its C.G. is displaced from the mid-point between the rollers. Develop the equation of motion of the plank in the direction of oscillation.



- (i) Determine the frequency of this oscillation.
- (ii) Investigate the motion of the plank, when the direction of rotation of both the rollers are reversed. 10
- (b) A pair of spur gears with  $20^\circ$  full-depth involute teeth consists of a 20 teeth pinion meshing with a 41 teeth gear. The module is 3 mm while the face width is 40 mm. The material for pinion as well as for gear is steel with an ultimate tensile strength of  $600 \text{ N/mm}^2$ . The gears are heat treated for a surface hardness of 400 BHN. The pinion rotates at 1450 rpm and the service factor for the application is 1.75. Assume that the velocity factor accounts for the dynamic load and the factor of safety is 1.5. Determine the rated power that the gears can transmit, taking Lewis form factor as 0.32. 10
- (c) A steel rod of 10 cm diameter is forced into a steel ring of 15 cm external diameter and 6 cm wide. Measured strain in the circumferential direction on the external surface of the ring is found to be  $1.55 \times 10^{-4}$ . Assuming coefficient of friction for the mating surfaces to be 0.25, estimate the force required to push the rod out of the ring. Use  $E = 200 \text{ GPa}$ . 10
- (d) Describe the properties of the following aluminium alloys :  
Duralumin, Y-alloy, Magnalium and Hindalium. 10

### Section – C

(Answer any two questions)

5. (a) Classify gating designs for pouring of metals into the mould cavity in a casting operation. Show them by sketches.

A mould of  $50 \text{ cm} \times 25 \text{ cm} \times 10 \text{ cm}$  has the provision of a top gating system with pouring height of 15 cm and cross-sectional area of the gate as  $5 \text{ cm}^2$ . Determine the filling time. 10

- (b) Name four types of resistance welding processes. Describe with sketch “Spot welding”. 10

- (c) Describe with sketches Ultrasonic Machining Process (USM) and the principle of metal removal by this. 15

- (d) Write the generalized Taylor’s tool life equation. Also write the simplified Taylor’s tool life equation.

During machining of low carbon steel with HSS tool, the following observations have been made :

Cutting speed, m/min	40	50
Tool life, min	40	10

Derive the V-T relationship.

5



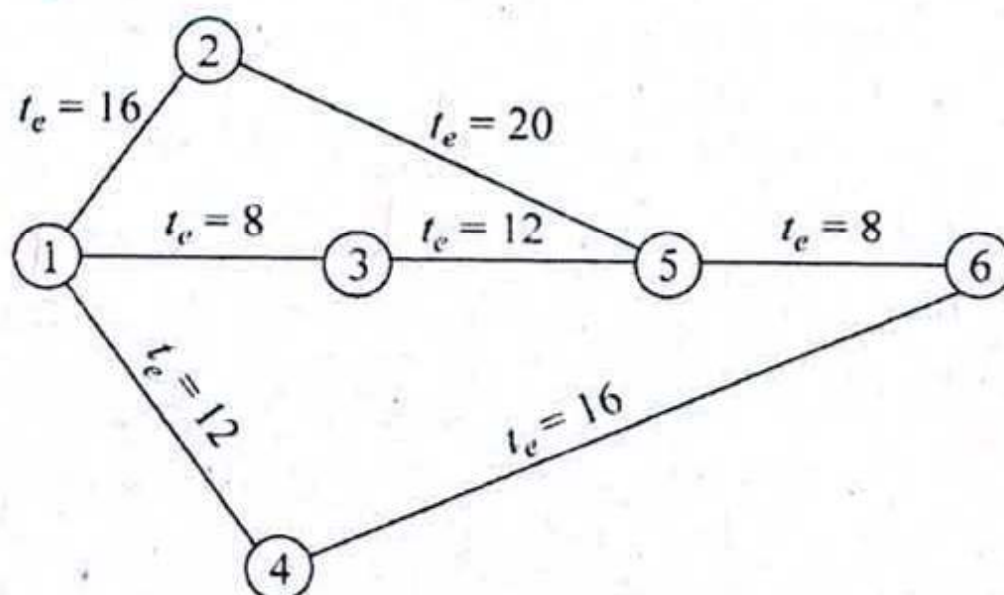
6. (a) (i) Distinguish between "Simple Moving Average" and "Weighted Moving Average" methods of forecasting.
- (ii) Demand for an item of a particular size and specification in the past six months, in a firm had been as follows :

January	February	March	April	May	June
600	700	800	800	900	1000

Compute a weighted 4 months moving average for July. 10

- (b) (i) Explain what is "Break Even Analysis" ? Demonstrate by a graphical representation.
- (ii) The Fixed costs of a company are ₹700,000. The net sales amount is ₹1,200,000 annually. The direct costs are 35% of sales in rupees. Determine the following :
- (I) "The Break Even Point" in terms of sales Rupees.
- (II) The sales required to earn a profit of ₹1,60,000.00. 15
- (c) (i) With respect to PERT Analysis define the following :
- Earliest Starting Time ( $T_E$ )  
 Latest Finish Time ( $T_L$ )  
 Slack, and  
 critical path

- (ii) Indicate the Earliest Starting and Latest Finish times on the following network and also indicate the critical path on it. The  $t_e$  values indicated are as per standard deviation.



15

7. (a) The sales of cars for an automobile manufacturing company for last five years are given below :

Year	Sales (Y) (No. of cars)	Demand index (X) (No. of cars)
2015	1800	2000
2014	1600	1500
2013	1500	1400
2012	1300	1100
2011	1100	1000

Find the relation between the demand index (X) and sale of cars (Y). Make a forecast for the year 2016; supposing the demand index rise to 2100. Use Least square method. 10

(b) Describe Laser Beam Machining (LBM). Give a detailed schematic diagram. Also discuss the Mechanics of LBM. 10

(c) Explain in detail "Wire Drawing" process. Give a detailed drawing of the set-up. What is the function of "Dog-Gripping tool" for this process? 10

(d) (i) For calculation of simple interest 3 sets of  $p$  = principal,  $n$  = no. of years and  $r$  = rate are given. Simple interest has to be calculated by using C-program. Draw a Flow chart using "Loop Control Structure".

(ii) Write a C-code to compute the volume and Area of a sphere using the formulas.

$$V = 4 \frac{\pi r^3}{3}$$

$$A = 4\pi r^2$$

10

