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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2011-2012

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

Full Marks : 210

Time : 3 Hours

Machine design hand book-1 will be provided.

The figures in the margin indicate full marks.

Assume reasonable value for any missing data. Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION - AThere are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) For a bolted assembly with eight bolts, the stiffness of the bolt is $k_b = 1.0$ MN/mm and the stiffness of the members is $k_m = 2.6$ MN/mm. The joint is subjected ^{to} the occasional disassembly and should be preloaded accordingly. Assume the external load is equally distributed to all the bolts. It has been determined to use M6 \times 1 bolts. **(15)**
- (i) Determine the maximum external load P_{max} that can be applied to the entire joint without exceeding the proof strength of the bolts.
- (ii) Determine the maximum external load P_{max} that can be applied to the entire joint without causing joint separation.
- (b) The cantilever bracket shown in Fig. for Q. 1(b) is bolted to a column with three M12 \times 1.75 bolts. The bracket is made from BS 070M20 cold-drawn steel. Find the factors of safety for the following failure modes: shear of bolts, bearing of bolts, bearing of bracket, and bending of bracket. All dimensions in Fig. for Q. 1(b) are in mm. **(20)**
2. (a) A steel bar of thickness h , to be used as a beam is welded to a vertical support by fillet welds as shown in Fig. for Q. 2(a). Given the dimensions are $b = 30$ mm, $c = 150$ mm, $d = 30$ mm, **(17)**
- (i) Find the safe force F based on allowable shear stress in the welds of 130 MPa.
- (ii) Find the allowable load (F) considering the material properties as follows:
- Bar: $S_{ut} = 350$ MPa, $S_y = 210$ MPa
- Support: $S_{ut} = 340$ MPa, $S_y = 200$ MPa
- Electrode: $S_{ut} = 480$ MPa, $S_y = 400$ MPa
- (b) The cantilever tube shown in Figure for Q. 2(b) is to be made of an aluminum alloy with $S_y = 276$ MPa. The outside diameter of the tube is 42 mm and the thickness is 5 mm. The bending load is $F = 1.75$ kN, the axial tension is $P = 9.0$ kN, and the torsion is $T = 72$ N.m. **(18)**
- Find the design factor of safety based on:
- (i) maximum shear stress theory
- (ii) distortion-energy theory

ME 341

3. (a) A cylinder subjected to internal pressure p_i has 350 mm outer diameter and 25 mm wall thickness. For the cylinder material, $K_{Ic} = 80 \text{ MPa} \cdot m^{1/2}$, $S_y = 1200 \text{ MPa}$ and $S_{ut} = 1350 \text{ MPa}$. If the cylinder contains a radial crack in the longitudinal direction of depth 12.5 mm, determine the pressure that will cause uncontrollable crack growth. (15)
- (b) Shown in Figure for Q 3(b) is a 2.8 mm by 20 mm latching spring that supports a load of $F = 100 \text{ N}$. The inside radius of the bend is 3 mm. Using curved beam theory, determine the stresses at the inner and outer surfaces at the bend. Find the factor of safety guarding against yield if the spring material is BS 416S21. (20)
4. (a) A non-rotating AISI 1040 hot rolled steel shaft of 30 mm diameter is subjected to a completely reversed bending load at a temperature of 200°C . Corresponding to a reliability of 90% and stress cycles of 3×10^4 , estimate the fatigue strength of the shaft. (15)
- (b) A completely reversed axial load of 15 kN is applied to a machine finished plate (BS 070M20, HR) as shown in the Figure for Q 4(b). Determine the fatigue factor of safety for achieving infinite life based on Goodman equation at 99% reliability. (20)

SECTION – B

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

5. (a) The shaft as shown in Figure for Qs. No. 5(a), is supported in bearings at o and c and is subjected to bending loads due to the force components acting at A and B. The shaft is made of BS070M20 steel. If a factor of safety of 4.0 based on yield strength is to be used, find the shaft diameter at the point of maximum bending moment. (20)
- (b) A cylindrical air tank stores air at 20 MPa. The tank is to have an inside diameter of 200 mm. What should be the wall thickness if it is made of 301, $1/4$ -hard stainless steel ($S_y = 520 \text{ MPa}$) with design factor of safety 3.0 based on yield strength and a joint efficiency of 90%. (15)
6. (a) A 18 mm diameter roller is in contact with a plate cam surface whose radius of curvature is 80 mm. If the Hertz compressive stress developed is 1800 MPa for a load of 10 kN, determine the width of the plate cam surface. The roller and cam both are made of carbon steel. (17)
- (b) A steel cantilever beam is fabricated from a plate of 6 mm thickness. If a load $F = 3 \text{ kN}$ is applied as shown in Figure for Qs. No. 6(b), what will be the size of the beam for a maximum deflection of 1.0 mm. Neglect the effect of direct shear. Use Castigliano's theorem. (18)

