L-3/T-1/ME **Date : 28/06/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

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**.

Symbols have usual meanings.

1. (a) The rack-pinion system as shown in Figure for Q. 1(a) is attached to a spring and a rolling disc. Consider that the rolling disc rolls on the surface without slipping. Calculate the natural frequency of free vibrations. **(23)**

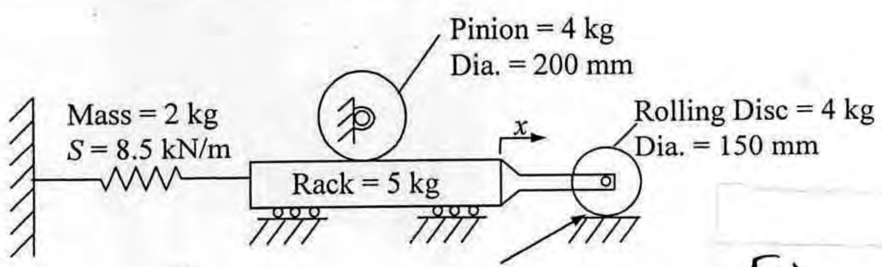


Figure for Q.1(a)

(b) A horizontal flat steel cantilever of length 140 mm and of cross-section 12 mm wide by 6 mm thick is clamped at one end with the 12 mm side horizontal, and carries a mass of 0.5 kg at the free end. Mass of the cantilever is 0.08 kg. Elastic modulus of the cantilever material is E = 200 GPa. Find the frequency of transverse vibration of the cantilever. **($23\frac{2}{3}$)**

2. (a) A mass of 2.4 kg hanging from the lower end of a vertical spring is pulled downward through a definite distance and then released. If the resulting motion is controlled by a viscous damping such that the ratio of the first downward displacement to the third is 4 : 1 and five vibrations are completed in 4 sec, find the stiffness of the spring and the damping force. **(20)**

(b) A small 20 kg block A is attached to the rod BC of negligible mass which is supported at B by a pin and bracket and at C by a spring of constant k = 2 kN/m as shown in Figure for Q. 2(b). The system can move in a vertical plane and is in equilibrium when the rod is horizontal. The rod is acted upon at C by a periodic force P of magnitude $P = P_m \sin \omega_f t$, where P_m = 6 N. Knowing that b = 200 mm, determine the range of values of ω_f for which the amplitude of vibration of block A exceeds 3.5 mm. **(20)**

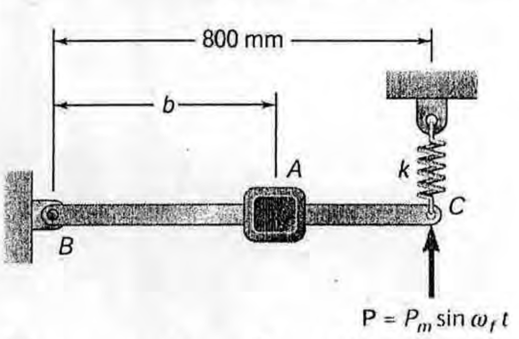


Figure for Q.2(b)

Contd P/2

ME 345

Contd … Q. No. 2

(c) In many practical situations, it is possible to reduce but not eliminate the dynamic forces that cause vibrations. Different methods are used to control vibrations. Mention four of them, that you think important. **($6\frac{2}{3}$)**

3. (a) The turbine rotor of a ship has a mass of 20 t, has a radius of gyration of 0.6 m and rotates at 3000 rev/min. The ship is pitching 10° above and 10° below the horizontal, the motion being simple harmonic and having a period of 12 s. The rotor turns in a clockwise direction when viewed from aft. Determine the maximum value of the gyroscopic couple and the direction of yaw as the bow rises. **(23)**

(b) A motor drives a machine through a friction clutch which slips when the torque on it reaches 40 N m. The moment of inertia of the motor armature is 1.6 kg m^2 and that of the rotating part of the machine is 3.0 kg m^2. The torque developed by the motor is 27 N. m assumed constant at all speeds and when the clutch is engaged the steady speed of motor and machine is 500 rev/min. At a given instant the clutch is disengaged and remains so for 4 s and then it is reengaged. Find the time of slipping after re-engagement and determine how much energy is lost during slipping. **($23\frac{2}{3}$)**

4. (a) In the gear train as shown in Figure for Q. 4(a), the input shaft X is directly connected to the sun-wheel A of the epicyclic gear and it rotates the annular wheel B through the geared side shaft, turning about a fixed axis, and the pinion D and external wheel B_0 on the casing of B. The teeth are all of the same and the numbers are as follows: E = E_1 = 75, D = 30, B_0 = 120, A = 40, C = 30, B = 100. If the speed of the input shaft is 112 rev/min, find the speed of the output shaft Z. **(23)**

(b) As shown in Figure for Q. 4(b), a brake drum 330 mm diameter is acted on by two brake shoes which are mounted on a pin A, and pushed apart by two hydraulically operated pistons at B, each exerting a force of *P* N on the shoe on which it makes contact. The brake lining on each shoe extends 60° above to 60° below the horizontal centre line. The coefficient of friction is 0.2. The radial pressure between the lining and the drum is proportional to the rate of wear of the lining. Find the value of P to produce a braking torque of 180 Nm. **($23\frac{2}{3}$)**

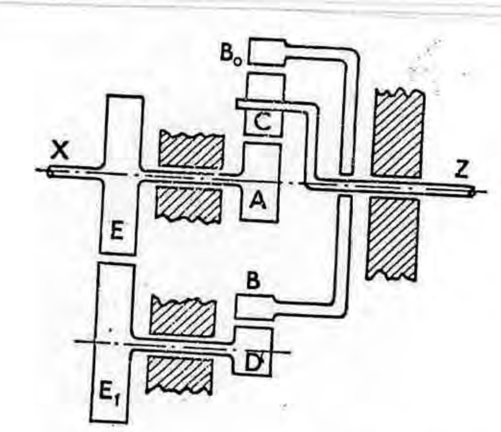


Figure for Q. 4(a)

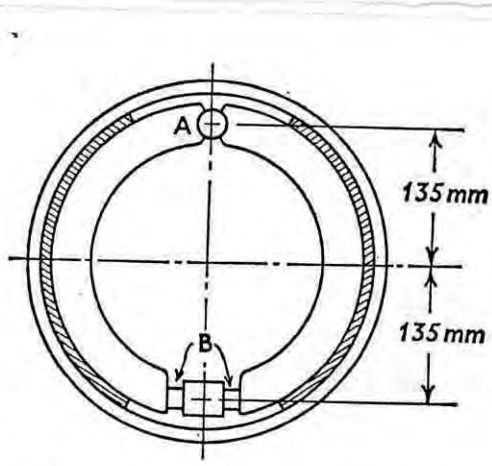


Figure for Q. 4(b)

SECTION – B

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

5. The mechanism as shown in Fig. for Q. No. 5 has the dimensions as follows: OA = 30 mm, AB = 80 mm. BC = 50 mm, BG = 40 mm, FG = 40 mm and EF = 60 mm.
The crank OA rotates at a uniform speed of 100 rpm. For the given configuration determine, the velocity and the acceleration of point E. **(46⅔)**

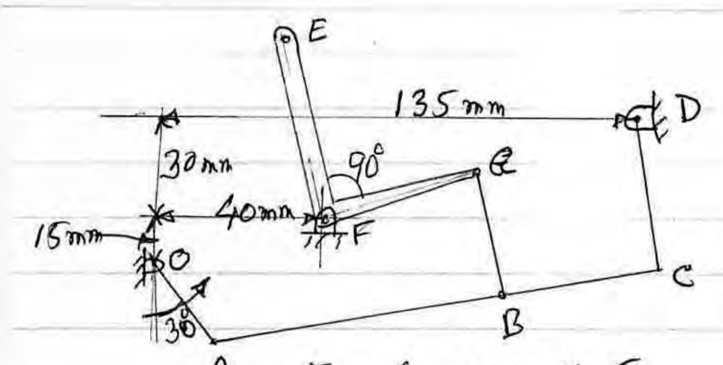


Fig. for ques. No. 5

6. A cam with a minimum radius of 30 mm, rotating clockwise at a uniform speed of 150 rpm to give motion to a knife-edge follower as below: **(46⅔)**
   (a) Follower to move outwards through 20 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 next 90° of cam rotation, and
   (d) Follower to dwell for the rest of the cam rotation.

