USN | | | | | | | | | | | **06ME52**

Fifth Semester B.E. Degree Examination, May/June 2010
Design of Machine Elements - I

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Use of design data hand book is permitted.

PART – A

1 a. Sketch and explain, biaxial and tri-axial stresses, stress tensor and principal stresses. **(06 Marks)**

b. The state of stress at a point in a structural member is shown in Fig.Q1(b). The tensile principal stress is known to be 84 N/mm^2. Determine i) the maximum shearing stress at the point and orientation of its plane ii) the shearing stress τ_{xy}. **(10 Marks)**

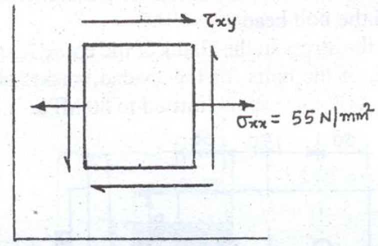

Fig.Q1(b)

c. Briefly discuss the factors influencing the selection of suitable material for machine element. **(04 Marks)**

2 a. A round rod of diameter 30mm is to sustain an axial compressive load of 20 kN and twisting moment of 1.5 kN.m. The rod is made of carbon steel C40 (σ_{yt}=328.6 MPa). Determine the factor of safety as per following theories of failure:
   i) Maximum principal strain theory.
   ii) Maximum elastic strain energy theory. **(08 Marks)**

b. A flat plate subjected to a tensile force of 5 kN is shown in Fig.Q2(b). The plate material is grey cost iron having σ_u value of 200 MPa. Determine the thickness of the plate. Factor of safety is 2.5 **(08 Marks)**

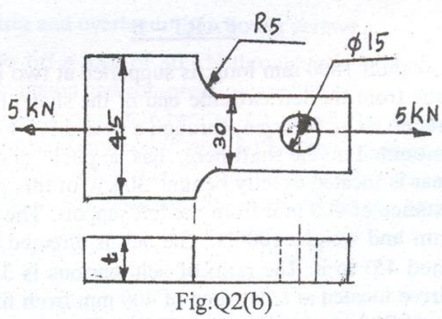

Fig.Q2(b)

c. Determine the maximum torsional impact that can withstand, without permanent deformation by a 100mm cylindrical shaft 5 m long and made of SAE 1045 annealed steel (τ_y = 180 MPa and G = 82 GPa). Factor of safety = 3. **(04 Marks)**

3 a. Derive the Soderberg's equation

$$\frac{1}{N}=\frac{\sigma_m}{\sigma_y}+K_{f_t}\frac{\sigma_a}{A\cdot B\cdot C\cdot \sigma_{en}}$$

where A is surface finish factor, B is size factor and C is the load factor. **(06 Marks)**

b. A hot rolled steel shaft is subjected to a torsional moment that varies from 330 Nm (clockwise) to 110 Nm (counter clockwise) as the applied bending moment at the critical section varies from +440 Nm to –220 Nm. The shaft is of uniform cross section and no key way is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 MPa and yield strength of 410 MPa. Take the endurance limit as half the ultimate strength, factor of safety = 2, size factor of 0.85 and a surface finish factor of 0.62. **(14 Marks)**

4 a. An M20×2 steel bolt, 100mm long is subjected to an impact load. The energy absorbed by the bolt is 2 N.m. Take E = 206 GPa.

i) Determine the stress in the shank of the bolt if there is no threaded portion between the nut and the bolt head.

ii) Determine the stress in the shank if the entire length of the bolt is threaded. **(08 Marks)**

b. Determine the size of the bolts for the loaded bracket shown in Fig.Q4(b), if the allowable tensile stress in the bolt material is limited to 80 MPa. **(12 Marks)**

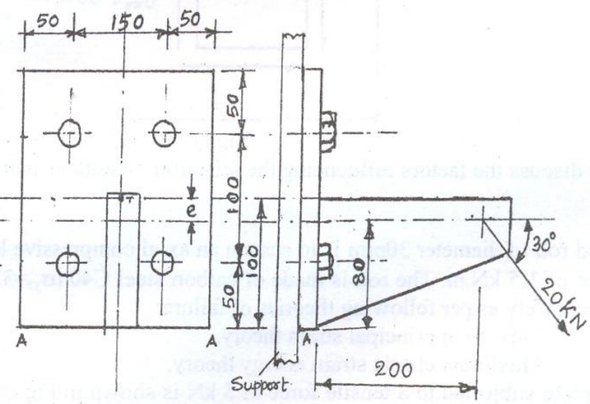

Fig.Q4(b)

