Engg. Services Exam. 2011

12901

D-RSR-L-ZRB

MECHANICAL ENGINEERING

Paper II

(Conventional)

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

INSTRUCTIONS

Candidates should attempt Question No. 1 in Section A which is compulsory, TWO questions from Section B and TWO questions from Section C.

Question No. 1 is of short answer type.

The number of marks carried by each subdivision of a question is indicated at the end of the subdivision/question.

Answers must be written only in ENGLISH.

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

Unless otherwise indicated, symbols and notations used have their usual meanings.

Neat sketches to be drawn, wherever required.

SECTION A

2×20=40

1. (a) (i) Define "Stability" and "Isochronism" for spring-controlled governors.

(ii) Draw the controlling force vs. radius of rotation of governor balls for unstable, stable and isochronous governors.

(b) A crank and slotted lever Quick Return Motion Mechanism used in a shaping machine has a distance of 200 mm between the centre of oscillation 'A' of the slotted lever and the centre of rotation 'B' of the crank. The radius of the crank BC is 100 mm.

(i) Show on a diagram the extreme positions of the lever AD during one complete rotation of the crank.

(ii) Find the ratio of the time of cutting to the time of the return stroke.

(c) (i) What is critical damping for a spring, dashpot and mass vibrating system ?

(ii) Such a system has mass m = 10 kg, spring stiffness k = 4000 N/m and damping coefficient c = 40 N/m/s. Find the critical damping coefficient, and the damping factor ζ.

(d) A tapered bar 200 mm long, tapers uniformly from a diameter of 40 mm to a diameter of 20 mm over its axial length. If an axial compressive force of 10 kN is applied on the bar, what is the strain energy absorbed in the bar ? E = 100 kN/mm^2.

(e) A cantilever AB, 5 m long is fixed at end A. At end B, an upward load of 2 kN is applied. At point C, 2 m from end B, a downward load of 2 kN is applied. Draw the bending moment diagram of the cantilever.

(f) A thin cylindrical shell of diameter 200 mm, wall thickness t is subjected to an internal pressure of 2 N/mm^2. The longitudinal joint efficiency of the shell is 80%. What should be the minimum wall thickness of shell, if allowable stress in shell is limited to 100 MPa ?

(g) Explain how grain refinement improves the strength of a polycrystalline material.

(h) Stub tooth spur gears are preferred for medium and heavy duty applications. Justify this statement in about twenty words.

(i) Which theory of failure will result in economic shaft design ?

(j) Why are V-belts used in short centre drives ?

(k) What is meant by allotropism ? What is its importance ?

(l) List four undesirable affects of decarburization of steels after heat treatment.

(m) Name four fibre materials generally used in metal-matrix composites.

(n) Enumerate four defects caused due to residual stresses in welded joints.

(o) What is isostatic pressing of metal powders ? What are its advantages ?

(p) What is critical ratio in scheduling ? What is the meaning of critical ratio scheduling value of 2 ?

(q) What are the steps involved in method study ?

(r) What are the methods of finding initial solution in transportation problems ?

(s) A company purchases a product at ₹ 50 per unit and sells it at ₹ 90 per unit. The hiring charges for storing the unit are ₹ 20,000. Determine the number of units to be sold to achieve break-even. If the company sells 750 units, calculate the margin of safety.

(t) An array of 50 integer numbers is to be read by using Fortran program. Write the program lines for the same.

SECTION B

2. (a) Three steel tubes of outer diameter 20 mm and inner diameter 16 mm each are welded together so that their centres form an equilateral triangle of side 20 mm. Three meter length of this composite tube is used as a simply supported beam at ends with a central point load. How much point load can be applied if the maximum stress in beam sections is not to exceed 100 MPa ? *10*

(b) Two bevel gears A and B (having 60 teeth and 40 teeth, respectively) are rigidly mounted on two co-axial shafts X and Y as shown in Figure 2(b). A bevel gear C (having 50 teeth) meshes with A and B and rotates freely on one end of an arm. At the other end of the arm is welded a sleeve and the sleeve is riding freely loose on the axes of the shafts X and Y. If the shaft X rotates at 120 r.p.m. clockwise and the arm rotates at 120 r.p.m. anticlockwise, find the speed of shaft Y. *10*