   The line of stroke of the follower is offset 10 mm from the center of the cam. The displacement of the follower takes place with uniform and equal acceleration and retardation on both the outward and return strokes. Draw the profile of the cam and also draw the displacement, the velocity and the acceleration diagrams for one complete revolution of the cam.

7. (a) A five cylinder in-line engine running at 750 rpm has successive cranks 144° apart, the distance between the cylinder center lines being 375 mm. The piston stroke is 225 mm and the ratio of the connecting rod to the crank is 4. Examine the engine for balance of primary and secondary forces and couples. Find the maximum values of these and position of the central crank at which these maximum values occur. The reciprocating mass for each cylinder is 15 kg. **(23)**
   (b) A cast iron flywheel used for a four stroke I-C engine is developing 15 kW at 300 rpm. The hoop stress developed in the flywheel is 5.5 MPa. The total fluctuation of speed is to be limited to 3% of the mean speed. If the work done during the power stroke is $\frac{1}{3}$ times more than the average work done during the whole cycle. Find: (i) mean diameter of the flywheel, (ii) mass of the flywheel, (iii) cross-sectional dimension of the rim if width is twice the thickness. (Assume density of cast iron is 7250 kg/m^3) **(23⅔)**

Contd P/4

8. (a) A V-belt drive consists of three V-belts in parallel on grooved pulleys of the same size. The angle of groove is 30° and the coefficient of friction is 0.12. The cross-sectional area of the belt is 220 mm^2 and the permissible safe stress in the material is 3 MPa. Calculate the power that can be transmitted between two pulleys of 450 mm diameter rotating at 750 rpm. **(23)**

(b) The turning moment curve for an engine is represented by the equation, **($23\frac{2}{3}$)**

$$T = (20000 + 9500 \sin 2\theta - 5700 \cos 2\theta) \text{ N-m}$$

Where θ is the angle moved by the crank from inner dead center? If the resisting torque is constant, find: (i) Power developed by the engine, (ii) Angular acceleration of the flywheel when the crank has turned through 45° from inner dead center, (iii) Moment of inertia of flywheel. If the total fluctuation of speed is not exceed 1% of mean speed which is 200 rpm.

L-3/T-1/ME **Date : 05/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols indicate their usual meaning. Assume any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Derive the general heat conduction equation in Cartesian co-ordinate system and hence simplify it for the case of steady heat flow through an isotropic medium of constant thermo-physical properties with no heat generation. **(17)**

(b) Consider the base plate of a 1200-W household iron that has a thickness of L = 0.5 cm, base area of A = 300 cm^2, and thermal conductivity k = 15 W/m.K as shown in the Fig. for Q. 1(b). The inner surface of the base plate is subjected to uniform heat flux, generated by the resistance heaters inside and the outer surface loses heat to the surroundings by convection (T_α = 20 °C, h = 80 $W/m^2.K$). Disregarding the radiation heat loss, obtain the expression for the variation of temperature in the base plate and hence evaluate the temperature on both sides of the base plate. **(18)**

2. (a) Show the analogy among heat, fluid and electric current flow and briefly describe the concept of thermal resistance. **(20)**

Using the concept of thermal resistance network, solve the following problem as shown in the Fig. for Q. 2(a).

Steam at $T_{\alpha 1}$ = 320 °C flows in a cast iron pipe (k = 80 W/m.K) whose inner and outer radius are r_1 = 2.5 cm and r_2 = 2.75 cm respectively. The pipe is covered with 3 cm thick glass wool insulation (k = 0.05 W/m.K). heat is lost to the surroundings at $T_{\alpha 2}$ = 5 °C by natural convection and radiation with a combined heat transfer coefficient of h_2 = 18 $W/m^2.K$. Considering the heat transfer coefficient, h_1 = 18 $W/m^2.K$ at the inner surface of the pipe, determine the heat loss from the steam per unit length of the pipe.

(b) What do you understand by critical radius of insulation? Obtain the expression of critical radius of insulation for a cylindrical body subjected to convection at the outer surface. **(15)**

Contd P/2

ME 301

3. (a) With suitable examples briefly explain why fins are used for. Also discuss the factors that are to be considered in design and selection of fins. **(10)**

(b) A homogeneous spherical radioactive material (k = 15 W/m.K) of radius r_0 = 0.04 m is generating heat at the rate of 5×10^7 W/m^3. The generated heat is dissipated to the environment steadily. The outer surface of the sphere is maintained at 110 °C. Assuming this process as 1-D steady heat conduction, find the temperature distribution inside the solid and determine the temperature of the center of the sphere. Also determine the rate at which sphere loses heat to the environment. **(25)**

4. (a) For a lumped capacitance system, show that $\frac{\theta}{\theta i} = e^{-Bi*Fo}$, where the symbols have their usual meaning. **(15)**

(b) A long 35 cm diameter cylindrical shaft made of stainless steel (k = 15 W/m.K; ρ = 7900 kg/m^3; C_p = 477 J/kg.k; $\alpha = 3.95 \times 10^{-6}$ m^2/s) comes out of an oven at a uniform temperature of 500 °C. The shaft is then allowed to cool down in a chamber where T_α = 320 °C and h = 60 W/m^2.K. Determine the temperature at the center of the shaft 20 minutes after the start of cooling. Also determine the heat transfer from the shaft during this time period if the length of the shaft is 2.5 m. Use the enclosed charts for your calculations. **(20)**

SECTION – B

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

5. (a) A plane wall is subjected to specified temperature on one side and convection on the other. The finite difference formulation of this problem is to be obtained, and the nodal temperatures under steady state conditions as well as the rate of heat transfer through the wall are to be determined. The corresponding diagram is given in Fig. 5(a), where Δx = 0.1 m, k = 2.3 W/m.°C, h = 18 W/m^2.°C, T_0 = 95°C and T_α = 15°C. **(25)**

(b) How can a node on an insulated boundary be treated as an interior node in the finite difference formulation of a plane wall? Explain. **(10)**

6. (a) Show that the intensity of radiation emitted by a black body at absolute temperature, T is : $I_b(T) = \frac{\sigma T^4}{\pi}$ (W/m^2.Sr). **(17)**

(b) A flat black surface of area A_1 = 10 cm^2 emits 1000 W/m^2.Sr in the normal direction. A small surface A_2 having the same area as A_1 is placed relative to A_1 as shown in Fig. 6(b), at a distance of 0.5 m, Determine the solid angle subtended by A_2 and the rate at which A_2 is irradiated by A_1. **(18)**

Contd P/3

7. (a) The spectral emissivity of an opaque surface at 1000K is given by **(18)**

$\varepsilon_1 = 0.1$ for $\lambda_0 = 0$ to $\lambda_1 = 0.5\ \mu m$

$\varepsilon_2 = 0.5$ for $\lambda_1 = 0.5$ to $\lambda_2 = 6\ \mu m$

$\varepsilon_3 = 0.7$ for $\lambda_2 = 6$ to $\lambda_3 = 15\ \mu m$

$\varepsilon_4 = 0.8$ for $\lambda_3 > 15\ \mu m$

Determine the average emissivity over the entire range of wavelengths and the radiation flux emitted by the material at 1000K.

