L-3/T-1/ME Date : 16/01/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **ME 341** (Machine Design I)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable value of any missing data.

Symbols carry their meaning. Machine Design book will be supplied.

1. (a) A perfect column is centrally loaded and has following data: l = 853.71 mm, end-condition: fixed-rounded, cross-section is an angle of size 40 × 40 × 6 mm, material: steel, E = 200 GPa, S_y = 385 MPa. Find, **(17½)**

(i) Type of column (Euler or, Johnson)

(ii) The buckling load and design load for a safety factor of 3.

(iii) The direction of buckling with reference to cross-section shown in Fig. 1(a).

(b) An eccentrically (e = 2 mm) loaded Al column has the cross-section shown in Fig. 1(b). Given: E = 70 GPa, S_y = 165 MPa, l = 1000 mm, end-condition: pinned-pinned. **(17½)**

(i) With a sketch show normal stresses at mid-span of the column.

(ii) Find the eccentricity ratio.

(iii) Find the maximum normal stress at mid-span and check whether yielding occurs.

2. (a) An ACME thread (2α = 29°) power screw carries a load of 2.5 kN. Given: single threaded screw and pitch = 6 mm, pitch dia = mean dia = 30 mm, collar dia = 80 mm, friction coefficient = 0.05. **(17½)**

(i) Determine if the screw is self-locked in the absence of collar friction.

(ii) Find the torque and mechanical advantage if the load is lifted in the absence of collar friction.

(iii) Net torque required to lift the load if collar friction is present.

(b) A locational interference fit is given by 105 mm H7/p6. Assume normal distribution. **(17½)**

(i) Sketch the assembly and label all pertinent dimensions.

(ii) Given, natural spread (N.S.) and tolerance (T) both are symmetric about mean for pin and hole.

And, N.S. = 2.5 times T for hole

N.S. = 3 times T for pin

If, 20% of the assembly was rejected being too tight, what is the maximum interference that was accepted?

Contd P/2

3. (a) A single steel bolt (E = 200 GPa) connects two C.I. plates (t = 30 mm, E_m = 80 GPa) as shown in fig. 3(a). Given: M 10 × 2 bolt, total bolt length (L) = 75 mm. After snug fit, the nut is turned $\frac{1}{4}$th of a full rotation to induce pretension F_i in the bolt. Calculate: **(17½)**

(i) k_b, k_m and joint constant C.

(ii) F_i.

(b) The head of a pressure vessel is fastened by 4 identical bolts (M 14 × 2, property class 9.8, coarse pitch). Given: joint constant C = 0.25 and the gasket area is thrice the nominal bolt cross-section for each bolt. Separation of joint starts when total tension on the head is 280 kN. For each bolt, calculate: **(17½)**

(i) Pre tension F_i.

(ii) Gasket pressure and initial torque corresponding to F_i. Bolts are lubricated.

(iii) Chance of bolts material failure and damping force when joint separation starts.

4. (a) (i) List the possible modes of failure for the bolted joints shown in Fig. 4(a). As shown, 6 identical bolts each of a nominal major dia 16 mm are placed at the corners of a uniform hexagon. Distance of each bolt = 50 mm from the bolt group centroid, G. **(18)**

(ii) Identify the most critically loaded bolt.

(iii) Find the maximum shear stress on the bolt.

(iv) Find the maximum bearing stress on the plate that has a thickness of 10 mm.

(b) (i) Why is heat treatment necessary after welding? **(17)**

(ii) For the welded connection (Fig. 4(b)) the load F is centroidal. Find fatigue safety factor using Gerber criterion, material: AISI 1018 CD, required reliability is 95%.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

Assume any missing data.

5. (a) A carbon steel ball (E = 207 GPa) of 30 mm diameter is to be used in a ball bearing where the radius of curvature of inner and outer race is 32 mm. The race material is stainless steel with E = 190 GPa. If the yield stresses of ball and race materials are 250 MPa and 300 MPa, respectively, determine the safe load P that can be applied considering a factor of safety 1.4. Use Poisson's ratio of 0.3 for both the materials. **(17)**

(b) The cantilever shaft in Figure for Q. No. 5(b) is subjected to both torsional and bending load. If the deflection and angle of twist are not to exceed 0.5 mm and 2°, find the minimum diameter of the shaft. Use Castigliano's theorem in your design. Assume, E = 207 GPa and γ = 0.3 for this material. **(18)**

Contd P/3

ME 341

6. (a) A simply supported beam has an edge crack at the mid-section as shown in Figure for Q. No. 6(a). The beam cross-section is rectangular with the dimensions given in figure. Determine the maximum allowable force F if the length of crack is 2 mm. Consider the beam material as Aluminum 7178 and a factor of safety 2 in your calculation. **(17)**
For the maximum load, what will be the value of horizontal normal stress at a vertical distance of 0.01 mm from the crack tip?
(b) Two cylindrical parts are to be assembled to make an interference fit. The nominal diameter of the assembly is 100 mm. Before assembly, the inner member (copper) has an outer radius that is 0.2 mm larger than the inner radius of the outer member (aluminum). If there is no other force acting on the assembly, determine the maximum and minimum principal stress in both the members. Assume Poisson's ratio of 0.3 for both the materials. Also take $r_i = 30$ mm for copper cylinder and $r_o = 80$ mm for aluminum cylinder. **(18)**

7. (a) Gear A is applying a vertical downward force of 2 kN on gear B (attached to shaft CD) as shown in Figure for Q. No. 7(a). The gears transmit a power of 10 KW at a speed of 500 rad/s. Consider the case of static loading. If the shaft CD is also subjected to an axial compressive force of 2 kN, determine the minimum diameter of shaft CD based on the distortion energy theory. The shaft CD is made of AISI 1040 CD steel material. **(18)**
(b) A cylindrical pressure vessel having inside and outside diameters of 200 mm and 300 mm contains gas under cyclic pressure between 0 to 50 MPa. During a routine inspection, a nick of 0.2 mm has been discovered on the outer edge of the cylinder. The material is steel with $S_{ut} = 500$ MPa, $S_y = 350$ MPa, and $K_{IC} = 90$ MPa $\sqrt{m}$. Estimate the remaining life of the cylinder in number of cycles using the fracture mechanics approach. Consider the values of $C = 6.89 \times 10^{-12}$ m/cycle/(MPa$\sqrt{m}$)^m and m = 3.0 for this material. **(17)**

8. (a) The cold drawn AISI 1040 steel member shown in Figure for Q. No. 8(a) is subjected to completely reversed axial load of – 5 kN to + 5 kN and a bending load of 8 kN. If a fatigue factor of safety 1.5 is to be used on the basis of modified Goodman approach, determine the minimum size h for this part. Consider room temperature operation and choose 95% reliability for your design. **(20)**
(b) The steel shaft (AISI 1050 HR) AB with diameter d is subjected to the completely reversed load as shown in Figure for Q. No. 8(b). Find the diameter of the shaft for a finite life of 10^5 cycles. Consider the fully corrected endurance strength for this material and part as 250 MPa. **(15)**