PART – B

5 A power transmission shaft 1800 mm long, is supported at two points A and B. Whereas A is at a distance of 300 mm from the left extreme end of the shaft, B is at the right extreme end. A power of 50 kN is received at 500 rpm, through a gear drive located at the left extreme end of the shaft. The gear mounted on the shaft here, has a pitch diameter of 300 mm and weighs 700 N. The driver gear is located exactly behind. 30 kW of this power is given out through a belt drive located at a distance of 600 mm from the left support. The pulley mounted on the shaft has a diameter of 400 mm and weighs 1000N. The belt is directed towards the observer below the horizontal and inclined 45° to it. The ratio of belt tensions is 3. The remaining power is given out through a gear drive located at a distance of 400 mm from the right support. The driver gear has a pitch diameter of 200 mm and weighs 500 N. The driven gear is located exactly above. Selecting C40 steel (σ_y = 328.6 MPa) and assuming factor of safety 3, determine the diameter of a solid shaft for the purpose. Take k_b = 1.75 ; k_t = 1.5 & pressure angle ϕ = 20° for both the gears. **(20 Marks)**

6 a. Design a protected type cast iron flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted to be 20% greater than the full load torque. The allowable shear stress in the bolt is 60 MPa and allowable shear stress in the flange is 40 MPa. **(10 Marks)**

b. Design a sleeve type cotter joint, to connect two tie rods, subjected to an axial pull of 60 kN. The allowable stresses of C30 material used for the rods and cotters are $\sigma_t = 65$ N/mm^2; $\sigma_c = 75$ N/mm^2; $\tau = 35$ N/mm^2 ; cast steel used for the sleeve has the allowable stresses $\sigma_t = 70$ N/mm^2; $\sigma_c = 110$ N/mm^2; $\tau = 45$ N/mm^2 . **(10 Marks)**

7 a. The lengths of a flat tie bar, 15mm thick, are connected by a butt joint with equal cover plates on either side. If 400 kN is acting on the tie bar, design the joint, such that the section of the bar is not reduced by more than one rivet hole. Working stresses for the material of the bar are 85 MPa in tension, 60 MPa in shear and 110 MPa in crushing. **(10 Marks)**

b. A 16mm thick plate is welded to a vertical support by two fillet welds as shown in Fig.Q7(b). Determine the size of weld, if the permissible shear stress for the weld material is 75 MPa. **(10 Marks)**

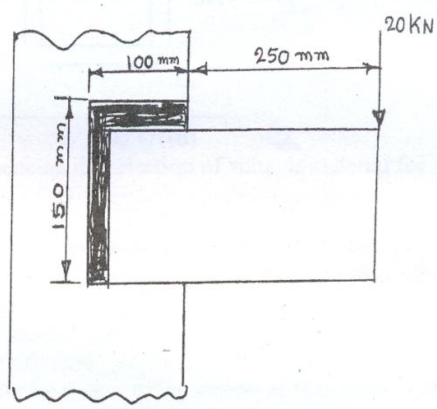

Fig.Q7(b)

8 a. Explain self locking and overhauling in power screws. **(04 Marks)**

b. A screw jack is to lift a load of 80 kN through a height of 400 mm. Ultimate strengths of screw material in tension and compression are 200 N/mm^2 and in shear it is 120 N/mm^2. The material for the nut is phosphor bronze for which the ultimate strength is 100 N/mm^2 in tension, 90 N/mm^2 in compression and 80 N/mm^2 in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm^2. Design the screw and the nut and check for the stresses. Take FOS = 2. Assume 25% overload for the screw rod design. **(16 Marks)**

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Fifth Semester B.E. Degree Examination, May/June 2010
Dynamics of Machines

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What is "principle of virtual work"? Explain. **(04 Marks)**

b. For the mechanism shown in Fig. Q1(b), determine the torque on the link AB for static equilibrium of the mechanism. Given, AB = 20 mm, BC = 60 mm, CD = 35 mm, AD = 50 mm, BE = 45 mm, CE = 20 mm and DG = 25 mm. **(16 Marks)**

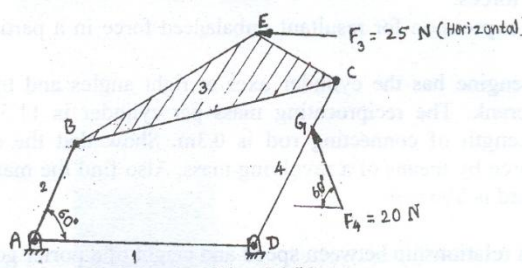

Fig. Q1(b)