(b) Show that the reciprocity relation regarding the thermal radiation is : $A_1F_{12} = A_2F_{21}$. **(17)**

8. (a) The long circular half-cylinder shown in Fig. 8(a) has a diameter of 60 cm and a square rod 20 cm by 20 cm placed along the geometric centerline. Both are surrounded by a large enclosure. Find F_{12}, F_{13} and F_{11} in accordance with the nomenclature in the figure. **(17)**

(b) A cubical room 3m by 3m by 3m is heated through the floor by maintaining it at a uniform temperature of 310K. Since the side walls are well insulated, the heat loss through them can be considered negligible. The heat loss takes place through the ceiling, which is maintained at 280K. All surfaces have an emissivity $\varepsilon = 0.85$. Determine the rate of heat loss by radiation through the ceiling. **(18)**

----

(4)

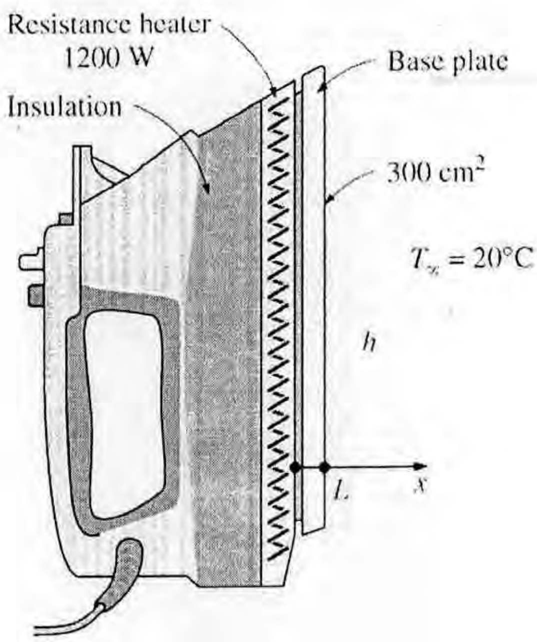


Fig. for Q. 1(b)

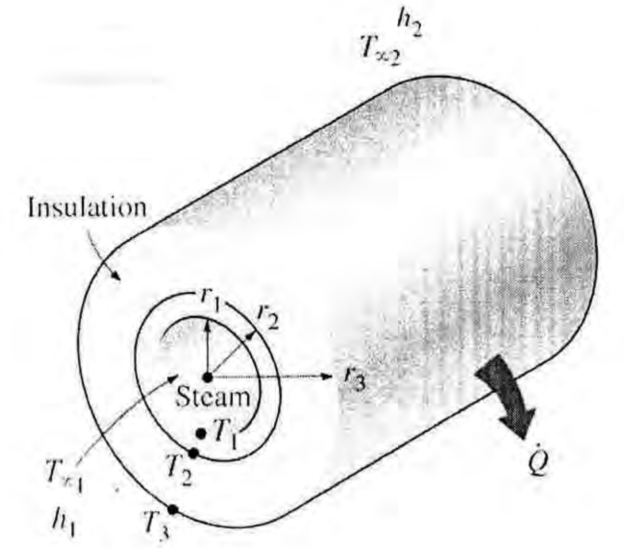
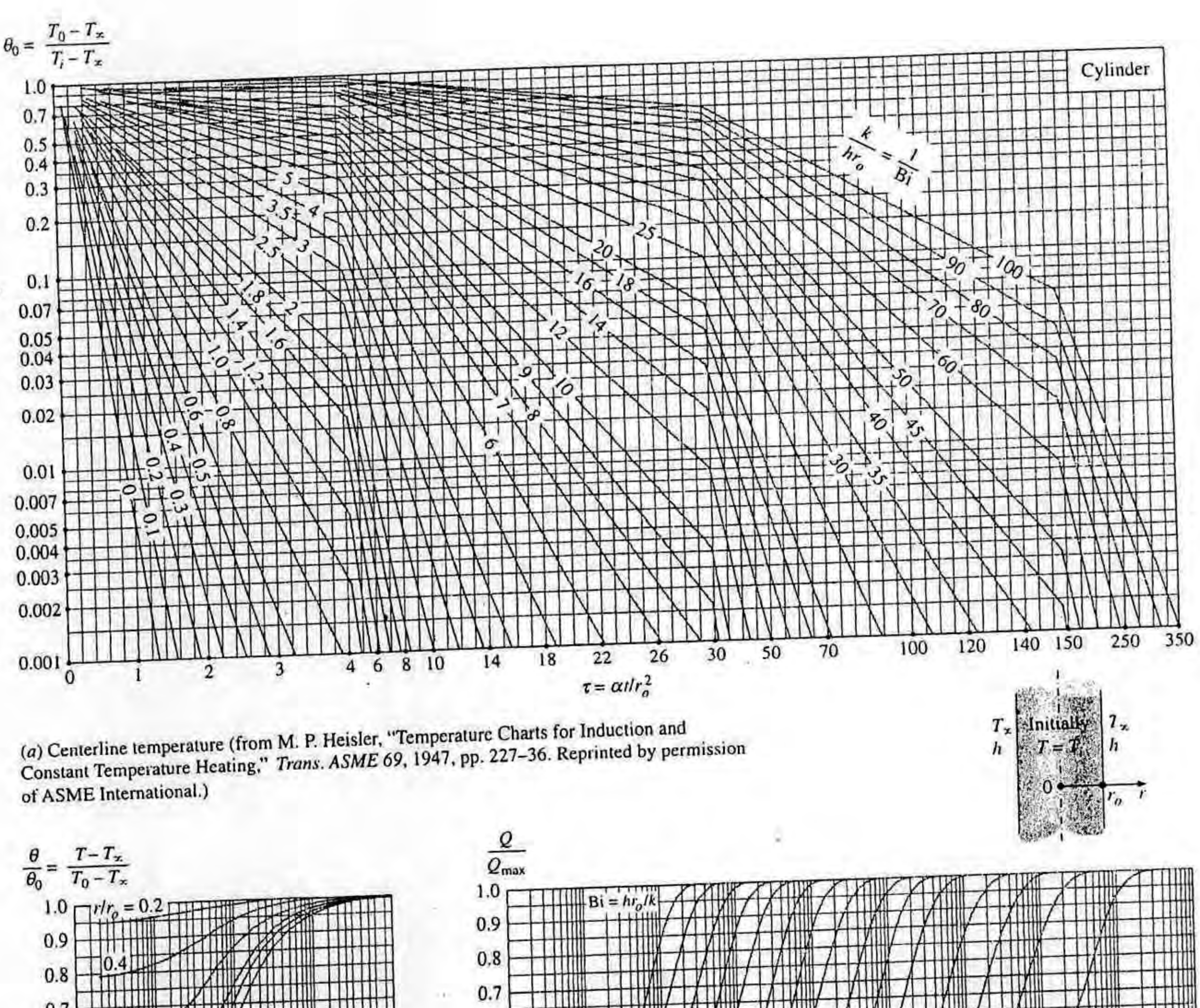
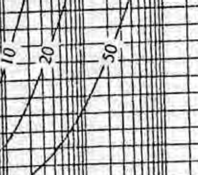
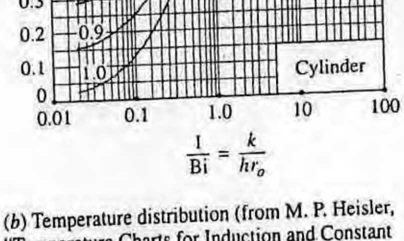


Fig. for Q. 2(a)

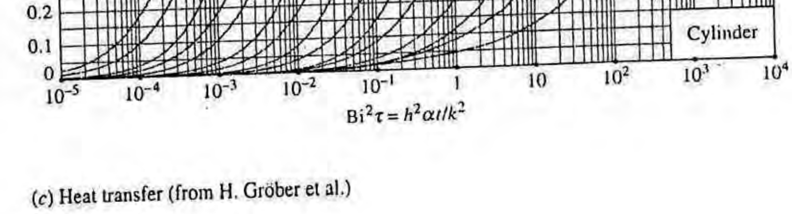


(*a*) Centerline temperature (from M. P. Heisler, "Temperature Charts for Induction and Constant Temperature Heating," *Trans. ASME 69*, 1947, pp. 227–36. Reprinted by permission of ASME International.)





(*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.)

FIGURE 4–17

Transient temperature and heat transfer charts for a long cylinder of radius r_o initially at a uniform temperature T_i subjected to convection from all sides to an environment at temperature T_∞ with a convection coefficient of h.