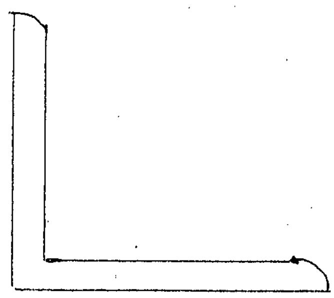
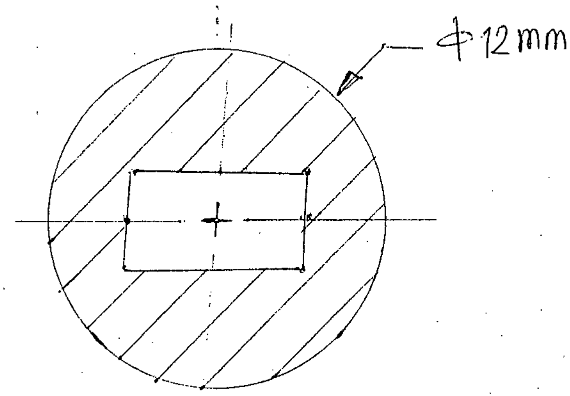


FIG. 1(a)



Central slot: 3x6mm

FIG. 1(b)

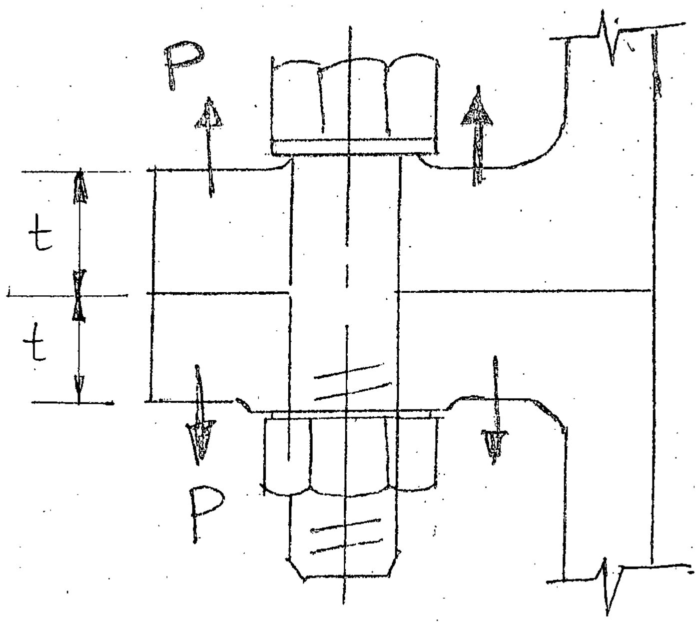


FIG. 3(a)

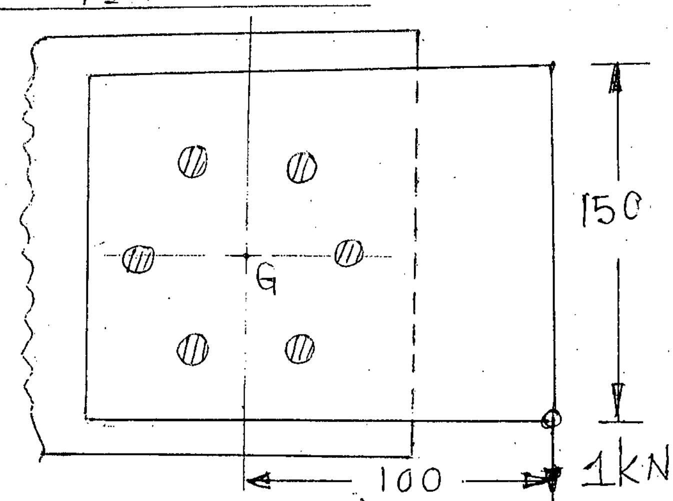


FIG. 4(a).

Dimensions in mm

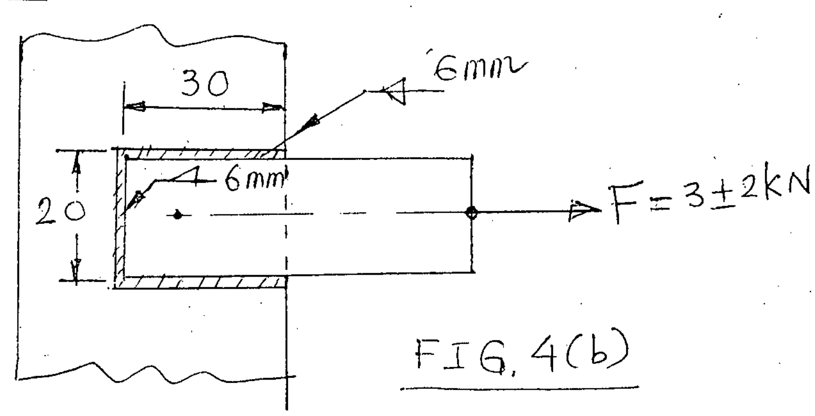


FIG. 4(b)

Dimensions in mm

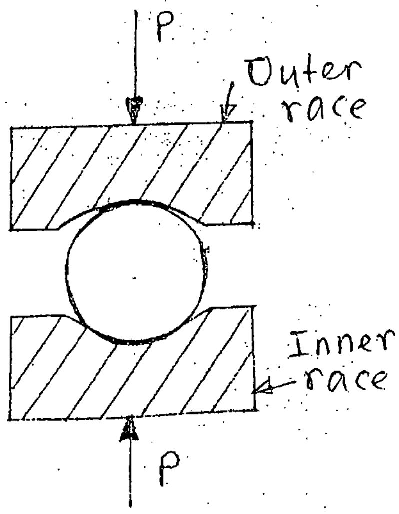


Figure for Q. No. 5 (a)

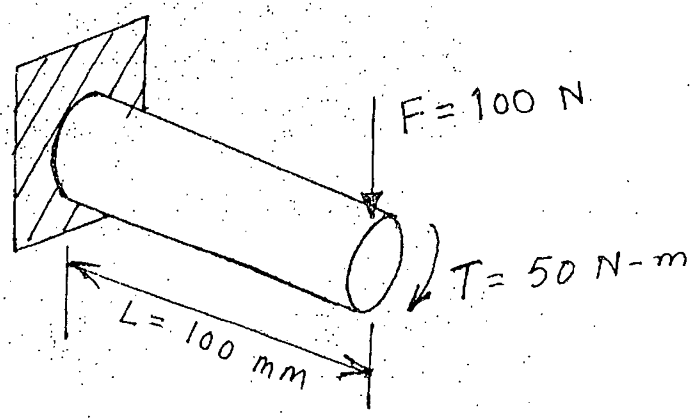


Figure for Q. No. 5 (b)

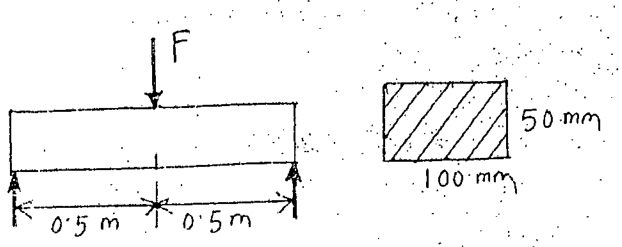


Figure for Q. No. 6 (a)

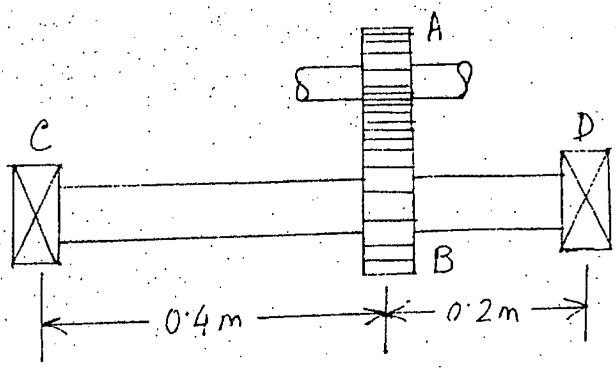


Figure for Q. No. 7 (a)