ME 341

7. (a) A shaft and a hole are to have natural tolerances of 0.05 mm and 0.075 mm respectively. Determine the mean clearance such that not more than 6 percent of the assemblies will have clearances less than 0.05 mm. What percentage will have clearances greater than 0.175 mm? (18)
- (b) A shaft is to fit in a hole with a basic size of 200 mm. Determine limit diameters, tolerance, allowance and deviations based on sliding fit. Show them with a neat sketch. Use hole basis system. (17)
8. (a) A column is to be built of 12 mm, AISI 1020, rolled steel plates, into a square box section. It is 1.8 m long and centrally loaded to 350 kN. Consider one end fixed and other end free for your design. (35)
- (a) Determine the size of section for safety factor of 2.75.
- (b) Compute factor of safety from the Secant formula for the size as found in (a). Consider eccentricity ratio of 0.25 for your calculation. ($S_u = 448$ MPa, $S_y = 330$ MPa).
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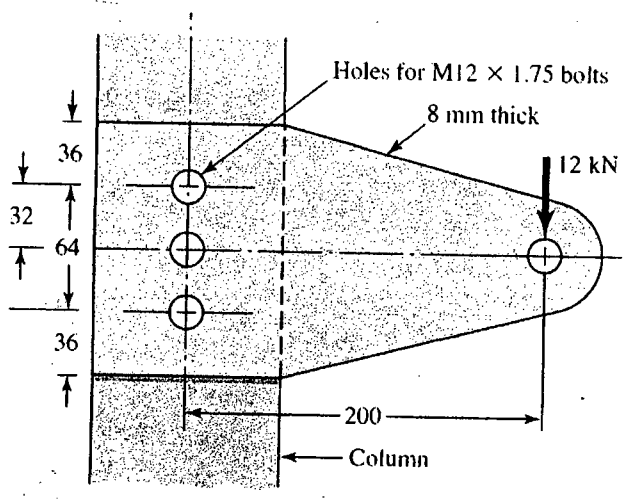


Figure for Q. 1(b)

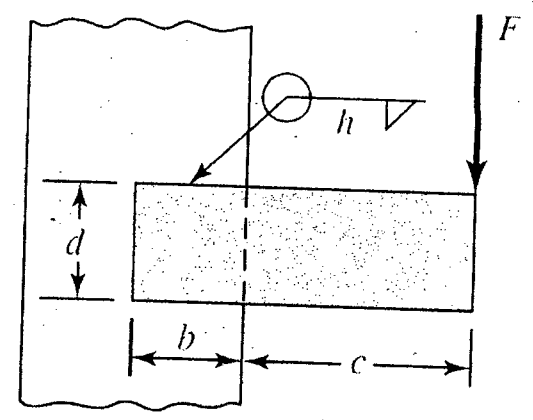


Figure for Q. 2(a)

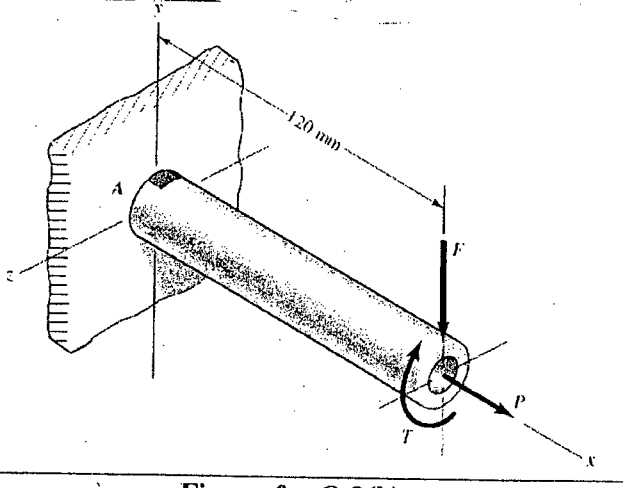


Figure for Q. 2(b)

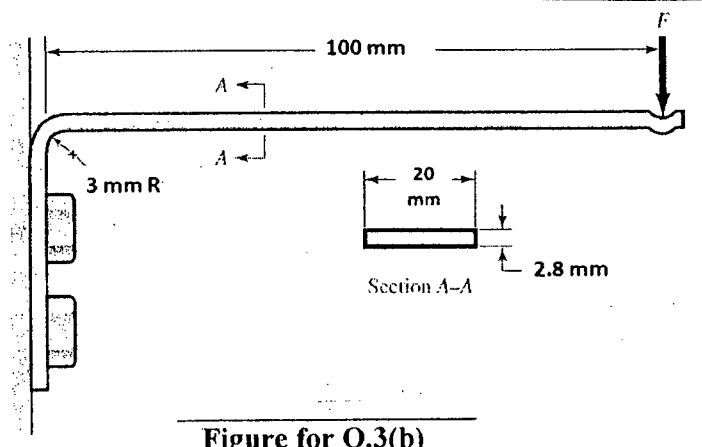


Figure for Q. 3(b)