Charts for Q.4(b)

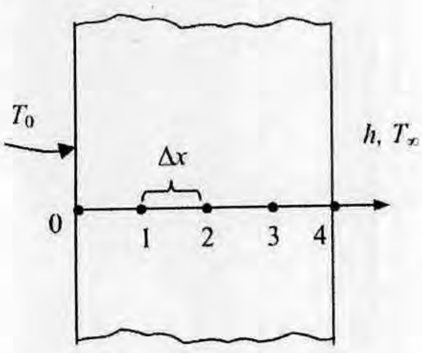


Fig. 5(a)

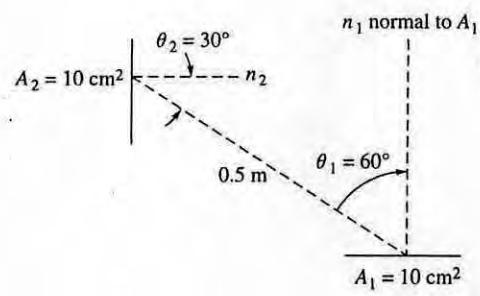


Fig. 6(b)

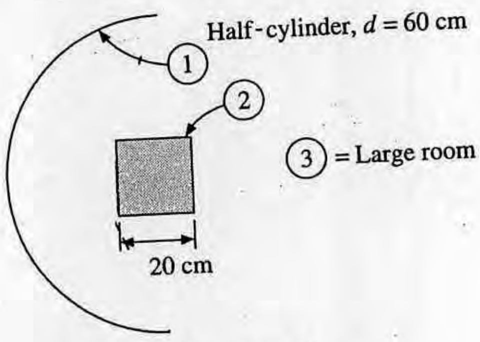


Fig. 8(a)

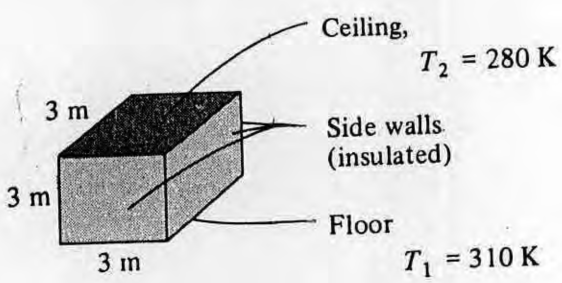


Fig. 8(b)

TABLE
Blackbody radiation functions

λT, μm·K	$f_{0\lambda}(T)$	λT, μm·K	$f_{0\lambda}(T)$
555.6	0.00000	5,777.8	0.71806
666.7	0.00000	5,888.9	0.72813
777.8	0.00000	6,000.0	0.73777
888.9	0.00007	6,111.1	0.74700
1,000.0	0.00032	6,222.2	0.75583
1,111.1	0.00101	6,333.3	0.76429
1,222.2	0.00252	6,444.4	0.77238
1,333.3	0.00531	6,555.6	0.78014
1,444.4	0.00983	6,666.7	0.78757
1,555.6	0.01643	6,777.8	0.79469
1,666.7	0.02537	6,888.9	0.80152
1,777.8	0.03677	7,000.0	0.80806
1,888.9	0.05059	7,111.1	0.81433
2,000.0	0.06672	7,222.2	0.82035
2,111.1	0.08496	7,333.3	0.82612
2,222.2	0.10503	7,444.4	0.83166
2,333.3	0.12665	7,555.6	0.83698
2,444.4	0.14953	7,666.7	0.84209
2,555.6	0.17337	7,777.8	0.84699
2,666.7	0.19789	7,888.9	0.85171
2,777.8	0.22285	8,000.0	0.85624
2,888.9	0.24803	8,111.1	0.86059
3,000.0	0.27322	8,222.2	0.86477
3,111.1	0.29825	8,333.3	0.86880
3,222.2	0.32300	8,888.9	0.88677
3,333.3	0.34734	9,444.4	0.90168
3,444.4	0.37118	10,000.0	0.91414
3,555.6	0.39445	10,555.6	0.92462
3,666.7	0.41708	11,111.1	0.93349
3,777.8	0.43905	11,666.7	0.94104
3,888.9	0.46031	12,222.2	0.94751
4,000.0	0.48085	12,777.8	0.95307
4,111.1	0.50066	13,333.3	0.95788
4,222.2	0.51974	13,888.9	0.96207
4,333.3	0.53809	14,444.4	0.96572
4,444.4	0.55573	15,000.0	0.96892
4.555.6	0.57267	15,555.6	0.97174
4,666.7	0.58891	16,111.1	0.97423
4,777.8	0.60449	16,666.7	0.97644
4,888.9	0.61941	22,222.2	0.98915
5,000.0	0.63371	27,777.8	0.99414
5,111.1	0.64740	33,333.3	0.99649
5,222.2	0.66051	38,888.9	0.99773
5,333.3	0.67305	44,444.4	0.99845
5,444.4	0.68506	50,000.0	0.99889
5,555.6	0.69655	55,555.6	0.99918
5,666.7	0.70754	∞	1.00000

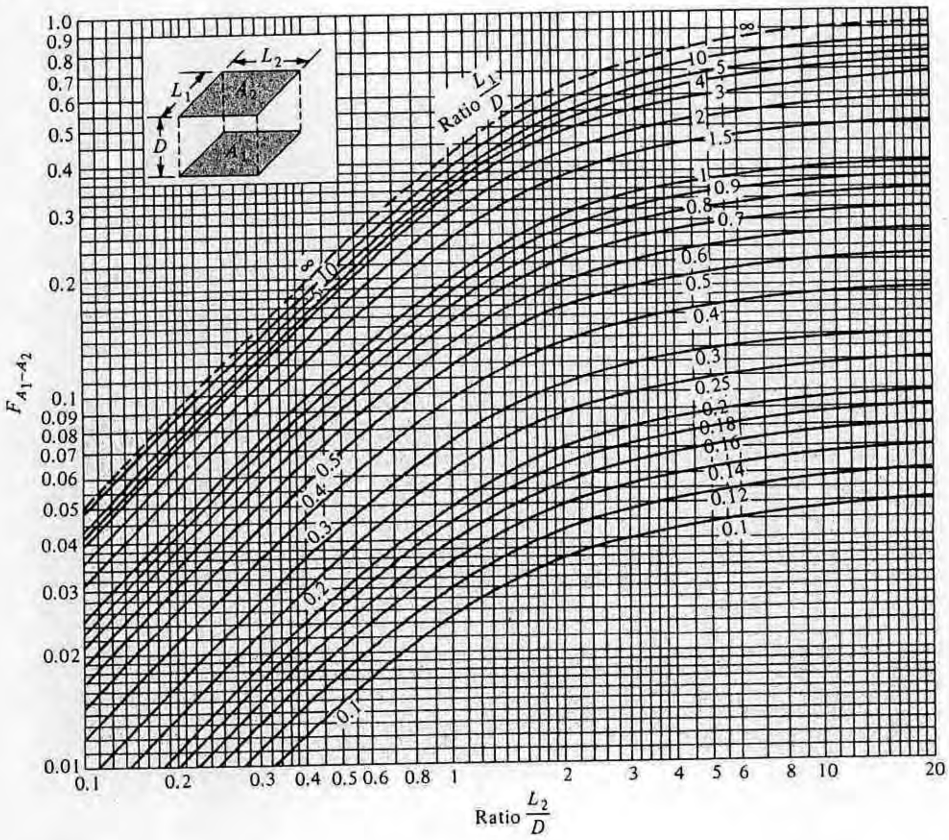


FIGURE
View factor $F_{A_1-A_2}$ from a rectangular surface A_1 to a rectangular surface A_2 which are adjacent and in perpendicular planes. (From Mackey et al.)