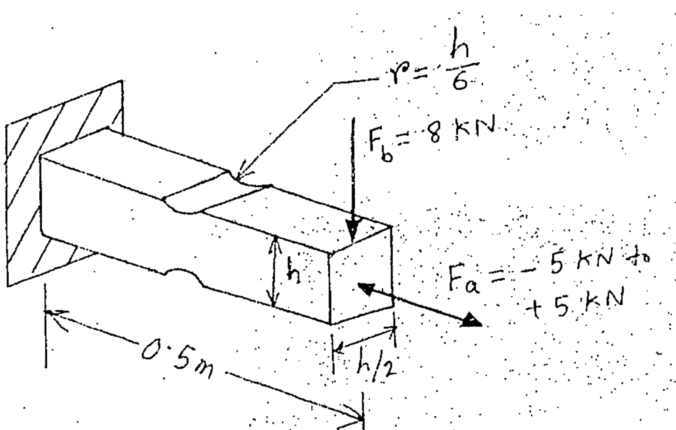


Figure for Q. No. 8 (a)

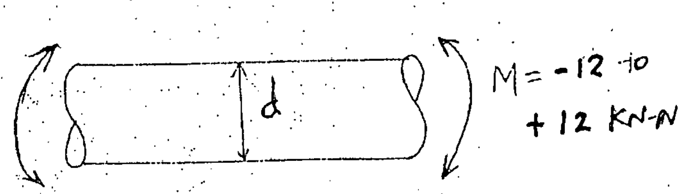


Figure for Q. No. 8 (b)

L-3/T-1/ME **Date : 21/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **ME 321** (Fluid Mechanics I)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable data if missing.

1. (a) With help of diagrams explain weirs and notches. Deduce an expression of actual flow rate through a V-Notch. **(18)**

(b) A rectangular notch 450 mm width is used for measuring discharge of water at the rate of 35 l/s. An error of 1.65 mm was made, while measuring the head over the notch. Calculate the percentage error in the discharge. Consider, $c_d = 0.61$. **(17)**

2. (a) Considering a control volume, deduce the steady flow energy equation. **(18)**

(b) Water is flowing through a reducer as shown in the given figure. If the deflection in the mercury manometer is 10 mm, find the flow rate of water. **(17)**

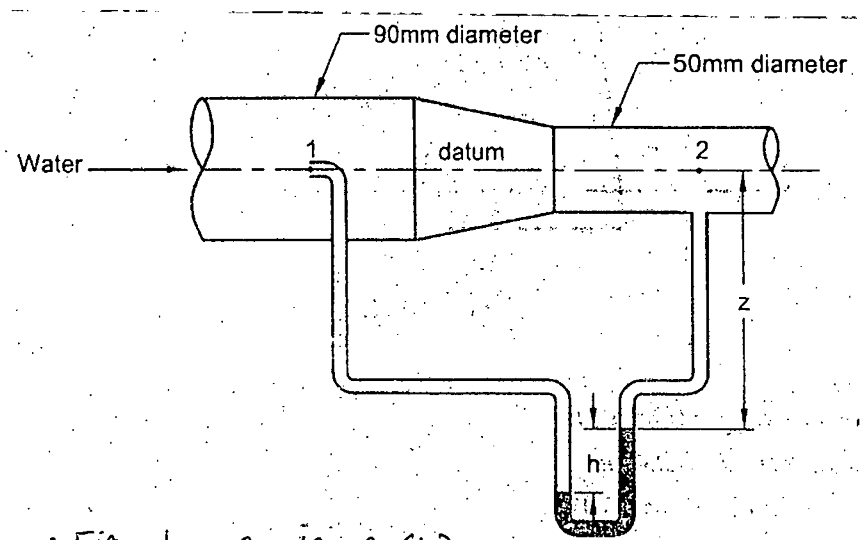


Fig. for Q. No. 2(b)

3. (a) Obtain an expression for the pressure at a height z from sea level for static air when the temperature varies linearly with elevation by $T = T_0 + kz$, where T_0 is the temperature at the datum z_0 and k is a constant. **(18)**

(b) Find the flow rate of water, if the pump develops 5 kW on the flow. The deflection in the mercury manometer is 1 m. **(17)**

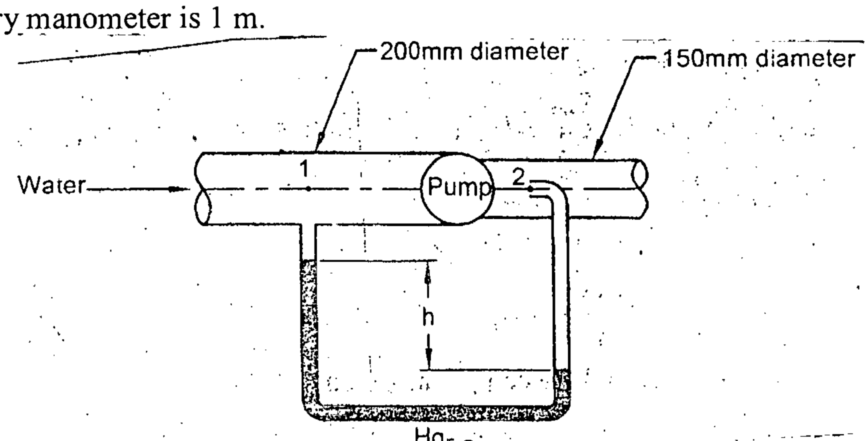


Fig. for Q. No. 3(b)

ME 321

4. (a) Explain coefficient of contraction with an example. Find an equation of actual flow rate through an orificemeter. **(18)**

(b) A venturimeter is fitted to a 145 mm diameter pipeline carrying water, which is inclined at 45° to the horizontal. The throat diameter of the venturimeter is 50 mm and is placed higher than the inlet side. The difference in pressure between throat and the inlet is equal to 0.9 m of mercury. Find the actual flow rate of water through the venturimeter. Take, $c_d = 0.98$. **(17)**

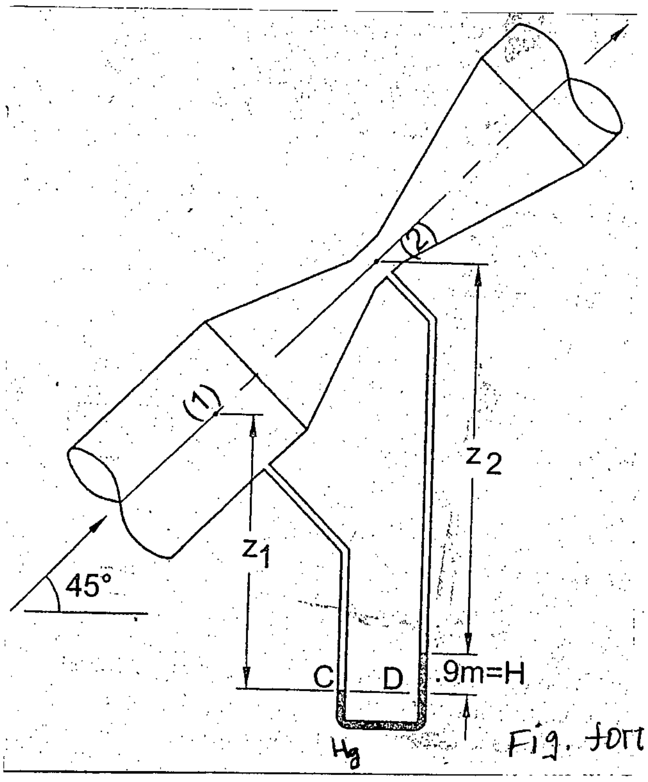


Fig. for Q. NO. 4(b)