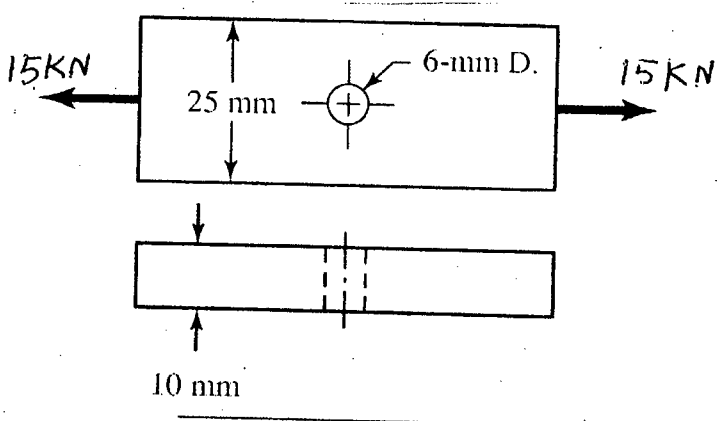
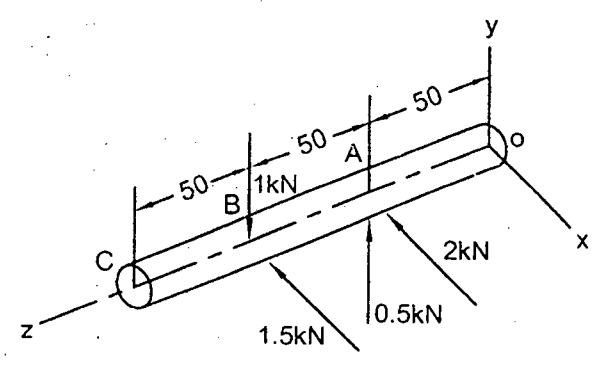


Figure for Q. 4(b)



(all dimensions are in mm)

Figure for Q. 5(a)

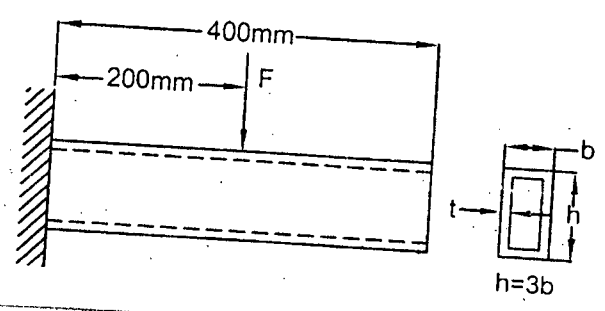


Figure for Q. 6(b)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2011-2012

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 meaning. Assume any missing data with reasonable accuracy.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION - AThere are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Two 3.0 cm diameter stainless-steel bars, 10 cm long, have ground surfaces and are exposed to air with a surface roughness of about 1 μm . If the surfaces are pressed together with a pressure of 50 atm and the two-bar combination is exposed to an overall temperature difference of 100°C, calculate the axial heat flow and temperature drop across the contact surface. Given that the contact coefficient, $h_c = 1894 \text{ W/m}^2\text{°C}$. The thermal conductivity of steel is 16.3 W/m.°C. (17)
- (b) Consider steady-state heat conduction in a square region of side 2b, in which energy is generated at a constant rate of 'g' W/m³. The boundary conditions for the problem are shown in Fig. 1(b). Write the finite-difference equations for nodes 1, 3 and 5 in this figure. (18)
2. (a) Derive the expressions for temperature distribution and heat loss from an extended surface (fin) of uniform cross section area. The end of the extended surface is insulated. (18)
- (b) An experimental device that produces excess heat is passively cooled. The addition of pin fins to the casing of this device is being considered to augment the rate of cooling. Consider a copper pin fin 0.25 cm in diameter that protrudes from a wall at 95°C into ambient air at 25°C. The heat transfer is mainly by natural convection with a coefficient equal to 10 W/m² K. Calculate the heat loss, assuming that (a) the fin is 'infinitely long' and (b) the fin is 2.5 cm long and the coefficient at the end is the same as around the circumference. Finally, (c) how long would the fin have to be for the infinitely long solution to be correct within 5 percent? Conductivity of copper is 396 W/mK. (17)
3. (a) A large block of steel [$k = 45 \text{ W/m.°C}$, $\alpha = 1.4 \times 10^{-5} \text{ m}^2/\text{s}$] is initially at a uniform temperature of 35°C. The surface is exposed to a heat flux (a) by suddenly raising the surface temperature to 250°C and (b) through a constant surface heat flux of $3.2 \times 10^5 \text{ W/m}^2$. Calculate the temperature at a depth of 2.5 cm after a time of 0.5 min for both these cases. The error function table has been attached here (Table-A1). (17)

ME 301

Contd ... Q. No. 3

(b) A 5 cm thick iron plate [$k = 60 \text{ W/m}\cdot^\circ\text{C}$, $C_p = 460 \text{ J/kg}\cdot^\circ\text{C}$, $\rho = 7850 \text{ kg/m}^3$ and $\alpha = 1.6 \times 10^{-5} \text{ m}^2/\text{s}$] is initially at $T_i = 225^\circ\text{C}$. Suddenly, both surfaces are exposed to an ambient at $T_\infty = 25^\circ\text{C}$ with a heat transfer coefficient $h = 500 \text{ W/m}^2\text{C}$.