2 a. State and explain D'Alembert's principle. **(04 Marks)**

b. Show that the coefficient of fluctuation of speed in a fly wheel is given by $k\frac{e}{Iw^2}$, where, e is the fluctuation of energy, I is the moment of inertia and w is the mean speed. **(04 Marks)**

c. The turning moment diagram of a four-stroke engine is assumed to be represented by four triangles, the areas of which from the line of zero pressure are :
Suction stroke = 440 mm^2 (Negative)
Compression stroke = 1600 mm^2 (Negative)
Expansion stroke = 7200 mm^2 (Positive)
Exhaust stroke = 660 mm^2(Negative)
Each sq. mm. of area represents 3N – m of energy. If the resisting torque is uniform, determine the mass of rim of the flywheel to keep the speed between 218 and 222 rpm. Mean radius of the rim is 1.25 m. **(12 Marks)**

3 a. Derive an expression for frictional torque in a flat pivot bearing. Assume uniform pressure across the bearing surface. **(06 Marks)**

b. Show that the linear velocity of the belt in a belt drive, for maximum power transmission, is given by $\upsilon = \sqrt{\frac{T}{m}}$, where, T= maximum allowable tension in the belt, and m = mass per unit length of the belt. **(04 Marks)**

c. An open belt drive is required to transmit 10 kW from a motor running at 600 rpm. Diameter of the driving pulley is 250 mm and speed of driven pulley is 220 rpm. The belt is 12 mm thick and has a mass density of 0.001 g/mm^3. Safe stress in the belt is not to exceed 2.5 N/mm^2 The two shafts are 1.25 m apart. The coefficient of friction is 0.5. Determine the width of belt. **(10 Marks)**

4 a. Explain static and dynamic balance of a system of revolving masses. **(06 Marks)**
b. Why two masses in different planes are necessary to rectify dynamic unbalance? **(04 Marks)**
c. A system of four revolving masses A, B, C and D is completely balanced. Masses C and D make angles 90° and 195° respectively, with B in the same sense. Planes B and C are 250 mm apart. The radius of rotation of the four masses are 150 mm, 200 mm, 100 mm, and 180 mm respectively. Masses B, C and D are 25 kg, 40 kg and 35 kg respectively. Determine : i) Mass A and its angular position with mass B, ii) Axial positions of planes A and D. **(10 Marks)**

PART – B

5 a. Explain the direct and reverse crank method of analysis of radial engines for primary and secondary forces. **(06 Marks)**
b. Derive an expression for resultant unbalanced force in a partially balanced single cylinder engine. **(04 Marks)**
c. A v-twin engine has the cylinder axes at right angles and the connecting rods operate a common crank. The reciprocating mass per cylinder is 11.5 kg and the crank radius is 75 mm. Length of connecting rod is 0.3m. Show that the engine may be balanced for primary force by means of a revolving mass. Also find the maximum secondary force if the engine speed is 500 rpm. **(10 Marks)**

6 a. Establish a relationship between speed and height of a porter governor, taking friction on the sleeve into account. **(08 Marks)**
b. In a porter governor, each of the four arms is 400 mm long. The upper arms are pivoted on the axis of the sleeve, whereas the lower arms are attached to the sleeve at a distance of 45 mm from the axis of rotation. Each ball has a mass of 8 kg and the load on the sleeve is 60 kg. Determine the range of speed of the governor for extreme radii of rotation of 250 mm and 300 mm. **(12 Marks)**

7 a. Derive an expression relating the angle of heel and linear velocity for dynamic stability of a two wheel vehicle, negotiating a curve. **(10 Marks)**
b. The turbine rotor of a ship has a mass of 2200 kg and rotates at 1800 rpm clockwise when viewed from the stern. The radius of gyration of rotor is 320 mm. Determine the gyroscopic couple and state its effect when :
i) The ship steers to the right at a speed of 25 kmph in a curve of radius 250 m
ii) The ship pitches, with the bow rising at an angular velocity of 0.8 rad/s. **(10 Marks)**