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Show that the pressure in a fluid is constant at a point; it acts equally in all directions at a given point. **(12)**

(b) A pressure gage connected to a closed gas tank reads 101.3 kPa when the ambient pressure is atmospheric pressure. The entire set up is submerged in flood water and the pressure gage is sunk 5 m into water. Will the pressure gage reading change or remain same? If the reading changes, what will be the new reading? **(12)**

(c) A 1.2 m long, 2 cm diameter shaft rotates inside an equally long cylinder that is 2.06 cm in diameter. Calculate the torque required to rotate the inner shaft at 2000 rpm if SAE-30 oil at 20°C (μ = 0.4 Pa-s) fills the gap. Also, calculate the horsepower required. Assume symmetric motion. **(11)**

Contd P/3

ME 321

6. (a) Gate AB is 5 m wide into the paper and opens to let fresh water out when the ocean tide is dropping. The hinge at A is 1 m above the fresh water level. At what ocean level h will the gate first open? Neglect the gate weight. Take seawater specific gravity = 1.025. See Figure for Q. 6(a). **(17)**

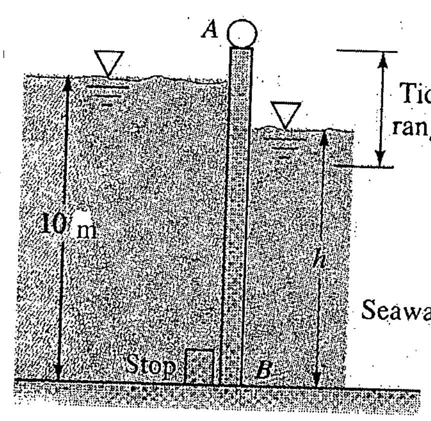


Figure for Q6a

(b) Show that the shape of the free surface of liquid in a container rotating at a constant angular velocity is a paraboloid of revolution. Does the shape of the free surface depend on the fluid properties? Justify your answer. **(18)**

7. (a) What is stream function? Show that the change in the value of the stream function between two points is related to the volume flow rate between the points. **(12)**

(b) The x and y components of fluid velocity in a 2D flow field are: u = x and v = −y, respectively. Determine the stream function and the velocity potential function. Plot the flow net for $\Psi = 0, \pm 1$, and $\Phi = 0, \pm 1$. Interpret them. **(23)**

8. (a) Show that the pressure distribution on the surface of a rotating cylinder is given by, **(20)**

$$p_s = p_0 + \frac{1}{2}\rho U^2 \left(1 - 4\sin^2\theta + \frac{2\Gamma\sin\theta}{\pi a U} - \frac{\Gamma^2}{4\pi^2 a^2 U^2}\right)$$

The notations have their usual meanings.

(b) Determine the drag and lift on the rotating cylinder. **(10)**

(c) What is Magnus effect? Explain with example. **(5)**

L-3/T-1/ME **Date : 26/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **ME 361** (Instrumentation and Measurement)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) What are the fundamental methods of measurement? Describe. **(10)**

   (b) With a block-diagram describe the generalized measuring system and discuss. **(10)**

   (c) Classify all types of possible errors during measurement and discuss. **(10)**

   (d) What do you mean by hysteresis? How would the hysteresis of an instrument affect its accuracy? **(5)**

2. (a) Briefly describe the working principle of a strain gauge. What do you mean by gauge factor? Describe its physical meaning. **(12)**

   (b) What do you mean by piezoelectric pressure transducer? Describe. **(8)**

   (c) Describe the basic fluid pressure measuring methods used in practice. **(15)**

3. (a) What are the advantages of using LVDT? **(8)**

   (b) What are the merits and demerits of using venture, flow nozzles and orifice? **(9)**

   (c) What do you mean by PIV? Describe its working principle. **(8)**

   (d) Describe the application of turbine-type and magnetic flowmeter. **(10)**

4. (a) State the differences between hydraulic and pneumatic load cell. **(10)**

   (b) Name the basic types of torque measuring devices. What are the differences between water-brake and electric dynamometers? Describe. **(10)**

   (c) Write short notes on the following: **(15)**

   (i) Tactile sensor (ii) uncertainity analysis (iii) Nyquist frequency

Contd P/2

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable values for missing data. All symbols have their usual meaning.

5. (a) Show that, for voltage sensitive ballast circuit: **(15)**

$$\frac{\Delta e_0}{e_i} = \frac{\Delta R_2/R}{4 + 2(\Delta R_2/R)}$$

(b) Name the general functions of different signal conditioning stages that are used in measurement system and discuss? **(10)**

(c) Classify the signal filters and show the characteristics of real filters. **(10)**

6. (a) A differential amp is needed to amplify the voltage difference between two temperature sensors. The sensors have an internal resistance of 5 kΩ, and the maximum voltage difference between the sensors will be 2 V. Design the differential amp circuit to have an output of 12 V when the difference between the inputs is 2 V. **(15)**

(b) Briefly describe the working principle of instrumentation amplifiers with necessary circuit diagram and derive the equation for V_{out}. **(20)**

7. (a) Given a 12-bit A/D converter operating over a voltage range from –5 to 5 V, how much does the input voltage have to change, in general, in order to be detectable. **(10)**

(b) Explain the working principle of a "Successive Approximation ADC". **(10)**

(c) Write short note on DAC. **(15)**

8. (a) State and illustrate the laws of thermocouple. **(5)**

(b) What is an IC temperature sensor and where it is used? **(5)**

(c) Briefly describe a method for measuring very high temperature. **(10)**

(d) What are the different methods for measurement of heat flux? Illustrate one of them. **(15)**

L-3/T-1/ME **Date : 30/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **ME 301** (Conduction and Radiation heat Transfer)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

The symbols have their usual meanings.