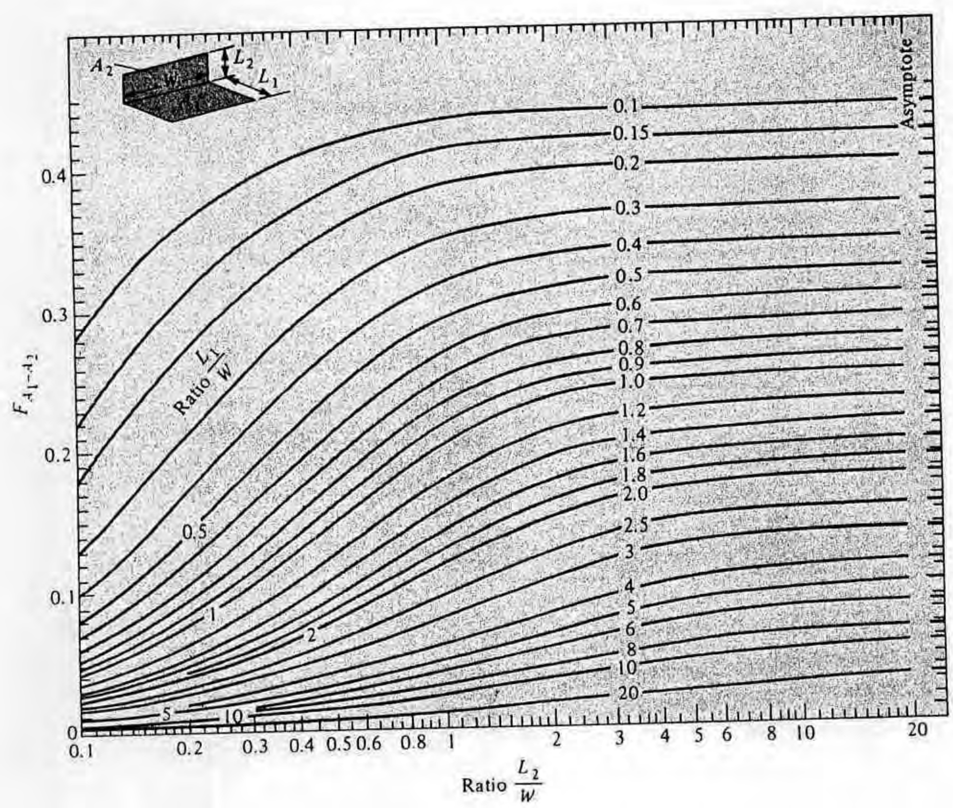


FIGURE
View factor $F_{A_1-A_2}$ from a rectangular surface A_1 to a rectangular surface A_2 which are parallel to and directly opposite each other. (From Mackey et al.)

L-3/T-1/ME **Date : 30/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

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 any missing data.

Machine Design book will be supplied.

1. (a) The plate with a circular hole in Fig. for Q. No. 1(a) is subjected to a tensile stress σ_0 at the boundaries AB and CD. The plate is made of steel 4340 material with S_y = 1515 MPa, if b = 200 mm, a = 50 mm, and the plate thickness, t = 20 mm, determine the maximum value of σ_0 that can be safety applied considering a safety factor of 1.5. **(18)**

   Perform another analysis to calculate the maximum value of σ_0 assuming two edge cracks of 2 mm each at points E and F of the hole, in directions perpendicular to the loading direction. What is the percentage of reduction of the allowable stress (σ_0) if cracks are present?

   (b) The steel bar AB in Fig. for Q. No. 1(b) is subjected to the load F = 10 kN acting at point C of lever BC. Determine the midpoint deflection of bar AB along the vertical direction for this loading. Use castigliano's theorem. **(17)**

2. (a) The estimated contact force between a wheel and railroad (Fig. for Q. No. 2(a)) is 300 kgf. The wheel is made of steel material with E = 207 GPa, γ = 0.3 and H_B = 300. First consider the case of static loading. Determine the maximum shear stress generated in the wheel if the wheel diameter is 300 mm and width 80 mm. Also, determine the location of this stress. **(20)**

   Now, for fatigue loading, if the design requirement is such that the parts will not fail upto 10^8 cycles of loading, what minimum width of the wheel would be necessary.

   (b) A hollow steel shaft with 100 mm inner diameter and 1 m of length transmits 10 kW power at 1000 rpm in the mixing chamber of a food processing industry. If S_{sy} = 300 MPa, G = 80 GPa for this shaft material, and the allowable angle of twist is 4°, determine the minimum thickness of the shaft considering a safety factor of 1.5. **(15)**

3. The machine shaft in Fig. for Q. No. 3, is machined from steel material and is subjected to a combined axial, bending, and torsional stresses. F is a fluctuating load that varies between 0 and + 10 kN, whereas M is completely reversed bending moment of ± 10 kN-m. The shaft is also subjected to a constant torsional load of 5 kN-m (not shown in Figure).

Contd P/2

ME 341

Contd ... Q. No. 3

Considering, d = 50 mm, D = 100 mm, S_{ut} = 800 MPa, S_{yt} = 500 MPa, determine the factor of safety that is maintained in the design for infinite life based on – **(35)**

(i) Soderberg equation

(ii) Gerber equation

Choose 95% reliability for the design.

4. (a) In a press and shrink fit assembly of the two cylindrical pipes (Fig. for Q. No. 4(a)), the radial interference is given by δ = 0.5 mm. The pipes are made of steel material with E = 207 GPa, S_y = 550 MPa, and γ = 0.3 and the pipe dimensions are given as r_0 = 200 mm, R = 150 mm, r_i = 120 mm. If the inner pipe is alo subjected to an internal pressure of p_i, determine its maximum allowable value according to the maximum shear stress theory. {Hint: Consider the stresses developed in the inner cylinder only in your analysis]. **(20)**

(b) In a microprocessor package, the stresses at a point on the outside surface of the package are given as σ_x = – 60 MPa, σ_y = –50 MPa, τ_{xy} = 40 MPa. If the ultimate tensile and compressive strength of the package material at that point are 150 MPa and 175 MPa, respectively, find the factor of safety 'n' against failure based on the Column-Mohr failure theory for brittle material. **(15)**

SECTION – B

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

Symbols carry their usual meaning. Assume reasonably any missing data.

'Shigley's Mechanical Engineering Design' Book will be supplied.

5. (a) An eccentrically loaded column (e = 0.12 mm, ec/k^2 = 0.02) has the cross-section as shown in Fig. for Q. No. 5. Use following data: Column material is AISI 1030 CD, E = 207 GPa, compressive load is 70 kN, end-condition: pinned-pinned, l = 500 mm. Calculate, at the mid-span (i) the lateral deflection and (ii) the maximum compressive stress. **(16)**

(b) Another column is centrally loaded and has following data: l = 1280 mm and end-condition: fixed-rounded. Material properties and cross-section are same as in Q. No. 5(a). **(19)**

(i) find the buckling load and design load for a safety factor of 3 (ii) find the direction of buckling with reference to the cross-section.

6. A sliding fit has following particulars:

45 mm H7/g6

Natural spread coincides with tolerance for both hole and shaft. **(35)**

(i) Neatly draw and label the assembly showing all important dimensions (ii) Calculate the minimum, maximum and most frequent clearances (iii) If, 15% of the assembly is rejected because of too much clearance, what is the maximum clearance that is accepted?

Contd P/3

ME 341

7. (a) An ACME thread ($2\alpha = 29°$) power screw carries a load of 2 kN. Given: pitch = 5 mm, pitch dia = mean dia = 35 mm, the screw is double threaded. Ignore collar friction and take f = 0.092. **(15)**

   (i) Is the screw self-locked?

   (ii) Calculate the mechanical advantage and torque required to lift the load.

   (iii) Will the efficiency of the screw increase if collar friction is considered? briefly justify your answer.

   (b) A single steel (E = 207 GPa) bolt connects C.I. members (E_m = 80 GPa) as shown in Fig. for Q. No. 7(b). **(20)**

   Given: M 14 × 2 bolt, Property class 9.8, grip length = $l = l_d + l_t$ = 100 mm, Coarse pitch, $l_d = 6\ l_t$, Initial torque induces pre-tension in the bolt which becomes 70% of proof load. Calculate:

   (i) the joint constant 'C'.

   (ii) initial torque, given bolt condition is lubricated.

   (iii) the separation force.

   (iv) if the safety factor (n_0) guarding against separation is 1.5, calculate the corresponding values of the damping force and bolt stress.

8. (a) A group of four bolts connect a steel plate as shown in Fig. for Q. No. 8(a). For the 1 kN loading shown, **(15)**

   (i) Identify the bolt that is most critically stressed.

   (ii) the maximum shear stress in bolt.

   (iii) the maximum bearing stress in plate.

   Nominal major diameter of each bolt is 10 mm.