8 a. Find the velocity and acceleration of a roller follower operated by a tangent cam when the roller is making contact :
i) On the flank, ii) With the nose. **(12 Marks)**
b. A tangent cam with straight working faces tangential to a base circle of 120 mm diameter has a roller follower of 48 mm diameter. The nose circle radius of the cam is 12 mm and the angle between the tangential faces of the cam is 90°. If the speed of the cam is 180 rpm, determine the acceleration of the follower when :
i) During lift, the roller just leaves the straight flank
ii) The roller is at the top of the nose. **(08 Marks)**

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Fifth Semester B.E. Degree Examination, May/June 2010

Energy Engineering

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. With the help of a neat diagram, explain the working of spreader stoker. State the limitations of it. **(10 Marks)**

b. Explain the working of a cyclone furnace with a neat diagram. State its important merit and limitation. **(10 Marks)**

2 a. Draw a neat diagram of Schmidt – Hartmann boiler and explain its working. Indicate the direction of the flow of fluids on the figure. **(10 Marks)**

b. A steam generator operates under the following conditions.
Steam condition at boiler outlet : 16 bar, 250°C
Feed water temperature : 30°C
Steam generation rate : 30 tonnes per hour
Overall efficiency of the boiler : 80%
Air – fuel ratio by mass : 16.35
Required draught at the base of chimney : 1.96 kPa
Calorific value of the fuel used : 44 MJ/kg
Exhaust gas temperature at the exit of the boiler : 347°C.
Average temperature of gas in chimney : 327°C
Pressure and temperature of the atmosphere : 96 kPa, 27°C
Neglecting the velocity of gases at stack exit, determine the height of the stack and the diameter at its base. Use the following data:
At 16 bar, 250°C , $h_{sup} = 2917$ kJ/kg
At ts = 30°C , $h_f = 125.71$ kJ/kg. **(10 Marks)**

3 a. Explain the necessity of the cooling system in a diesel engine. With the help of neat diagrams, explain the working principle of i) Thermostat cooling and ii) Thermosiphon cooling. **(15 Marks)**

b. Explain briefly five important applications of diesel engines in power field. **(05 Marks)**

4 a. State the important factors to be considered while selecting the site for hydro-electric power plant. **(05 Marks)**

b. Draw a neat flow sheet diagram of a hydro-electric power plant indicating the essential elements. **(05 Marks)**

c. At a particular site the mean discharge (in millions of m^3) of a river in 12 months from January to December are 30, 25, 20, 0, 10, 50, 80, 100, 110, 65, 45 and 30 respectively. Draw the flow duration curve on graph sheet. Also estimate the power developed in MW if the available head is 90 m and the overall efficiency of generation is 87.4%. Assume each month of 30 days. **(10 Marks)**

PART – B

5 a. With the help of a neat diagram, explain the working of pressurized water reactor. (08 Marks)

b. State atleast three important merits and three main disadvantages of gas cooled reactor. (06 Marks)

c. Explain clearly about the disposal of radioactive wastes at nuclear power plants. (06 Marks)

6 a. Explain briefly the main applications of solar ponds. (06 Marks)

b. Draw neat figures and label the parts of :

i) Horizontal axis wind machine and

ii) Vertical axis wind machine. (06 Marks)

c. A horizontal shaft, propeller type wind turbine is located in area having the following wind characteristics:

Speed of wind 10 m/s at 1 atm and 15°C. Calculate the following:

i) Total power density in wind stream, w/m^2

ii) Maximum possible obtainable power density in w/m^2

iii) Actual obtainable power density in w/m^2 assuming 40% efficiency.

iv) Total power from the wind turbine of 120 m diameter. (08 Marks)

7 a. State atleast four important limitations of tidal power generation. (04 Marks)

b. Explain clearly the principle of OTEC focusing with any example on carnot and actual efficiencies. (06 Marks)

c. With a schematic flow diagram describe the working of a vapour dominated power plant. Also state the environmental problem associated with geothermal energy conversion. (10 Marks)

8 Write notes on the following:

a. Solar radiation at the earth surface

b. Energy plantation

c. Effect of temperature on biogas generation

d. Biogas plant. (20 Marks)

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USN | | | | | | | | | | | **06ME55**

Fifth Semester B.E. Degree Examination, May/June 2010
Turbomachines

Time: 3 hrs.   Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO questions from Part – A and TWO questions from Part - B.***
2. ***Use of Thermodynamic data hand book is permitted.***

PART - A

1 a. Define a turbo machine. Explain the principal components of a turbo machine. **(06 Marks)**
b. With the help of h – s diagram, explain various efficiencies of power generating turbo machines. **(06 Marks)**
c. Obtain an expression for T, using dimensional analysis, where T is the frictional torque of a disc of diameter D rotating at a speed N in a fluid of viscosity μ and density ρ in a turbulent flow. **(08 Marks)**