Assume reasonable value for any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Consider a large uranium plate of thickness L = 4 cm and thermal conductivity k = 28 W/m.K in which heat is generated uniformly at a constant rate of $\dot{e} = 5 \times 10^6$ W/m^3. One side of the plate is maintained at 0°C by iced water while the other side is subjected to convection to an environment at T_α = 30°C with a heat transfer coefficient of h = 45 W/m^2.K. Considering a total of three equally spaced nodes in the medium, two at the boundaries and one at the middle, estimate the exposed surface temperature of the plate under steady conditions using the finite difference approach. **(18)**

   (b) What are the four fundamental relationships/rule for view factors applicable in radiation heat transfer? Describe them with neat sketch. **(17)**

2. (a) Show that the total hemispherical emissivity of a surface at temperature T is equal to its hemispherical absorptivity for radiation coming from a blackbody at the same temperature. **(18)**

   (b) Two small surfaces dA_1 = 5 cm^2 and dA_2 = 10 cm^2 are separated by r = 100 cm and oriented as illustrated in the Fig. 2(b). Calculate the view factors between the surfaces. **(17)**

3. (a) A glass plate 30 cm square is used to view radiation from a furnace. The transmissivity of the glass is 0.5 from 0.2 to 3.5 μm. The emissivity may be assumed to be 0.3 up to 3.5 μm and 0.9 above that. The transmissivity of the glass is zero, except in the range from 0.2 to 3.5 μm. Assuming that the furnace is a blackbody at 2000°C, calculate the energy absorbed in the glass and the energy transmitted. **(17)**

   (b) Two aligned parallel rectangles with dimensions 6m × 8m are spaced apart by a distance of 2 m. If the two parallel rectangles are experiencing radiation heat transfer as black surfaces, determine the percentage of change in radiation heat transfer rate when the rectangles are moved 8 m apart. **(18)**

Contd P/2

4. (a) Consider two large parallel plates, one at T_1 K with emissivity $\varepsilon_1 = 0.8$ and the other at T_2 K with emissivity $\varepsilon_2 = 0.4$. An aluminum radiation shield with emissivity on both sides $\varepsilon_3 = 0.05$ is placed between the plates. Calculate the percentage reduction in the heat transfer rate resulting from the radiation shield. **(15)**

(b) Two parallel plates of size 1.0 m by 1.0 m spaced 0.5 m apart are located in a very large room, the walls of which are maintained at a temperature of 27°C. One plate is maintained at a temperature of 900°C and the other at 400°C. Their emissivities are 0.2 and 0.5 respectively. If the plates exchange heat between themselves and surroundings, find the net heat transfer to each plate and to the room. Consider only the plate surfaces facing each other. **(20)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) A long homogenous resistance wire of radius $r_0 = 0.5$ cm and thermal conductivity $k = 13.5$ W/m°C is being used to boil water at atmospheric pressure by the passage of electric current as shown in Fig. for Q. 5(a). heat is generated in the wire at a rate of $\dot{e}_{gen} = 5 \times 10^7$ W/m^3. If the outer temperature of the wire is measured to be 108 °C, obtain a relation for the temperature distribution and hence determine the temperature at the centerline of the wire when steady operating conditions prevail. **(20)**

(b) What do you understand by "Thermal Contact Conductance"? Briefly discuss the factors that affect the "Thermal Contact Conductance". **(15)**

6. (a) A spherical container of inner radius $r_1 = 2$ m, outer radius $r_2 = 2.1$ m and thermal conductivity of $k = 40$ W/m.K is filled with ice water at 0 °C. The container is gaining heat by convection from the surrounding air at $T_\alpha = 25$ °C with a heat transfer coefficient of $h = 20$ W/m^2.K. Assuming the inner surface container temperature to be 0 °C, obtain the relation for the temperature distribution through the container and hence determine rate of heat gain of the iced water. **(20)**

(b) To defrost ice accumulated on the outer surface of an automobile windshield, warm air is blown over the inner surface of the windshield as shown in Fig. 6(b). Consider an automobile windshield of thickness 5 mm and thermal conductivity of 1.4 W/m.K. The outside ambient temperature is –10 °C and the heat transfer coefficient is 200 W/m^2.K while the ambient temperature inside the automobile is 25 °C. Determine the value of heat transfer coefficient for the warm air blowing over the inner surface of the windshield necessary to cause the accumulated ice to begin melting. **(15)**

Contd P/3

7. (a) Obtain a relation for the fin efficiency of a fin of constant cross sectional area A_c, perimeter P, length L, thermal conductivity k, exposed to a medium at T_α with a heat transfer coefficient h. The fin is sufficiently long such that the fin tip temperature might be assumed to be equal to the ambient temperature, T_α. **(20)**

(b) The engine cylinder of a motorcycle is constructed of 2024-T6 aluminum alloy (k = 186 W/m.K) of height H = 0.15 m and outside diameter D = 50 mm as shown in Fig. 7(b). Under typical operating conditions, the outer surface temperature is of 500 K and is exposed to ambient air at a temperature of 300 K with a convective heat transfer coefficient of 50 $W/m^2.K$. Annular fins are integrally cast with the cylinder to increase the heat transfer to the surroundings. Consider 5 such fins, which are of thickness t = 6 mm, L = 20 mm and equally spaced. What is the increase in the heat transfer rate due to use of fins. Use the enclosed chart. **(15)**

8. (a) Show that when two semi-infinite solids (A and B of constant thermo-physical properties) initially being at uniform temperature $T_{A,i}$ and $T_{B,i}$ are brought into perfect contact, the steady-state interface temperature of these two bodies in contact T_i can be given as **(15)**

$$T_i = \frac{T_{A,i} + \beta T_{B,i}}{1+\beta}; \quad \text{where } \beta = \frac{\sqrt{(k\rho C_p)_B}}{\sqrt{(k\rho C_p)_A}}$$

The symbols have their usual meaning.

(b) In a production facility, 3-cm-thick large brass plates (k = 110 W/m.°C, ρ = 8530 kg/m^3, C_p = 380 J/kg.°C, and α = 33.9 × 10^{-6} m^2/s) that are initially at a uniform temperature of 25°C are heated by passing them through an oven maintained at 700°C. The plates remain in the oven for a period of 10 min. Taking the convection heat transfer coefficient to be h = 80 $W/m^2.°C$, determine the surface temperature of the plates when they come out of the oven. Use the enclosed chart. **(20)**

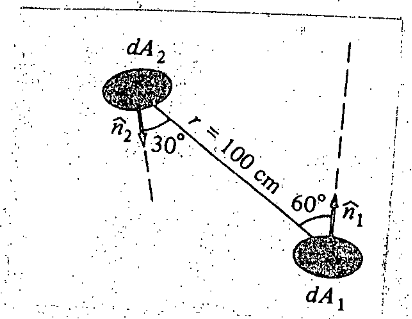


Fig. 2(b)

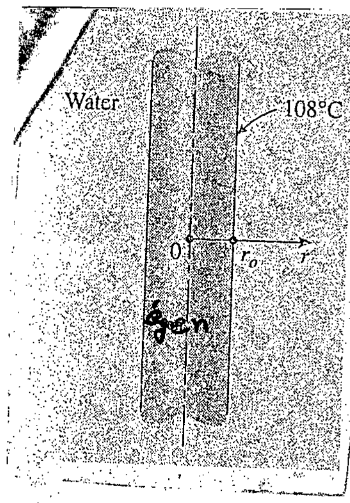


Fig for Q. 5(a)

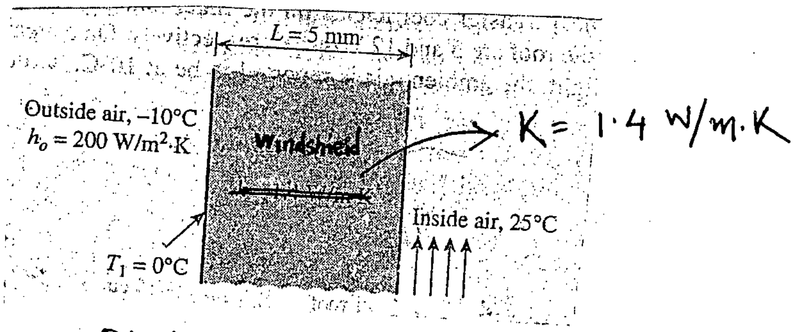


Fig for Q. 6(b)

