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Roll No.

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Candidate should write his/her Roll No. here.

Total No. of Questions : 03

No. of Printed Pages : 07

**M-SFS-I-2017 (11)**  
**MECHANICAL ENGINEERING**  
**(Optional Subject)**  
**First Paper**

Time : 3 Hours ]

[ Total Marks : 200

**Instructions to the candidates :**

1. This question paper consists of three questions and all questions are compulsory.
2. Marks for each question have been indicated on the right hand margin.
3. There is no internal choice in Question No. 1, remaining questions carry internal choice.
4. The first question is of very short-answer type consisting of 15 compulsory questions. Each one is to be answered in one or two lines. Question No. 2 is short answer type, word limit is 100. Question No. 3 is long answer/Essay type, word limit is 300.
5. Wherever word limit has been given, it must be followed to.
6. Question should be answered exactly in the order same as mentioned in the question paper. Answer to the various parts of the same question should be written together compulsorily and no answer of the other question should be inserted between them.

M/SFS/I/2017 (11)

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Question No. 1 is having 15 sub-question and each carries 4 marks. All questions are compulsory.

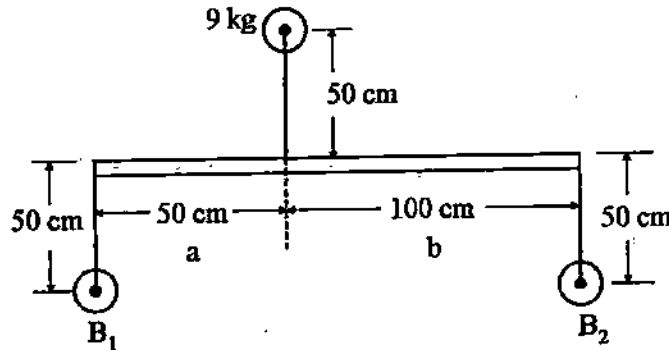
$$15 \times 4 = 60$$

1. (A) What is endurance limit ?
- (B) Draw Goodman diagram for fatigue loading.
- (C) What is pressure angle in gears ?
- (D) A thin cylindrical vessel of internal diameter  $d$  and thickness  $t$  is closed at both ends and is subjected to internal pressure  $P$ . How much would be the hoop stress and longitudinal stress in the material ?
- (E) What do you mean by self energizing brakes ?
- (F) Draw Mohr's circle for hydrostatic fluid.
- (G) What is the significance of bearing modules in the design of hydrodynamic bearings ?
- (H) What is the reason of using conical pin in locating a work having one hole in it ?
- (I) What is the purpose of providing side relief angle in single point cutting tool ?
- (J) What is the reason that when cutting speed increases beyond a certain value, the productivity keeps on decreasing ?
- (K) Why Beta distribution is assumed for activity time in PERT ?
- (L) What is the reasons of using  $\bar{X}$  charts in place of  $X$ -charts in quality control ?
- (M) Why tolerances are given to any product ?
- (N) What is the purpose to tool guiding elements in Jigs ?
- (O) What is the purpose of adding Mn in steel ?

2. Write the answer of any 10 questions from the following questions :  $10 \times 8 = 80$

- (A) Determine the elongation of a circular tapered bar at length 'L' under axial load P, if the diameter increases uniformly from  $D_1$  to  $D_2$ .
- (B) A hollow shaft of 200 mm external and 100 mm internal diameters is transmitting power at 50 rpm. If the maximum torque transmitted is 40% greater than mean value and maximum allowable shear stress in the shaft material is 60 MPa, determine the maximum angle of twist, if the length of the shaft is 5 metre. Take rigidity modulus  $G = 80$  GPa. Also, find the power transmitted.
- (C) A clutch plate having two contacting surfaces is required to transmit 140 kW at 1250 rpm. The outer diameter of the contact surface is to be 300 mm. The coefficient of friction is 0.4. Assuming a uniform pressure of  $0.17 \text{ N/mm}^2$ , determine the inner diameter of the friction lining.
- (D) A beam of rectangular section of depth 'd' is simply supported at ends and is subjected to a uniformly distributed load over its entire span 'L'. If the maximum deflection in the beam is restricted to  $\frac{L}{400}$  and the stress in the beam is not to exceed 120 MPa, calculate the maximum value of 'd' in terms of 'L'. Take  $E = 210$  GPa.
- (E) The torque exerted on the crank shaft of a 2 stroke engine can be described as  $T(N - m) = 10000 + \sin 2\theta - 1200 \cos 2\theta$ , where  $\theta$  is the crank angle as measured from inner dead centre. Assuming resisting torque to be constant, find the power developed by the engine at 100 rpm.

- (F) Masses  $B_1$ ,  $B_2$  and 9 kg are attached to a shaft in parallel planes as shown in figure. If the shaft is rotating at 100 rpm, find mass  $B_2$  for complete balance.