2 a. Representing all the components of velocity in a generalized turbo machine diagram, derive Euler turbine equation. **(06 Marks)**
b. Derive an expression for the utilization factor for an axial flow impulse turbine stage which has equiangular rotor blades, in terms of the fixed inlet blade angle and speed ratio and show the variation of utilization factor and speed ratio in the form of a graph. **(08 Marks)**
c. Determine the energy input to the fluid for a mixed flow pump for the given data :
i) Inlet hub diameter = 7cm ii) Speed : 50 rps iii) Impeller tip diameter = 28cm iv) $V_{axi} = V_{rad.out}$. Assume that the relative velocity at the exit equals the inlet tangential blade speed. **(06 Marks)**

3 a. Define degree of reaction for an axial flow machine. Prove that degree of reaction for an axial flow device (assuming constant velocity of flow) is given by $R = \frac{V_f}{2U}\left(\frac{\tan\beta_1 + \tan\beta_2}{\tan\beta_1 \tan\beta_2}\right)$. **(10 Marks)**
b. An axial flow compressor of 50% reaction design has blades with inlet and outlet angles of 44^0 and 13^0 respectively. The compressor is to produce a pressure ratio 5 : 1 with an overall isentropic efficiency of 87% when the inlet temp is 290K. The mean blade speed and axial velocity are constant throughout the compressor. Assume that blade velocity is 180m/sec and work input factor is 0.85. Find the number of stages required and the change of entropy. **(10 Marks)**

4 a. Derive an expression for an overall isentropic efficiency for finite number of stages of compression in terms of pressure ratio, stage efficiency, number of stages and ratio of specific heats for a compressor. **(10 Marks)**
b. In an axial flow compressor, air is taken at 1 bar and 288K. The delivery pressure of the compressor is 6.4 bars. The final temperature of air is 578K. Determine the following :
i) Overall isentropic efficiency ii) Polytropic efficiency iii) Number of stages required if the actual temp. rise per stage is limited to 14.5K assuming that the polytropic efficiency is equal to the stage efficiency. **(10 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART - B

5 a. With a neat sketch and velocity triangles, explain different vane shapes of the centrifugal compressor. Draw the inlet velocity triangle assuming $V_{U1} = 0.0$. **(10 Marks)**

b. Write a note on the following for an axial flow compressor :
i) Workdone factor ii) Radial equilibrium condition iii) Pressure ratio. **(10 Marks)**

6 a. Define the following terms for a centrifugal pump :
i) Manometric head ii) Manometric efficiency iii) NPSH. **(06 Marks)**

b. Derive an expression for the minimum starting speed for a centrifugal pump. **(06 Marks)**

c. A centrifugal pump is running at 1000 rpm. The output vane angle of the impeller is 45^0 and the velocity of flow at outlet is 2.5m/sec. The discharge thro' the pump is 200 lit/sec when the pump is working against the total head of 20m. If the manometric efficiency of the pump is 80%, determine i) diameter of the impeller ii) width of the impeller at outlet. **(08 Marks)**

7 a. Explain briefly a two stage pressure compounded impulse turbine and show the pressure and velocity variations across the turbine. **(06 Marks)**

b. Prove that the maximum rotor efficiency with equiangular rotor blades for impulse turbine is $\eta_{r\,max} = \text{Cos}^2\,\alpha_1$. **(06 Marks)**

c. What is meant by reaction staging? Prove that the maximum stage efficiency of Parson's (50% reaction) turbine is given by $\eta_{s\,max} = \dfrac{2\text{Cos}^2\alpha_1}{1+\text{Cos}^2\alpha_1}$. **(08 Marks)**

8 a. How do you classify the hydraulic turbines? **(04 Marks)**

b. Design a Pelton wheel for a head of 80m and speed 300 rpm. The Pelton wheel develops 103 kW shaft power. Take coefficient of velocity 0.98, speed ratio 0.45 and overall efficiency 0.80. **(08 Marks)**

c. A Kaplan turbine develops 9000 kW under a head of 10m. Overall efficiency of the turbine is 85%. The speed ratio based on outer diameter is 2.2 and flow ratio 0.66. Diameter of the boss is 0.4 times the outer diameter of the runner. Determine the diameter of the runner, boss diameter and specific speed of the runner. **(08 Marks)**

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