   (b) The welded cantilever is subjected to a cyclic torsional load of T_{max} = 2 kN.m, T_{min} = 1 kN.m. The material is AISI 1018 CD. Find, **(20)**

   (i) static safety factor guarding against yielding.

   (ii) fatigue safety factor using ASME elliptic failure criteria. Consider 90% reliability.

   Fatigue stress concentration factor should be calculated at end of parallel fillet weld.

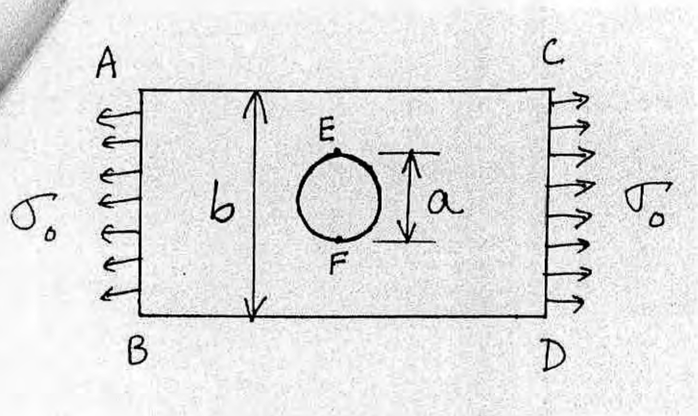


Fig. for Q. No. 1(a)

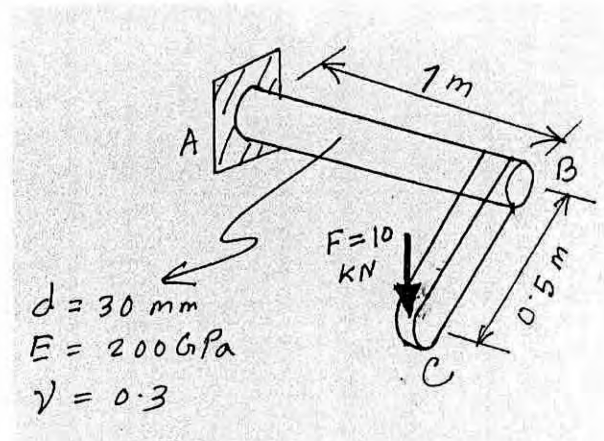


fig. for Q. No. 1 (b)

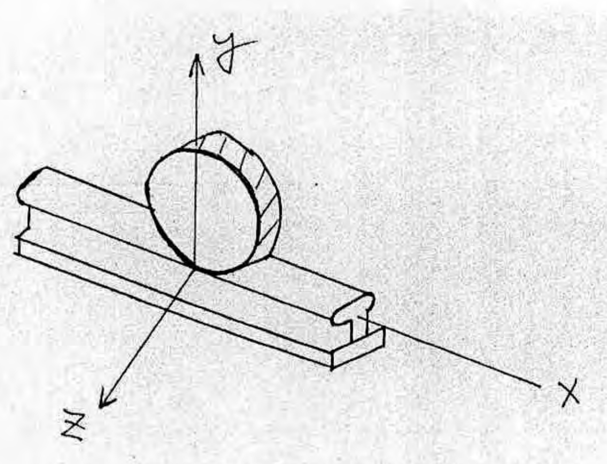


fig. for Q. No. 2(a)

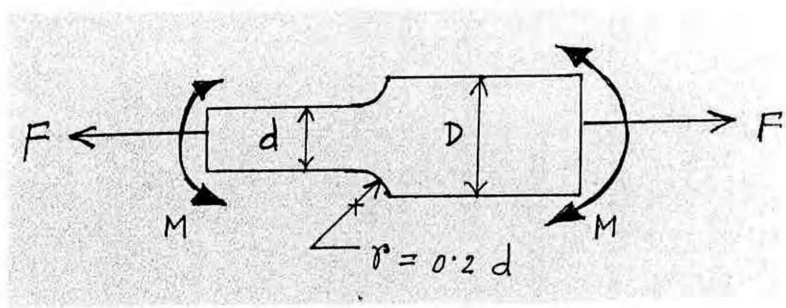


fig. for Q. No. 3

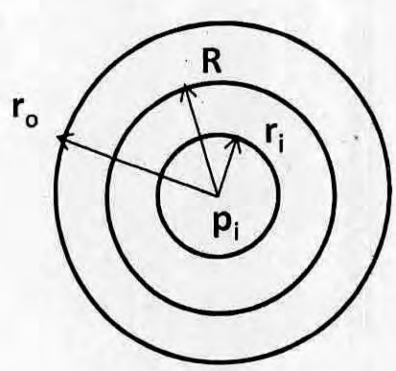
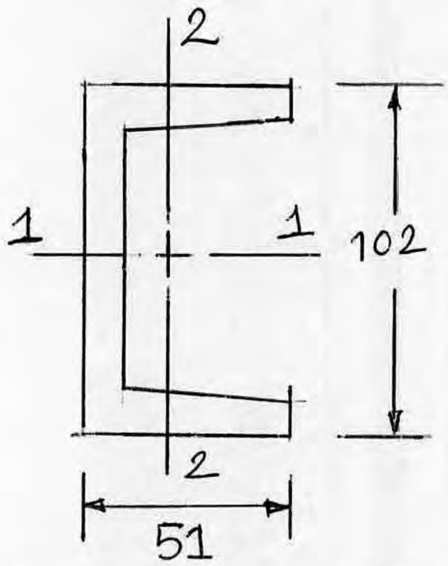


fig. for Q. No. 4(a)

ME 341



Dimensions in mm
Standard Channel Section

FIGURE for Q.5

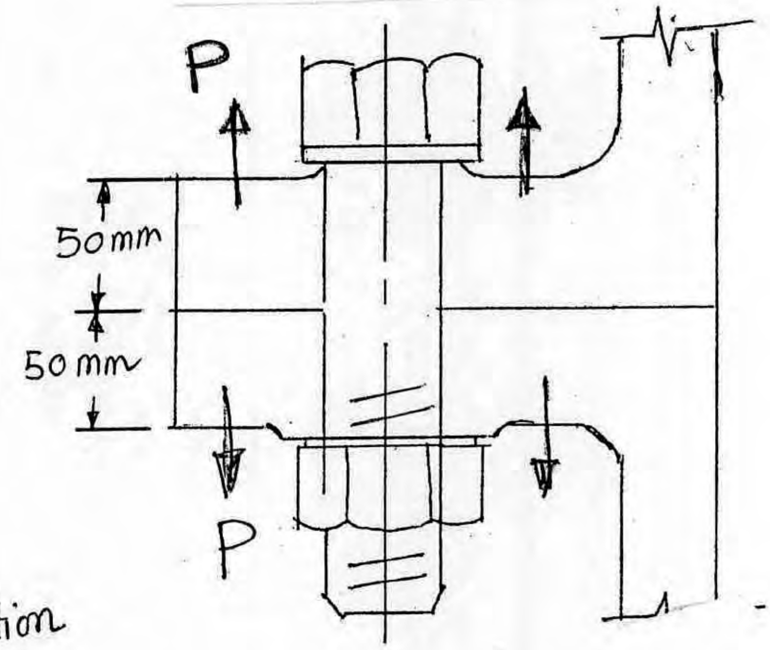
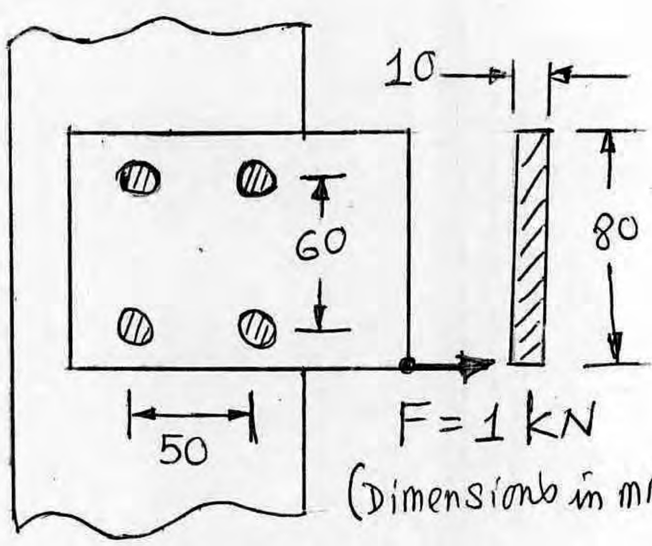
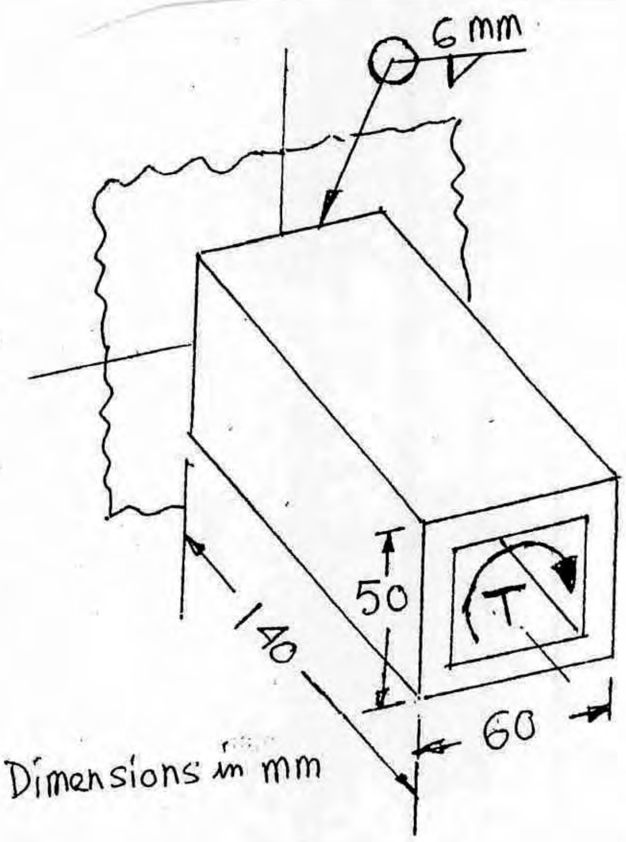