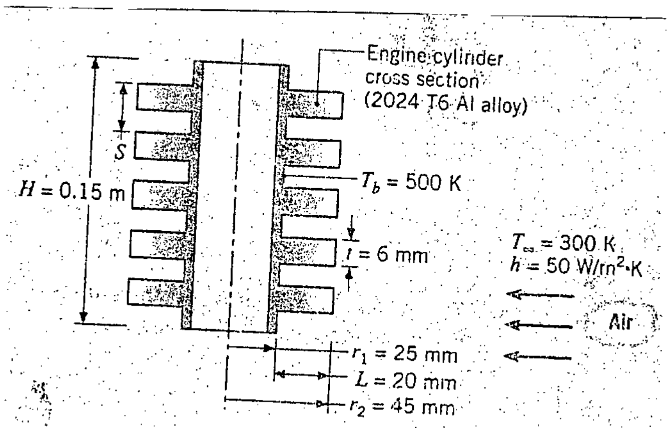
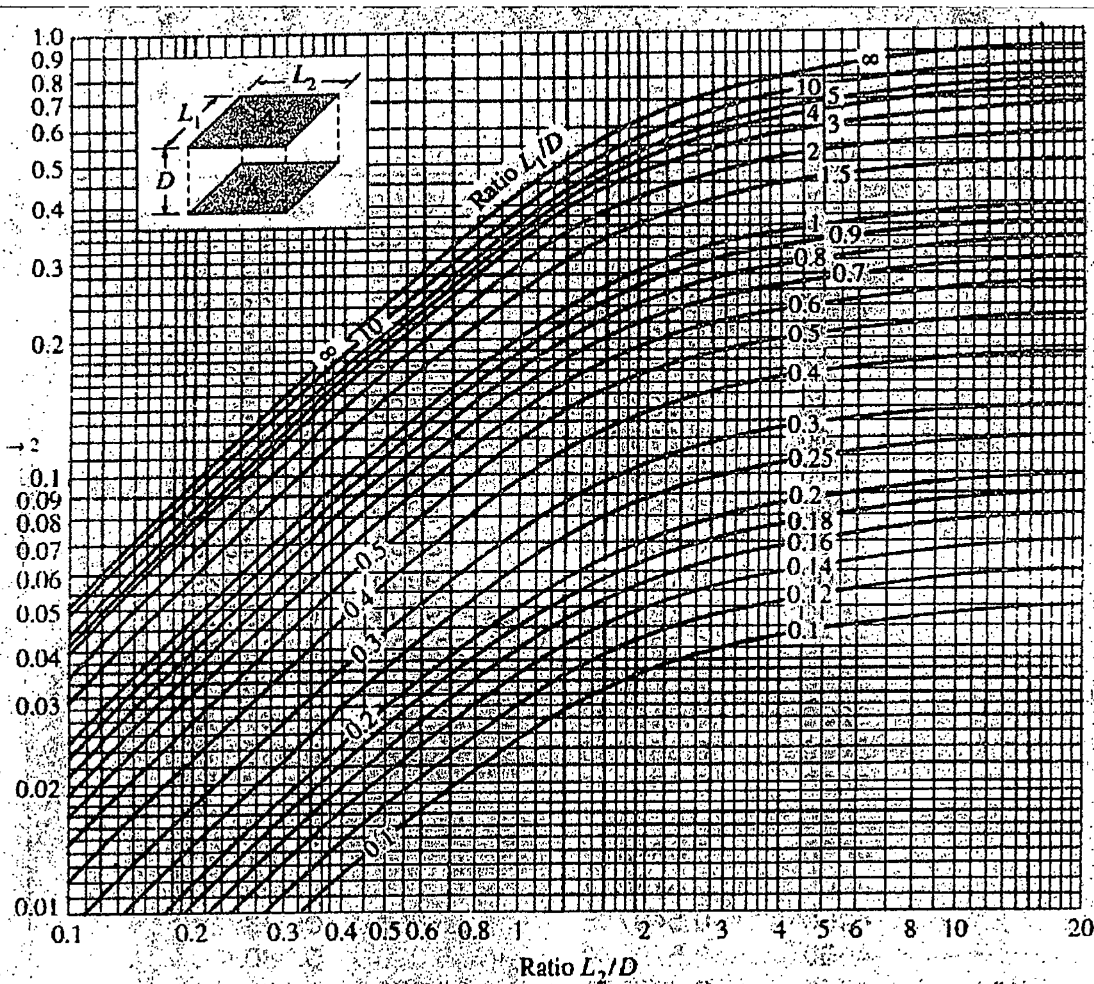


Fig. for Q. 7.(b)



Graph 1: View factor between two aligned parallel rectangles of equal size.

Blackbody radiation functions f_λ

λT, μm · K	f_λ	λT, μm · K	f_λ
200	0.000000	6200	0.754140
400	0.000000	6400	0.769234
600	0.000000	6600	0.783199
800	0.000016	6800	0.796129
1000	0.000321	7000	0.808109
1200	0.002134	7200	0.819217
1400	0.007790	7400	0.829527
1600	0.019718	7600	0.839102
1800	0.039341	7800	0.848005
2000	0.066728	8000	0.856288
2200	0.100888	8500	0.874608
2400	0.140256	9000	0.890029
2600	0.183120	9500	0.903085
2800	0.227897	10,000	0.914199
3000	0.273232	10,500	0.923710
3200	0.318102	11,000	0.931890
3400	0.361735	11,500	0.939959
3600	0.403607	12,000	0.945098
3800	0.443382	13,000	0.955139
4000	0.480877	14,000	0.962898
4200	0.516014	15,000	0.969981
4400	0.548796	16,000	0.973814
4600	0.579280	18,000	0.980860
4800	0.607559	20,000	0.985602
5000	0.633747	25,000	0.992215
5200	0.658970	30,000	0.995340
5400	0.680360	40,000	0.997967
5600	0.701046	50,000	0.998953
5800	0.720158	75,000	0.999713
6000	0.737818	100,000	0.999905