Calculate the temperature at a depth 1.0 cm from the surface at $t = 2 \text{ min}$ after the start of the cooling. Calculate the center temperature at $t = 2 \text{ min}$ after the start of the cooling. Calculate the energy removed from the plate per square meter during this time. (18)

4. A slab, $0 \leq x \leq L$, is initially at $F(x)$. For time $t > 0$, the boundaries at $x = 0$ and $x = L$ are kept at constant temperatures T_1 and T_2 , respectively. Obtain an expression for the temperature distribution $T(x,t)$ in the slab. (35)

SECTION - B

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

5. (a) Consider a large isothermal enclosure that is maintained at a uniform temperature of 2000 k. Calculate the emissive power of the radiation that emerges from a small aperture on the enclosure surface. What is the wavelength λ_1 below which 10% of the emission is concentrated? What is the wavelength λ_2 above which 10% of the emission is concentrated? Determine the wavelength at which maximum spectral power emits. (10)

(b) Consider a 5 mm square, diffuse surface ΔA_0 having a total emissive power of $E_0 = 400 \text{ W/m}^2$ (as shown in the Figure for the Q. No. 5(b)). The radiation field due to emission into the hemispherical space above the surface is diffuse, thereby providing a uniform intensity $I(\theta, \phi)$. Moreover, if the space is a nonparticipating medium (non-absorbing, non scattering and non emitting), the intensity is independent of radius for any (θ, ϕ) direction. Hence intensities at any points P_1 and P_2 would be equal. (25)

(i) What is the rate at which radiant energy is emitted by ΔA_0 ?

(ii) What is the intensity $I_{0,e}$ of the radiation field emitted from the surface ΔA_0 ?

(iii) Obtain an expression for emitted radiation in terms of intensity $I_{0,e}$.

(iv) Consider the hemispherical surface located at $r = R_1 = 0.5 \text{ m}$. Determine the rate at which radiant energy leaving ΔA_0 is intercepted by the small area ΔA_2 located in the direction $(45^\circ, \phi)$ on the hemispherical surface.

6. (a) Consider a conical enclosure of height h and base diameter D as shown in the figure for the Q. No. 6(a). Determine the view factor from the conical side surface to a ^{hole} hole of diameter d located at the center of the base. (15)

(b) Determine the view factor F_{1-2} between the rectangular surfaces shown in Figure for Q. No. 6(b). (20)

ME 301

7. (a) Two very large parallel plates are maintained at uniform temperatures of $T_1 = 1000$ k and $T_2 = 800$ k and have emissivities of $\epsilon_1 = \epsilon_2 = 0.2$ respectively. It is desired to reduce the ^{net} rate of radiation heat transfer between the ^{two} plates to one-fifth by placing this aluminum sheets with an emissivity of 0.15 on both sides between the plates. Determine the numbers of sheets that need to be inserted. (25)

(b) A thermocouple used to measure the temperature of hot air flowing in a duct whose walls are maintained at $T_w = 500$ k shows a temperature reading of $T_{th} = 850$ k. Assuming the emissivity of the thermocouple junction to be $\epsilon = 0.6$ and the convection heat transfer coefficient to be $h = 60$ W/m².°C, determine the actual temperature of air. (10)

8. (a) Consider a large plane wall of thickness $L = 0.4$ m, thermal conductivity $k = 2.3$ W/m.°C and surface area $A = 20$ m². The left side of the wall is maintained at a constant temperature of $T_1 = 80^\circ\text{C}$ while the right side loses heat by convection to the surrounding air at $T_\infty = 15^\circ\text{C}$ with a heat transfer coefficient of $h = 24$ W/m².°C. Assuming constant thermal conductivity and no heat generation in the wall, (i) express the differential equation and the boundary conditions for steady one-dimensional heat conduction through the wall, (ii) Obtain a relation for the variation of temperature in the wall by solving the differential equation, and (iii) evaluate the rate of heat transfer through the wall. (15)

(b) Write short note on solar radiation and its prospect in Bangladesh. (20)