FIGURE for Q.7 (b)



(Dimensions in mm)

FIGURE for Q.8(a)



Dimensions in mm

FIGURE for Q.8(b)

L-3/T-1/ME **Date : 04/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

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

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The questions are of equal value. Assume reasonable data if necessary.

1. Discuss elasticity of fluid with an example. The density of air and absolute pressure at a height of 700 m above sea level are 1.12 kg/m^3 and 89 kN/m^2 respectively. Find the pressure and density of air at a height of 3000 m from sea level considering adiabatic process.

2. (a) Explain the different types of heads of a flowing fluid. For unsteady flow in a control volume, derive the continuity equation.
(b) Water is flowing from a large reservoir through a nozzle as shown in Fig. for Q. No. 2(b). Find the flow rate of water and pressure at point 2.

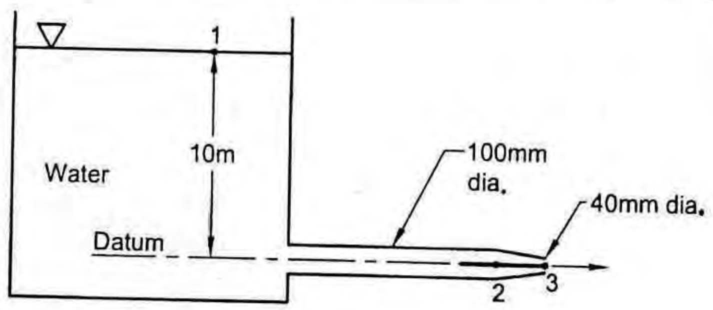


Fig. for Q. No. 2(b)

3. (a) What is vena contracta? Derive the equation of actual flow rate through a venturimeter.
(b) Air is flowing through a 75 mm diameter pipe as shown in Fig. for Q. No. 3(b). If the deflection in the manometer is 15 mm of Hg, find the flow rate of air. Density of air is 1.22 kg/m^3.

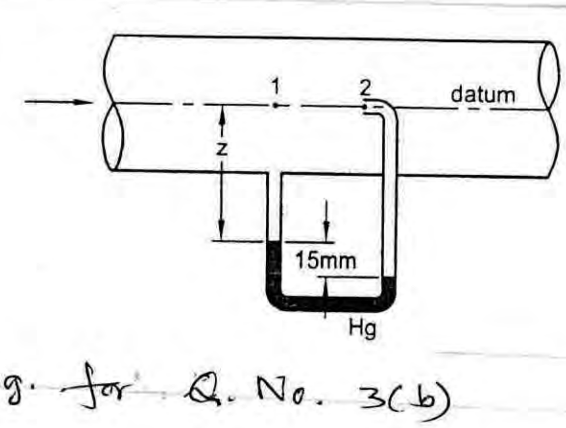


Fig. for Q. No. 3(b)

Contd P/2

ME 321

4. (a) Deduce Newton's law of viscosity. Why does viscosity of liquid decrease with temperature rise whereas reverse happens in case of gas?
(b) A cylindrical shaft of 95 mm diameter rotates at 50 rpm inside a cylinder of 96.4 mm diameter. Both the shaft and the cylinder are 0.5 m long. If the torque required to rotate the shaft is equal to 1 Nm, find the viscosity of the oil occupying the annular space.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
The figures in the margin indicate full marks.

5. (a) What is meant by continuum? Why is this assumption necessary in fluid mechanics? **(5)**
(b) Describe with neat sketches different conditions of rotational stability of submerged bodies. **(8)**
(c) What is metacentric height? What is the condition of stability of a floating body in terms of metacentric height? **(7)**
(d) Will the cone float in water as shown in Fig. Q. 5(d) with its vertex pointing downward? Take $h = 1$ m and $2\theta = 60°$. **(15)**

6. (a) Show that the centre of pressure on a submerged inclined plane always lies below the centroid. **(18)**
(b) Calculate the height H that will result in the gate automatically opening if $l = 2$ m in Fig. Q. 6(b). Neglect the gate weight. In this result independent of liquid density? **(17)**

7. (a) Determine the reading of the pressure gage shown in Fig. Q. 7(a), if $H = 2$ m and $h = 10$ cm. **(17)**
(b) The U-tube in Fig. Q. 7(b) is rotated about its right leg at 95 r/min, what will be the level h in the left leg if $L = 18$ cm and $D = 5$ cm? **(18)**

8. (a) What is incompressible flow? At what condition the flow of compressible fluids may be treated as incompressible flow? **(5)**
(b) What is streamline? What is stream function? Show that the lines of constant stream function are streamlines. **(10)**
(c) Show that for a 2D inviscid irrotational flow, the continuity equation may be expressed as a Laplace equation in velocity potential ϕ and the condition of irrotationality may be expressed as a Laplace equation in stream function, ψ. **(10)**
(d) Determine the stream function and the velocity potential for a line source and draw the flow net. **(10)**

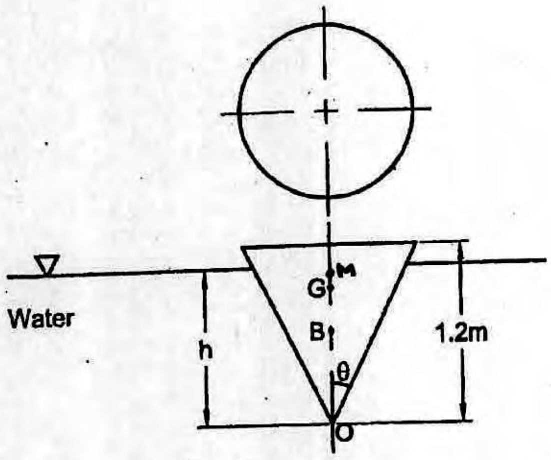


Figure for Q5d

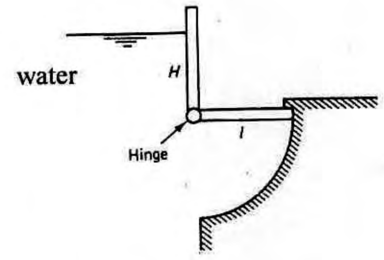


Figure for Q6b

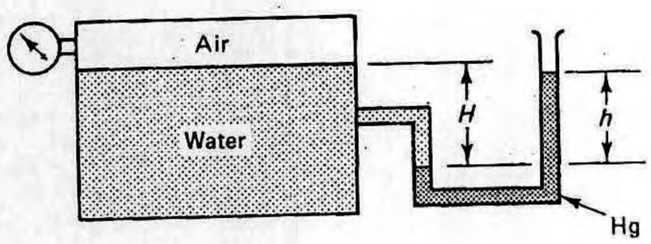


Figure for Q7a

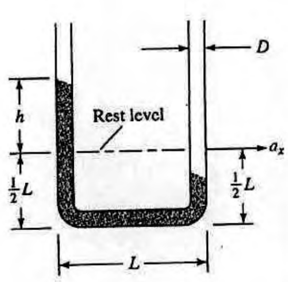


Figure for Q7b

L-3/T-1/ME **Date : 08/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

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) When a shall a calibration be performed? State the purpose of calibration. **(5)**