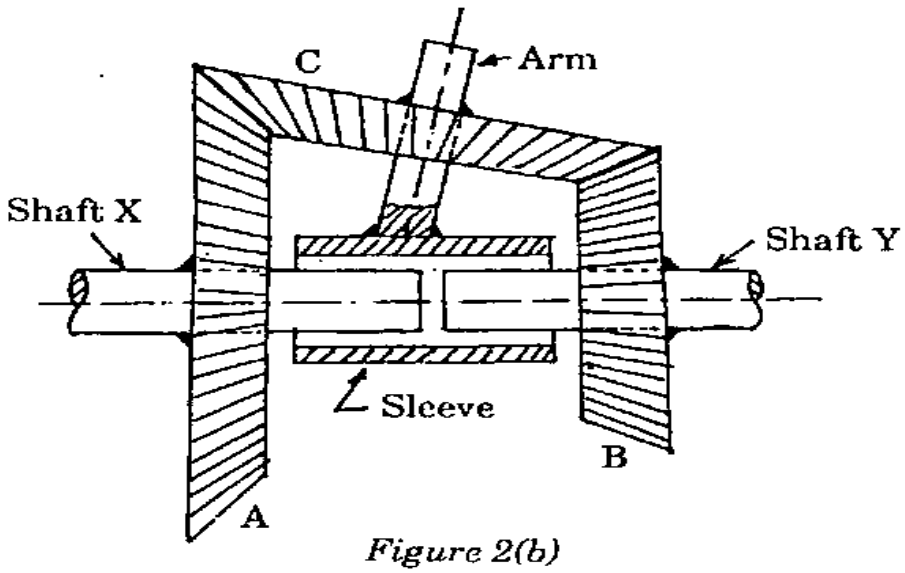

Figure 2(b)

(c) A hollow shaft whose ratio of internal diameter to external diameter (k) is 0·5, transmits 1·5 kW at 1400 rpm. At a certain section it is also subjected to a bending moment of 5 N.m. The shaft is to be made from chrome-vanadium steel having allowable shearing stress of 200 MPa. Design the shaft using the ASME code formula for transmission shafting as given below :

D_o (outer diameter) =

$$\left[\frac{16}{\pi \times \tau_{all}} \left(C_m . M^2 + C_t . T^2\right) \times \frac{1}{1 - k^4}\right]^{1/3}$$

Combined shock and fatigue factor for bending moment (C_m) is 1·5.

Combined shock and fatigue factor for torque (C_t) = 1·0.

Determine the internal and outer diameter of the shaft. *15*

(d) What are superalloys ? Name 3 superalloys. Give composition of Nimonic alloy. *5*

3. (a) Design a close coiled helical spring to have spring index of 8. Axial deflection in spring is not to exceed 100 mm under an axial load of 2600 N and shear stress developed in spring is not to exceed 300 N/mm^2. Steel wires are available in diameters of 10, 11, 12, 13, 14 mm (in steps of 1 mm). Determine most suitable wire diameter, mean coil diameter and number of coils in spring. Given G = 84000 N/mm^2. *10*

(b) A two-cylinder uncoupled locomotive has inside cylinders 70 cm apart, the cranks are at right angles and are each 0·3 m long. The mass of the revolving parts per cylinder is 160 kg and the mass of the reciprocating parts per cylinder is 180 kg. The whole of the revolving and two-thirds of the reciprocating parts are to be balanced and the balance masses are to be placed in the planes of rotation of the driving wheels at a radius of 80 cm. The driving wheels are 2 m diameter and 1·5 m apart.