Cyruy 23/09/13

L-3/T-1/ME

Date : 23/09/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2011-2012

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

Full Marks: 210

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) What are the fundamental methods of measurements? Describe. (05)
(b) When should a calibration be preferred? What is its purpose? (05)
(c) What do you mean by hysteresis of an instrument? Does it affect its accuracy? (05)
(d) Name the terms used in rating instrument performances and discuss. (10)
(e) Describe the generalized measuring system with a block diagram. What are the stages of measurement system? Mention types with examples. (10)
2. (a) Show three special waveforms of harmonic nature and mention its application. (12)
(b) Write short notes on 'Discrete Fourier Transforms'. (08)
(c) What do you mean by Nyquist frequency? Write down its importance. (06)
(d) What do you mean by response of measuring system? Describe amplitude, frequency and phase response. (09)
3. (a) What do you mean by time displacement relations for damped motion? Describe with proper sketches and examples. (05)
(b) With sketches describe the working principle of LVDT. Mention its advantages. (10)
(c) State and explain the laws of thermocouples. (05)
(d) What are the differences between RTD, thermistors and IC sensor. Mention the advantages of using RTD in temperature measurement. Sketch the various thermistor forms commercially available in the market. (15)
4. (a) What are the differences between variable inductance and variable reluctance transducers? Describe with sketches. (10)
(b) What do you mean by variable area flowmeter? Mention its advantages. (06)
(c) What do you mean by positive displacement flowmeter? Describe its working principle and use. (07)
(d) Write short notes on 'the Proving Ring' and hydraulic dynamometers. (12)

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) 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. (8)

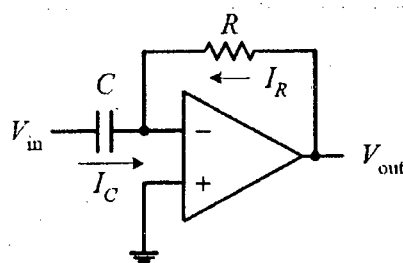


Fig. Ques. 5(a)

- (b) Write short note on "Instrumentation Amplifier" and "Sample-and-Hold Circuit". (10)
- (c) Distinguish between active and passive filters. Write down their relative advantages and disadvantages. For the following RC low-pass filter prove that signal attenuation,

$$\left| \frac{V_{out}}{V_{in}} \right| = \frac{1}{\sqrt{1 + (\omega RC)^2}} \text{ and cutoff frequency, } \omega_c = \frac{1}{RC}, \text{ where } \omega \text{ is the angular}$$

frequency of the input signal. (12)

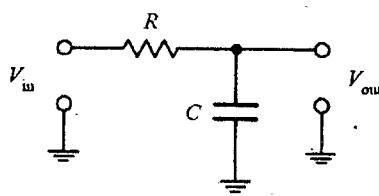


Fig. Ques. 5(c)

- (d) Mention some practical cases where low-pass, high-pass and band-pass filters are being used. (5)
6. (a) Determine the Transfer Function (TF) of a general second order system. Hence deduce the expression of amplitude ratio and phase angle. Discuss the response of a second order system under harmonic input. (20)

ME 361

Contd... Q. No. 6

(b) Using the internal design of an RS flip-flop, complete the following timing diagram for the Reset input (R). (5)

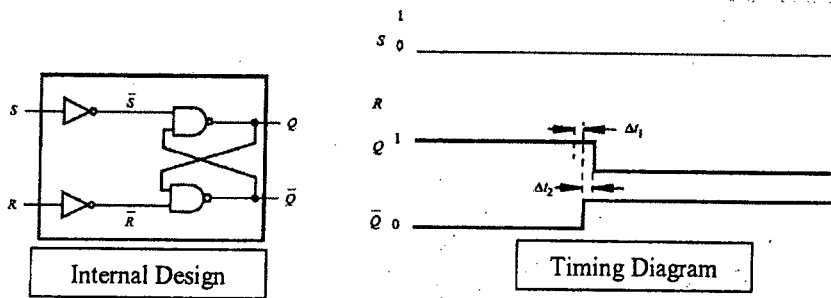


Fig. Ques. 6(b)

(c) Prove that the rise time of a first order system is given by $2.2 \times$ time constant. Given that the error, $e_m = x_\infty - x(t) = (x_\infty - x_0)e^{-t/\tau}$, where the symbols have their usual meaning. (10)

7. (a) Briefly explain the two compromises made in an A/D conversion process. (5)
- (b) Given a 12-bit A/D converter operating over a voltage range from 0 V to 10 V, how much does the input voltage have to change, in general, in order to be detectable? (5)
- (c) Distinguish between "analog" and "digital" signal. (5)
- (d) Design a circuit that can control the movement of a motor in a robot, using sensors with switches of your choice. (8)
- (e) Explain the working principle of a "Successive Approximation ADC". (12)

8. (a) Discuss the working principle of a microphone of your choice i.e. condenser type, electrodynamic type etc. (10)
- (b) Describe with proper sketches the working principle of a seismic instrument. (10)
- (c) Explain how a metallic resistance strain gage and electrical resistance strain gage work. (10)
- (d) Why capacitors are often used to eliminate noise in an electrical circuit. Discuss with the charging and discharging diagram of a capacitor. (5)

SECTION – A

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

Assume reasonable data if necessary.