$$f_\lambda = \frac{E_b(0\to\lambda T)}{\sigma T^4}$$

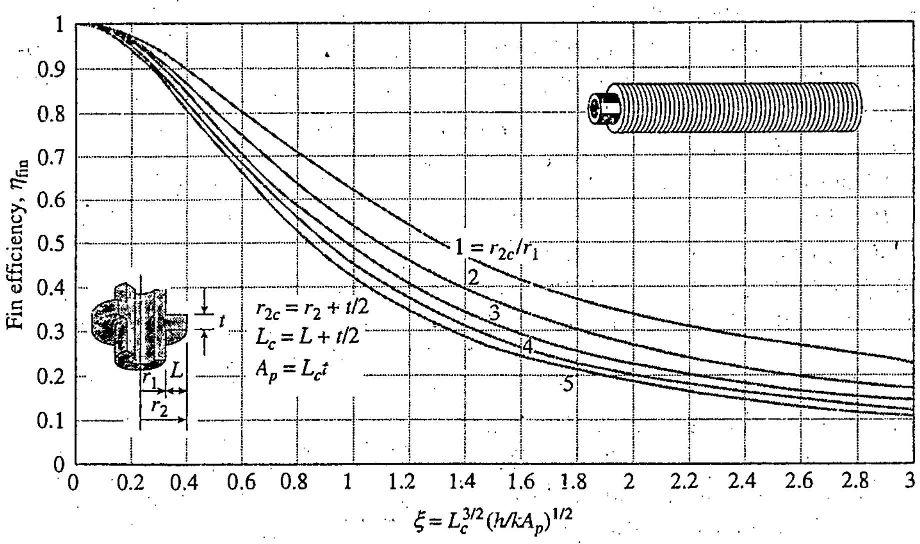
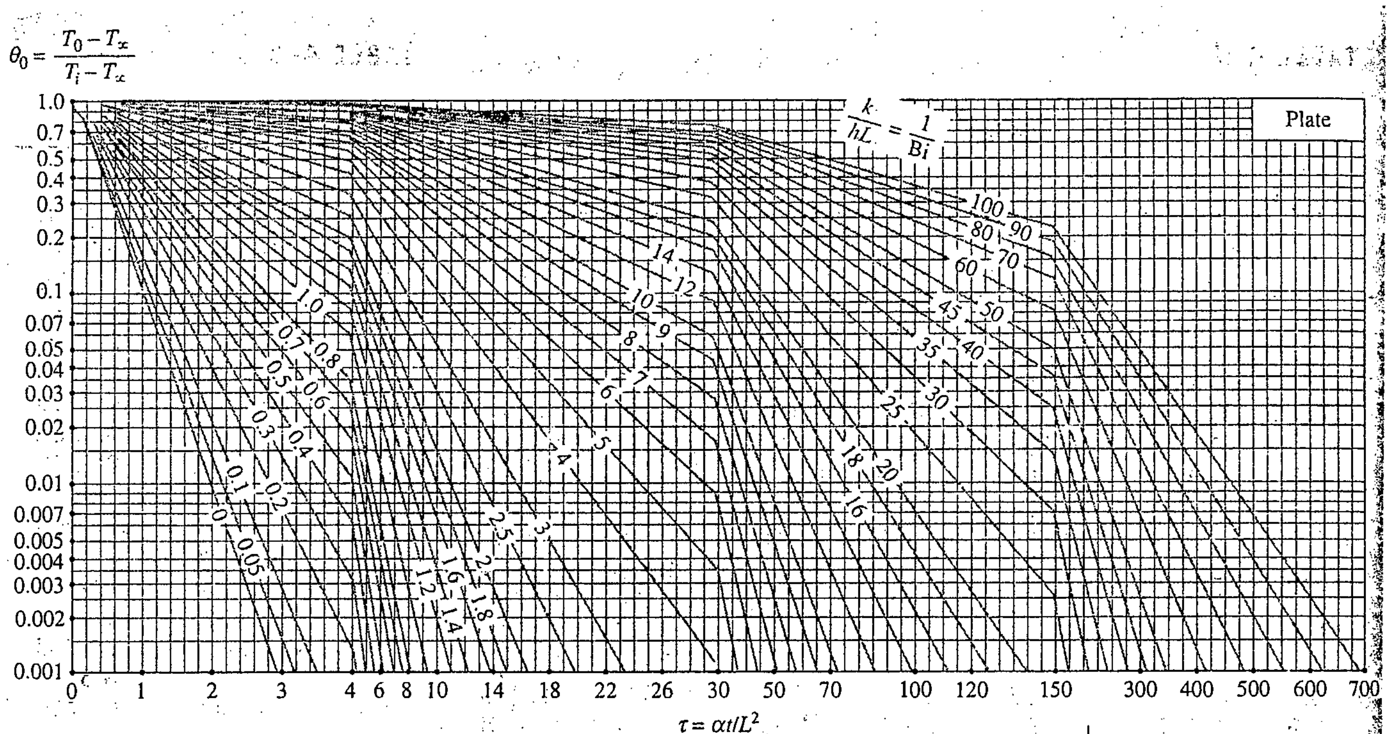
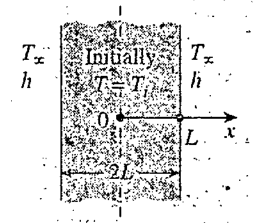
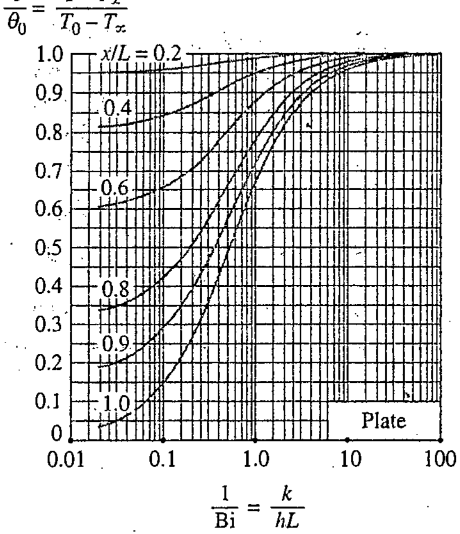


Chart for Q. 7(b)

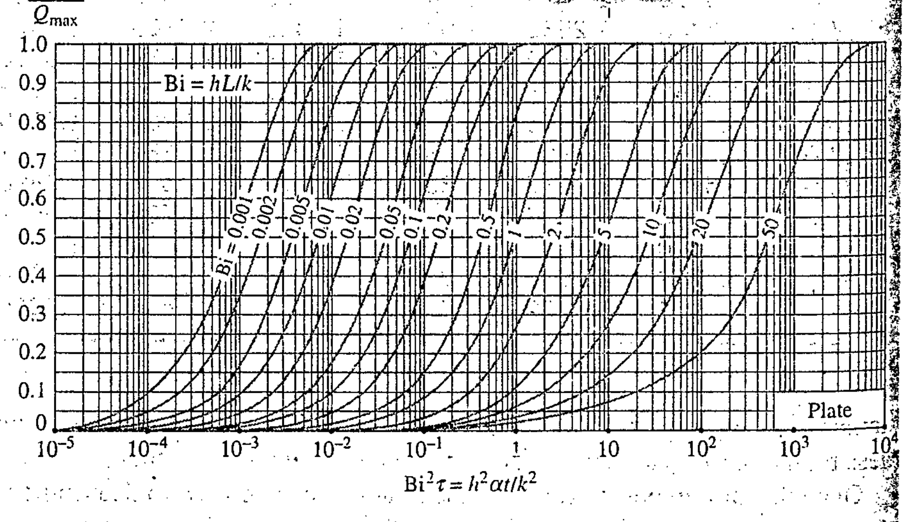




(*a*) Midplane temperature (from M. P. Heisler, "Temperature Charts for Induction and Constant Temperature Heating," *Trans. ASME 69*, 1947, pp. 227–36. Reprinted by permission of ASME International.)



(*b*) Temperature distribution (from M. P. Heisler, "Temperature Charts for Induction and Constant Temperature Heating," *Trans. ASME 69*, 1947, pp. 227–36. Reprinted by permission of ASME International.)



(*c*) Heat transfer (from H. Gröber et al.)

Chart for Q. 8(b)

L-3/T-1/ME **Date : 04/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **ME 345** (Mechanics of Machinery)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Assume any reasonable value for the missing data if there is any.