Find the magnitude and position of the balance masses. The driving crank speed is 300 r.p.m. *15*

(c) Draw a neat sketch of a cotter joint and show how its various elements are likely to fail under tensile loading. Give one engineering application of this joint. *5+4+1*

(d) What is Bauschinger's effect ? Make a neat sketch of stress-strain diagram and explain how yield strength in compression is reduced than the yield strength in tension. *5*

4. (a) Considering principal stresses in a steam boiler drum as p, 0·5p, 0 and Poisson's ratio ν = 0·30, equivalent stress in simple tension as σ, find p in terms of σ due to (i) maximum shear stress theory, (ii) strain energy theory, (iii) distortion energy theory. *10*

(b) A steam engine develops 300 kW at 120 r.p.m. The coefficient of fluctuation of energy as found from the turning moment diagram is to be 0·1 and the fluctuation of speed is to be kept within ±1% of the mean speed. Find the mass of the flywheel required, if the radius of gyration is 2 m. *10*

(c) (i) What are common modes of failure of rolling element bearings ?

(ii) Write a brief comment on the holding torque acting on epicyclic gear train casings. *5+5*

(d) What is ductile SG iron ? What is the purpose of adding magnesium or cerium in molten metal ? Why is its tensile strength more than the tensile strength of grey cast iron ? When the metal is cooled fast from molten state, what type of microstructure is obtained ? Make an approximate sketch of microstructure indicating the microconstituents. *10*

SECTION C

5. (a) A 12·5 mm diameter rod is to be reduced to 10 mm diameter by drawing in a single pass at a speed of 100 m/min. Assuming a die angle of 5° and coefficient of friction between the die and steel rod as 0·15, calculate :

(i) the power required in drawing.

(ii) maximum possible reduction in diameter of the rod.

(iii) if the rod is subjected to a back pressure of 50 N/mm^2, what would be the draw stress and maximum possible reduction ?

Take stress of the work material as 400 N/mm^2. *15*

(b) A round casting is 20 mm in diameter and 50 mm in length. Another casting of the same metal is elliptical in cross-section, with a major to minor axis ratio of 2, and has the same length and cross-sectional area as the round casting. Both pieces are cast under the same conditions. What is the difference in the solidification times of the two castings ? *10*

(c) Discuss the process capabilities and applications of Gas Metal Arc Welding, Gas Tungsten Arc Welding, and Diffusion Bonding processes. *15*

6. (a) Discuss the effects of the following elements on the machinability of steels : 5

(i) Aluminium and Silicon

(ii) Sulphur and Selenium

(iii) Lead and Tin

(iv) Carbon and Manganese

(v) Molybdenum and Vanadium

(b) Discuss the effects of inefficient dielectric and electrolyte circulation in the inter-electrode gap on the Electric Discharge Machining and Electro Chemical Machining processes respectively. 5

(c) Why are tools coated ? What are the common coating materials ? 5

(d) What is creep feed grinding ? Discuss its salient features, advantages, and application. 10

(e) With the help of a neat sketch, explain the working of a diamond pin locator. 5

(f) (i) State the methods of defining line segment of cutter motion using APT program format 5

(ii) The table of a CNC machine is driven by a Lead screw which is rotated by a DC servomotor. A digital encoder which emits 1000 pulses per second is mounted on the lead screw as a feedback device. If the lead screw pitch is 6 mm and motor rotates at 500 rpm, find

1. Basic Length Unit (BLU) of the system.
2. Linear velocity of the table.
3. Frequency of pulses generated by the feedback device. 5

7. (a) A machine is used for turning operation and it takes 30 minutes to machine the component. Efficiency of the machine is 80% and scrap is 25%. The desired output is 1200 pieces per week. Considering 40 hours per week and 50 weeks in a year, determine the number of machines required in a year. *5*

(b) Draw the flow chart for solving assignment problems by Hungarian method. *15*

(c) Explain least square method of forecasting. *10*

(d) Group the following variables as integer and real variables in FORTRAN program language : *10*

(i) NSUM

(ii) KMAX 2

(iii) DIA 24

(iv) LOAD 3

(v) THETA 5

(vi) COS

(vii) EPSON

(viii) RUPEE

(ix) NUMR

(x) MOMENT