1. (a) Explain the term total head of a flowing fluid. Derive one dimensional steadyflow energy equation. Under what circumstances does this equation reduces to the Bernoulli's equation? (18)

- (b) A certain oil of specific gravity 0.82 is flowing through a reducer as shown in Fig. for Q. No. 1(b). The pressure at point 1 is greater than that at 2 by 40 kPa. Neglecting losses find the flow rate of oil. (17)

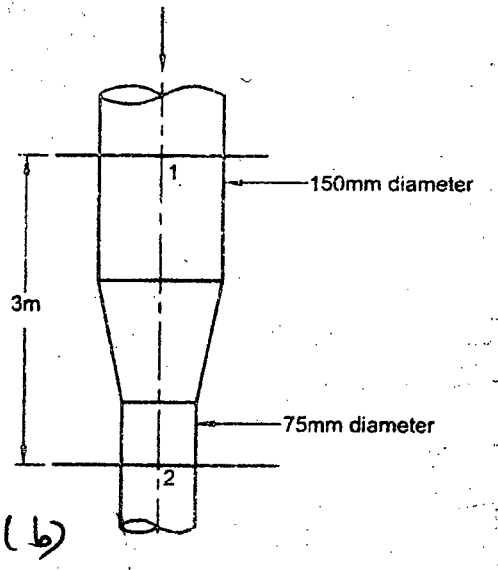


Fig. for Q. No. 1 (b)

2. (a) Distinguish between orifice, notch and weir. Derive an equation for the actual flow rate through the V-notch. (17)

- (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, $C_d = 0.61$. (18)

3. (a) What is vena contracta? Derive the continuity equation for unsteady flow of a control volume. (17)

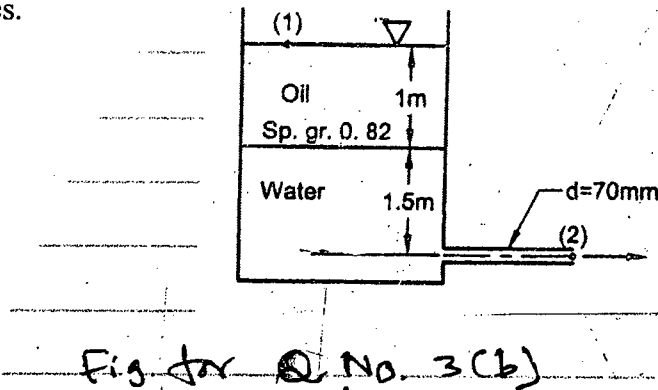
ME 321

Contd... Q. No. 3

(b) Find the flow rate of water through the pipe as shown in the figure for Q. No. 3(b).

Neglect all losses.

(18)



4. (a) Show that stress at a point in a static or moving fluid is equal in all directions.

(18)

(b) Find an expression for the pressure at a height Z from sea level for static air when the temperature varies linearly with elevation $T = T_0 + kZ$, where T_0 is the temperature at the datum Z_0 and k is a const.

(17)

SECTION - B

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

5. (a) What is stream function? Show that along a streamline there is no change in the magnitude of stream function.

(15)

(b) The velocity components in a steady, two-dimensional incompressible flow field are

(20)

$$u = 2y \text{ and } v = 4x$$

Determine the corresponding stream function. Show the streamlines for stream function, $\psi = 0, 1$ and 2 . Indicate the direction of flow along the streamlines. Interpret the flow field.

6. (a) Show that for a doublet the stream function may be expressed as

(15)

$$\psi = -\frac{K \sin \theta}{r}$$

(b) Show that for a flow around a circular cylinder the stream function may be expressed as

(20)

$$\psi = Ur \left(1 - \frac{a^2}{r^2} \right) \sin \theta$$

Derive an expression for the pressure on the surface of the cylinder.

ME 321

7. (a) Show that the free surface of the liquid in a rotating container is a paraboloid of revolution. (20)
- (b) Gate ABC in Fig. 7(b) has a fixed hinge line at B and is 2 m wide into the paper. The gate will open at A to release water if the water depth is high enough. Compute the depth h for which the gate will begin to open. Neglect the weight of the gate. (15)
8. (a) Explain the concepts of (i) fluid continuum and (ii) ideal fluid. (6+3)
- (b) Discuss various conditions of rotational stability of submerged bodies. (9)
- (c) A 95 mm diameter cylindrical shaft rotates at 50 rpm inside a 96.4 mm bore cylinder. Both the shaft and the cylinder are 0.5 m long. If the torque required to rotate the shaft is 1 Nm, find the viscosity of the oil occupying the annular space between the shaft and the cylinder. (17)