1. In the mechanism shown in Fig. for Q. No. 1, the crank OA is 75 mm long and rotates in anticlockwise direction at a constant speed of 150 rpm. The straight rod BCD oscillates about a fixed pin point at C. The links BC and CD are each 150 mm long and the link AB is 250 mm long. Link DE is 250 mm long. Find the velocity and acceleration of E. **$(46\frac{2}{3})$**

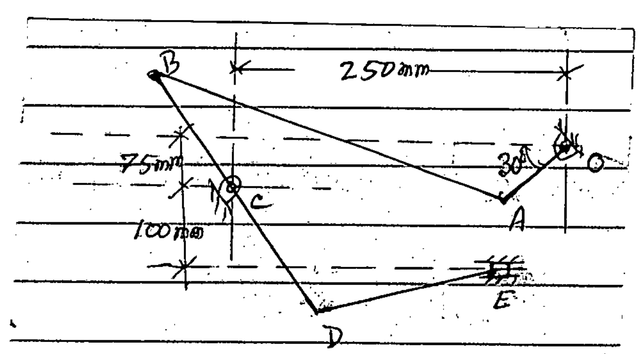


Figure for Ques. No. 1

2. Construct the profile of a cam to suit the following specifications: **$(46\frac{2}{3})$**

   (a) Follower to move outwards through 25 mm during 120° of cam rotation.

   (b) Follower to dwell for the next 60° of cam rotation.

   (c) Follower to return to its starting position during the next 90° of cam rotation.

   (d) Follower to dwell for the rest of the cam rotation.

   The base circle radius of the cam is 50 mm and the diameter of the roller of the follower is 10 mm. The line of stroke of the follower is offset by 20 mm from the axis of the cam shaft. If the displacement of the follower takes place with uniform and equal acceleration and retardation on both the outward and return strokes, find the maximum velocity and acceleration of the follower. Given that the cam is rotating with a speed of 1000 rpm clockwise.

3. (a) A four cylinder vertical engine has cranks 100 mm long. The planes of rotation of the first, second and fourth cranks are 350 mm, 250 mm and 200 mm respectively from the third crank and their reciprocating masses are 40 kg, 50 kg and 55 kg, respectively. Find the mass of the reciprocating parts for the third cylinder and the relative angular position of the cranks in order that the engine is in complete primary balance. **$(23\frac{2}{3})$**

   (b) The pistons of a 60° turn V-engine has strokes of 120 mm. The connecting rods, driving a common crank, have lengths of 200 mm. The mass of the reciprocating parts per cylinder is 1.2 kg and the speed of the crank shaft is 2000 rpm. Determine the magnitude of the primary and secondary forces. **(23)**

Contd P/2

4. (a) A punching press pierces 35 holes per minute in a plate using 10 kN-m of energy per hole during each revolution. Each piercing takes 20 percent of the time needed to make one revolution. A cast iron flywheel used with the punching machine is driven by a constant torque electric motor. The flywheel rotates at a mean speed of 210 rpm and the fluctuation of speed is not to exceed ± 1 percent of the mean speed. Find (i) power of the electric motor, (ii) mass of the flywheel, (iii) cross-sectional dimensions of the rim when the width is twice its thickness. (allowable hoop stress for cast iron = 4 MPa and density of cast iron = 7200 kg/m^3). **(23)**

(b) Two shafts whose centers are 1 m apart are connected by a V-belt drive. The driving pulley is supplied with 120 kW and has an effective diameter of 300 mm. It runs at 1000 rpm while the driven pulley runs at 375 rpm. The angle of groove on the pulleys is 40°. The cross-sectional area of each belt is 450 mm^2 and the permissible safe stress in the material is 2.9 MPa. The density of the belt is 1100 kg/m^3. The coefficient of friction between the belt and pulley is 0.28. Estimate the number of belts required and their length (open belt drive). **($23\frac{2}{3}$)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) The uniform bar of mass 12 kg is supported by a spring as shown in Fig. for Q. 5(a). A disc of mass 4 kg and radius 0.085 m is fixed to the bar at its free end. Calculate the natural frequency of free vibration of the system. **(23)**

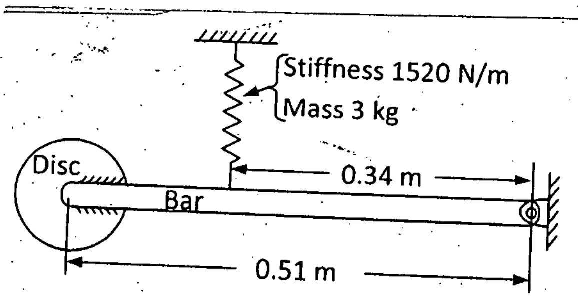


Figure for Q.5(a)

(b) The following particulars are given for a motor vehicle: total mass, 2040 kg; wheel base, 2.0 m; track width, 1.0 m; center of gravity, midway between the front and rear axle and 0.3 m above the road level; moment of inertia of each wheel, 3 kg-m^2; moment of inertia of parts turning at engine speed, 4 kg-m^2; each wheel radius, 0.4 m. The engine turns at 3000 rpm in clockwise direction when viewed from the front of the vehicle. The vehicle travels at a constant speed of 30 km/h and enters a right hand curve of 15 m radius. Determine the vertical load on each wheel. **($23\frac{2}{3}$)**

Contd P/3

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Contd ... Q. No. 7(b)

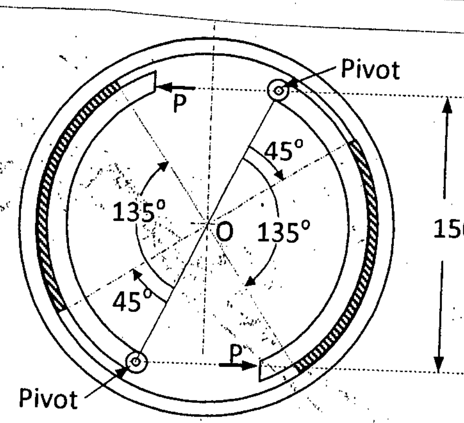

Figure for Q. 7(b)

8. (a) With a necessary sketch, explain briefly the condition for transmission of constant velocity ratio between two mating gear wheels. **(15)**

(b) A compound epicyclic gear train as shown in Fig. for Q. 8(b) is composed of a main train and an auxiliary train. The main consists of the shaft A carrying the arms on which the planet wheels D are mounted which mesh with the annular wheel C and the sun-wheel E which is secured to the shaft B. The auxiliary train consists of planet wheels G mounted on arms carried by C which mesh with the fixed annular wheel F and with the sun-wheel H which is also secured to the shaft B. All the wheels have the same diametral pitch and the tooth numbers are as follows: D, 25; E, 25; G, 30; H, 30. Find the velocity ratio of B to A. **(23)**

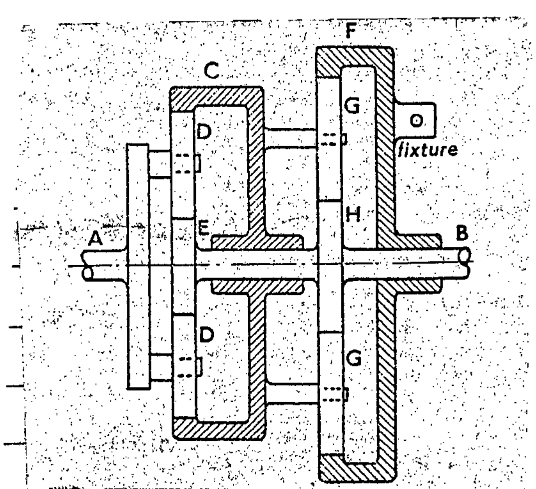

Figure for Q. 8(b)

(c) If the train in question 8(b) transmits 8 kW when A rotates at 600 rpm, determine the torque transmitted by the pinions E and H, respectively. **($8\frac{2}{3}$)**