- (G) A ladder is placed against a frictionless wall at an inclination of  $60^\circ$  with horizontal, is in a state of limiting equilibrium. The ladder has a length of 13 m and a uniform mass of 4 kg/m. Find the coefficient of friction between ladder and the floor.

- (H) Assume that the following specify a generalized linear programming problem :

$$\text{Min } Z = 3x_1 + 2x_2$$

$$\text{Subjected to } 2x_1 + x_2 \leq 2$$

$$3x_1 + 4x_2 \geq 12$$

$$x_1, x_2 \geq 0$$

Solve by using Simplex procedure.

- (I) A job arrives in a machine shop following a Poisson distribution with a mean rate of 1 per hour. If the average time to complete the job is 30 min, what is the probability that atleast 2 jobs will be waiting always ?
- (J) Elaborate on the significance of end relief angle on single point cutting tool.

- (K) How will you carry out the acceptance test of whether line of centre of work piece is parallel to the spindle axis ?
- (L) Prove the formula of optimum cutting speed for maximum production rate in economics of machining.

$$V_{\text{opt}} = \frac{C}{\left\{ \left( \frac{1}{n} - 1 \right) T_c \right\}^n}$$

$T_c$  = tool changing time

$n$  = tool life exponent

$c$  = machining constant

- (M) A 35 mm diameter shaft and bearing are to be assembled with a clearance fit. The tolerances and allowance are as under :

Allowance = 0.003 mm

Tolerance on hole = 0.007 mm

Tolerance on Shaft = 0.002 mm

Find the limits of size for the hole and shaft, if

(a) hole basis system is used.

(b) shaft basis system is used.

The tolerances are disposal unilaterally.

3. Write the answers of any 3 questions :

3 × 20 = 60

- (A) In order to evaluate mass moment of inertia of connecting rod, following observations were made :

Mass of connecting rod = 50 kg.

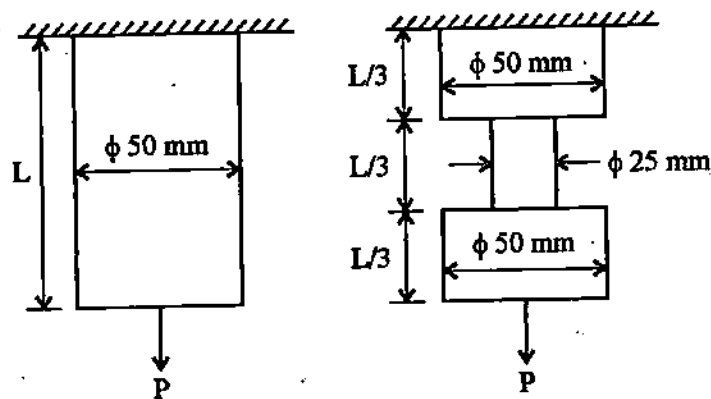
Distance between big end bearing and small end bearing is 1000 mm.

Diameter of big end bearing is 100 mm. Diameter of small end bearing is 50 mm.

Time period of oscillations when suspended from big end is 1.75 sec and when suspended from small end is 2 sec.

Determine the mass moment of inertia of connecting rod.

- (B) Compare the strain energies of the two bars A and B of the same material when subjected to the same axial tensile loads. Bars A and B are shown in the figure. Also compare their proof resilience in simple tension.



- (C) During turning of a mild steel rod of 160 mm diameter by using a single point cutting tool having signature  $0 - 0 - 10 - 8 - 15 - 15 - 0 \text{ mm}$  (ASA) following data was observed :

Speed (N) = 400 rpm

Feed (f) = 0.32 mm/rev

Depth of cut = 4.00 mm

Cutting force = 1200 N

Feed force = 800 N

Chip thickness ( $t_c$ ) = 0.8 mm

Calculate :

- Friction (F) and Normal friction force (N)
- Yield shear strength of the work material ( $\tau_s$ )
- Cutting power in kW.

(D) The following data refer to a two cylinder uncoupled locomotive :

Rotating mass per cylinder	= 289 kg
Reciprocating mass per cylinder	= 300 kg
Distance between wheels	= 1400 mm
Distance between cylinder centres	= 600 mm
Diameter of treads of driving wheels	= 1800 mm
Crank radius	= 300 mm
Radius of centre of balance mass	= 620 mm
Locomotive speed	= 50 km/hr
Angle between cylinder cranks	= $90^\circ$
Dead load on each wheel	= 3.5 tonnes

It is desired to balance whole of the revolving and two-third of the reciprocating mass.

Determine :

- (i) the swaying couple
- (ii) the variation in the tractive force
- (iii) the hammer blow, if balance mass for reciprocating part is 74.46 kg