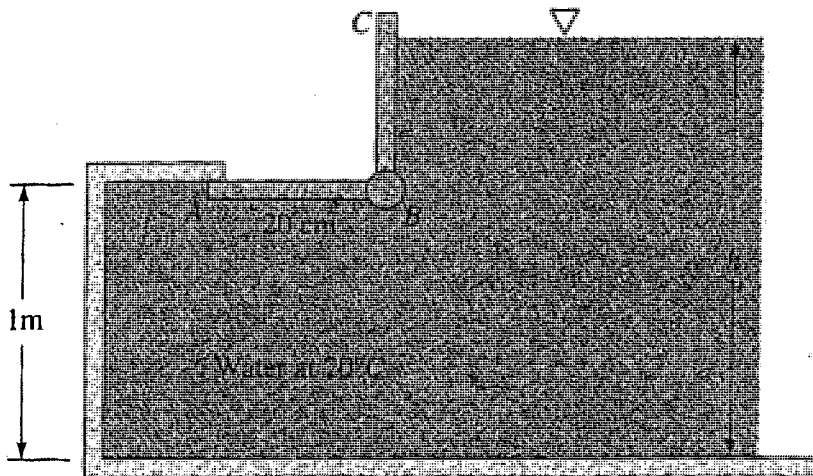


Figure 7(b)

10/09/13

L-3/T-1/ME

Date : 08/07/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2011-2012

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

Full Marks : 280

Time : 3 Hours

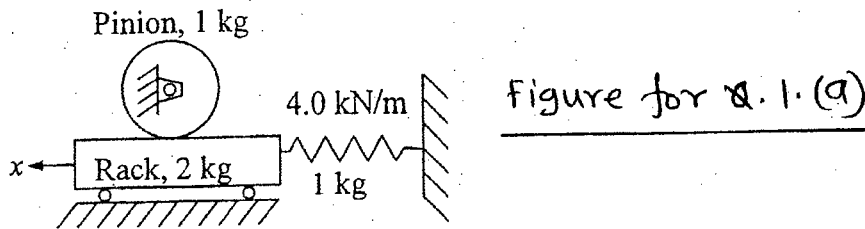
The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION - A

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

1. (a) A spring of stiffness 4.0 kN/m and mass of 1.0 kg, is attached to a sliding rack of 2.0 kg as shown in the figure for Q. 1(a). The rack is also geared to a pinion whose mass and radius are, respectively, 1.0 kg and 75 mm. Determine the equivalent mass against the spring and the natural frequency of vibration of the system. (23)



- (b) A light elastic shaft AB of uniform diameter, supported freely in bearings, carries a wheel at each end, and it is found that the natural frequency of torsional vibration is 40 Hz. A third wheel is mounted on the shaft at a point C such that $AC = \frac{3}{4} AB$. If all the wheels have the same moment of inertia, determine the natural frequencies of torsional vibrations. (23 ²/₃)

2. (a) A light uniform bar of mass m and length l is hinged at one end while the other end is carried by a spring of stiffness S so that in its rest position the bar is horizontal. Half-way along the bar a dash-pot is attached which produces a damping force of c per unit velocity. Write down the equation of motion obtained by taking moments about the hinge, and give an expression for the time period. (23)

(b) (i) Deduce an expression for the amplitude of forced-damped vibrations of a linear, single degree of freedom system. (12)

(ii) A simple vibrating system with one degree of freedom is under spring control and the motion is subjected to a damping force which is directly proportional to the velocity. The equivalent mass is 2.0 kg, the stiffness of the spring is 15 kN/m, and the damping force is 7 N at 1 m/s. Find the amplitude of the forced vibrations produced when a periodic force of $25 \cos (100t)$ N acts on the mass. (11 ²/₃)

Contd P/2

ME 345

3. (a) A motor vehicle of all-up mass 900 kg has a track of 1.5 m and the center of gravity is 0.38 m above ground level. The four road wheels have a total moment of inertia of 5 kg.m^2 and a rolling radius of 0.3 m. The vehicle is travelling at a speed of 45 m/s in a circular path of radius 180 m. Determine the total vertical component of the reaction on the two outer wheels, if the track is not banked.

(23)

(b) A compound epicyclic gear is shown in the figure for Q. 3(b). C and D form a compound wheel which rotates freely on shaft G. The planet wheels B and E rotate on pins fixed in arms attached to shaft G. C and F have internal teeth; the others have external teeth with the following numbers: A, 40; B, 30; D, 50; E, 20. If A rotates at 500 rev/min and wheel F is fixed, find the speed of shaft G.