   (b) Describe the generalized measuring system with a block diagram. What are the stages of measurement system? Describe. **(10)**

   (c) What do you mean by response of measuring system? Describe amplitude, frequency and phase response. **(20)**

2. (a) Write short notes on Discrete Fourier Transforms. **(5)**

   (b) What do you mean by beat frequency and hetrodyning. **(10)**

   (c) Describe three special waveforms of harmonic nature and mention its application. **(10)**

   (d) What do you mean by Nyquist frequency? State its importance. **(10)**

3. (a) Briefly describe the working principle of a strain gauge. What do you mean by gauge factor? Describe its physical meaning. **(8)**

   (b) What are the differences between pitot-tube and pitot static tube? Describe with sketches. **(10)**

   (c) Describe with sketches the elastic elements used as pressure sensors. **(10)**

   (d) Name any of the instruments that is used for measuring low pressure in a system. **(3)**

   (e) What is piezoelectric pressure transducer? Describe. **(4)**

4. (a) Describe the advantages of using venture for flow measurement. **(5)**

   (b) What are the advantages of using LVDT? **(5)**

   (c) What do you mean by psychoacoustics relationships? Describe with sketches the thresholds of hearing and tolerance for young people with good hearing. **(10)**

   (d) Write short notes on any three of the following: **(15)**

   (i) Proving ring
   (ii) Blackbox of an airplane
   (iii) Hall effect sensors
   (iv) Time-displacement relationships for damped motion.

Contd P/2

ME 361

SECTION – B

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

Make reasonable assumptions in case of any missing data.

5. (a) What will be the maximum V_{out} of the following diode clamp? How diodes can be used to protect switches against inductive kick? **(6)**

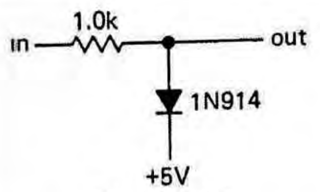


Figure 5(a)

(b) A square wave with period T that goes between +/– V_o is applied to the following RC circuit. Complete the following graphs: **(9)**

Plot V_{CAP} *(t)* for:

(i) $RC \approx T$

(ii) $RC << T$

(iii) $RC >> T$

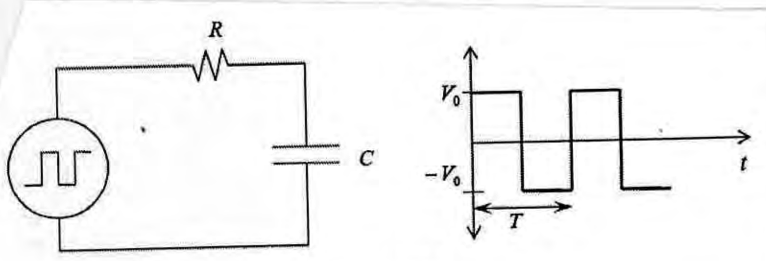


Figure 5(b)

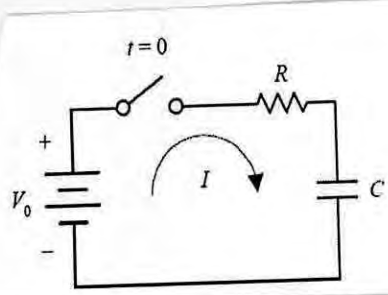
(c) For the following situations draw practical circuits using transistors: **(9)**

(i) Transistor as a switch

(ii) Emitter follower

(iii) Voltage amplifier

(d) In the following RC circuit assume that the switch is initially open unit time $t = 0$, at which time it is closed and left closed thereafter. Derive the expression of V_R and V_C. Hence plot, I vs. V_R and I vs. V_C. **(11)**

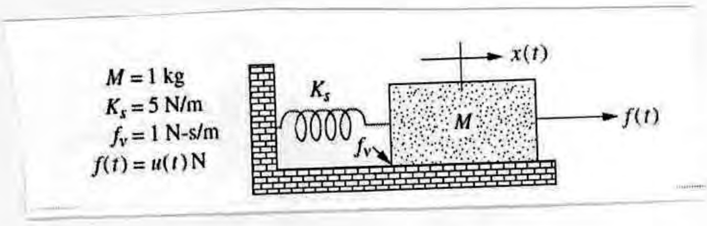


Contd P/3

ME 361

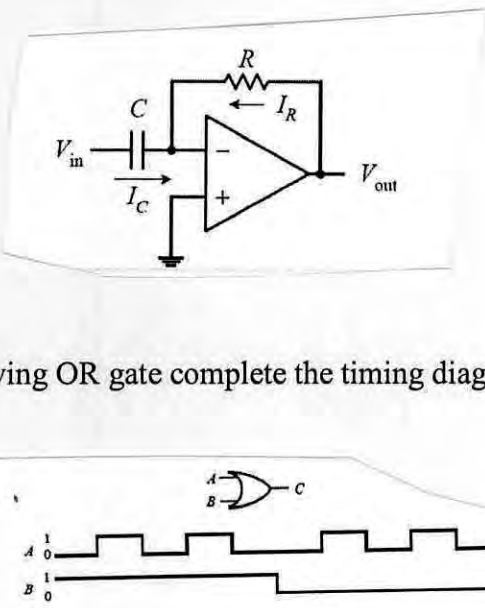
6. (a) Prove that the rise time of a first order system is given by 2.2 × time constant. **(7)**

(b) Solve for *x(t)* in the system shown in Figure 6(b) if *f(t)* is a unit step. **(15)**

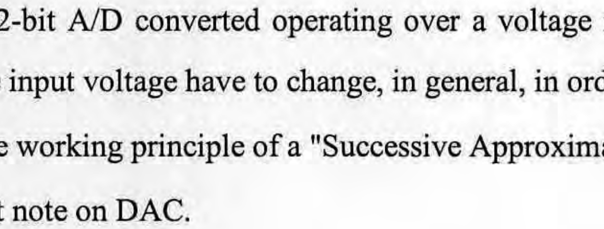


(c) Discuss the response of a second order system under harmonic input. **(13)**

7. (a) Find out V_{out} in terms of C, R and V_{in} for the following differentiator circuit. What will the shape of V_{out} be if the signal V_{in} is a triangular wave? Draw the input and output wave form. **(9)**



(b) For the following OR gate complete the timing diagram. **(3)**



(c) Given a 12-bit A/D converted 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? **(5)**

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

(e) Write short note on DAC. **(8)**

8. (a) Write short note on the following: **(21)**

   (i) Thermistor

   (ii) Thermocouple

   (iii) RTD

   (b) Many control systems use a combination of the three types of feedback: **(14)**

Proportional + Integral + Derivative (PID) Control. The foundation of the system is proportional control. Adding integral control provides a means to eliminate steady-state error but may increase overshoot. Derivative control is good for getting sluggish systems moving faster and reduces the tendency to overshoot. The response of the PID system can be described by the following equation,

$$\text{Output}_{PID} = K_P E + K_I K_P \sum(E\Delta t) + K_D K_P \frac{\Delta E}{\Delta t}$$

Design an analog PID controller using Operational amplifier.