(23 $\frac{2}{3}$)

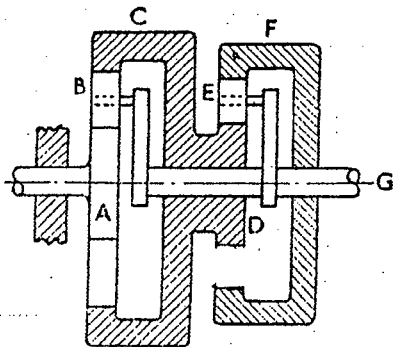


Figure for Question 3(b)

4. (a) Figure for Q 4(a) shows a friction brake in which the curved lever BC is pivoted at the fixed point C and carries a friction lining which presses on the rotating drum D over an arc of 90° . The diameter of the drum is 250 mm. The distance OB and OC are each 150 mm. The pressure exerted by the friction lining on the drum at any point P is $350 \sin \theta \text{ kN/m}^2$. The lining is 50 mm wide and the co-efficient of friction is 0.3. Calculate the braking torque exerted on the drum, also the amount of the force F which is required at B to apply the brake.

(30)

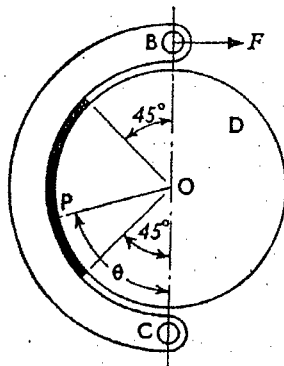


Figure for Question 4(a)

(b) Deduce an expression for the torque transmitted by a cone clutch.

(16 $\frac{2}{3}$)

ME 345

SECTION - B

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

5. A bent lever ABC is pivoted at the fixed point A as shown in Fig. for Q. No. 5. The angle ABC is 90°. The crank OD rotates clockwise at 150 rev/min about the fixed point O and point D slides on the lever as shown. For the given position find the angular velocity and the angular acceleration of the lever BC and also the acceleration of point B. (46 ²/₃)

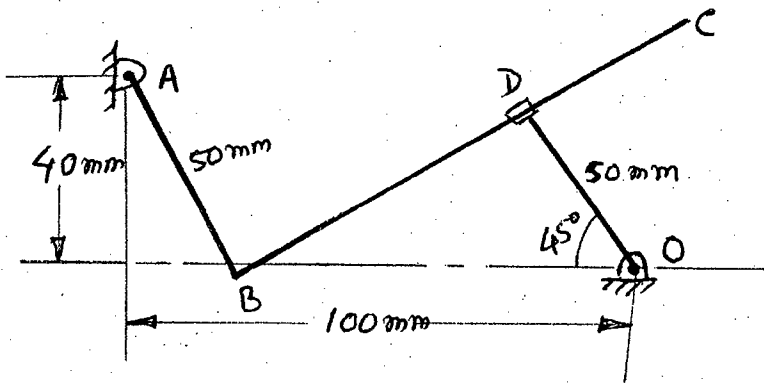


Fig. for Q. No. 5.

240

6. (a) The torque exerted by a multi-cylinder engine running at a mean speed of ~~400~~ rev/min against a uniform resistance, can be expressed by (26)

$$T = 2500 + 4000 \sin\theta + 600 \sin 2\theta + 60 \sin 3\theta \text{ (N.m)}$$

Where θ is the crank angle from inner dead centre in radians. Find the power of the engine and the minimum mass of the flywheel if its radius of gyration is 0.9 m and the maximum fluctuation of speed is to be $\pm 1\%$.

- (b) 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 0.12. The cross-sectional area of each belt is 800 mm² and the permissible safe stress in the material is 3 MPa. Calculate the power that can be transmitted between two pulleys ~~40~~⁴⁰⁰ mm in diameter rotating at 900 rpm. (20 ²/₃)

7. A flat faced reciprocating follower has the following motion: (46 ²/₃)
- (i) The follower moves out for 80° of cam rotation with uniform acceleration and retardation, the acceleration being twice the retardation.
 - (ii) The follower dwells for the next 80° of cam rotation.
 - (iii) It moves in for the next 120° of cam rotation with uniform acceleration and retardation the retardation being twice the acceleration.
 - (iv) The follower dwells for the remaining period. The ~~base~~^{base} circle diameter of the cam is 60 mm and the stroke of the follower is 20 mm. The line of movement of the follower passes through the cam centre.

Draw the profile of the cam showing all constructional details.

ME 345

8. (a) The piston of a 60° twin V-engine has strokes of 120 mm. The connecting rods driving a common crank has a length 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.

(20 $\frac{2}{3}$)

(b) A 3.6 m long shaft carries three pulleys, two at its two ends and the third at the mid point. The two end pulleys has mass of 80 kg and 40 kg and their centre of gravity are 3 mm and 5 mm respectively from the axis of the shaft. The middle pulley mass is 50 kg and its centre of gravity is 8 mm from the shaft axis. The pulleys are keyed to the shaft and the assembly is in static balance. The shaft rotates at 300 rpm in two bearings 2.4 m apart with equal overhang on either side. Calculate the relative angular positions of the pulley and the dynamic reactions at the two bearings.

(26)
