Mechanical/Steam
01/07/13

L-2/T-2/ME **Date : 01/01/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **HUM 201** (Sociology)

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) Discuss the underlying factors that contributed to the development of sociology as an independent discipline. **(10)**

   (b) 'Sociology is a categorical discipline not a normative discipline' — Explain. **(10)**

   (c) Critically discuss the functionalist theoretical perspective of sociology. **(15)**

2. (a) Define culture. What are the differences between material and non-material cultures? How can each affect the other? **(10)**

   (b) 'Ethnocentrism is a habit to judge other ways of life by the standards of our own group'— Explain. **(10)**

   (c) Discuss Karl Marx's explanation of technology and culture of a society. **(15)**

3. (a) What do you understand by poverty? Differentiate between absolute poverty and relative poverty. **(10)**

   (b) Illustrate the socio-cultural causes of poverty in Bangladesh. **(10)**

   (c) What is foreign aid? Critically discuss the dependency theory of development in the context of Bangladesh. **(15)**

4. Write short notes on any <u>three</u> of the following: **(35)**

   (a) System of social stratification

   (b) Types of socialization

   (c) Social Mobility

   (d) Cooley's looking glass self theory.

Contd P/2

HUM 201

SECTION – B

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

5. (a) Define environment. Briefly discuss different types of environment. **(10)**

   (b) What are the main sources of global warming? **(10)**

   (c) Briefly discuss the potential consequences of global warming. **(15)**

6. (a) Define social change. Show how the technological development have changed our social and family life. **(10)**

   (b) Write down the important characteristics of capitalism. **(13)**

   (c) Describe the social consequences of industrial revolution. **(12)**

7. (a) Define crime and deviance. Discuss the types of deviant behaviour. **(8)**

   (b) What do you mean by nuclear family and joint family? Briefly discuss the merits and demerits of nuclear family. **(20)**

   (c) Discuss the classification of cities with examples. **(7)**

8. Write short notes on any three of the following: **(35)**

   (a) Demographic transition theory

   (b) Evaluation of mega city

   (c) The causes of juvenile delinquency

   (d) Sources of social change.

Shamim
1/1/13

L-2/T-2/ME Date : 01/01/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **HUM 203** (Government)

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) How do you define state? What are the essential elements of a state? **(15)**
   (b) Classify constitution. Explain the characteristics of a good constitution. **(20)**

2. (a) What are the qualities of a good citizen? Discuss the safeguards of citizen rights in a state. **(15)**
   (b) Describe the functions of Executive in a state. **(20)**

3. (a) Explain the nature of presidential form of government. **(15)**
   (b) What is meant by good governance? Analyze the role of civil society in good governance. **(20)**

4. (a) Discuss the importance of the language movement of 1952. **(15)**
   (b) Describe the salient features of the constitution of Bangladesh. **(20)**

SECTION – B

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

5. (a) Discuss the advantages and disadvantages of parliamentary form of government. **(20)**
   (b) What is democracy? Identify the differences between democracy and dictatorship. **(15)**

6. (a) What is bureaucracy? Critically explain Max Weber's "Ideal Type of Bureaucracy". **(20)**
   (b) Define political party. Distinguish between political party and pressure group. **(15)**

7. (a) What do you know about socialism? Discuss the principles of Marxism. **(20)**
   (b) Review the external and internal determinants of the foreign policy of Bangladesh. **(15)**

8. (a) Define local government. Discuss the functions of urban local government institutions in Bangladesh. **(20)**
   (b) Discuss the major characteristics of the constitution of UK. **(15)**

Nazia Nafisa
19.12.12

L-2/T-2/ME **Date : 18/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **MME 291** (Metallic Materials)

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) Write the properties of coke used as a raw material for blast furnace. **(5)**

   (b) With necessary diagrams, explain how the dust from blast furnace gas is removed. **(15)**

   (c) Describe the order of elimination of impurities in basic Bessemer process. **(15)**

2. (a) Briefly describe the processing of chilled cast iron. What are the effects of alloying elements on chill depth and hardness of the chilled cast iron? **(15)**

   (b) What do you mean by 'bull's eye' structure? **(5)**

   (c) What are the purposes of alloying element in steel? **(5)**

   (d) Write short note on: **(10)**

   (i) Heat resisting steel

   (ii) Nickel steel

3. (a) Show the effects of % C on the hardness of plain carbon water hardening tool steels. Also mention the advantages and disadvantages of plain carbon water hardening tool steels. **(12)**

   (b) How cutting tools are prepared? **(12)**

   (c) What is the process of increasing hardness of a steel surface by adding nitrogen? Explain the process with its limitations. **(11)**

4. (a) Is it possible to prepare a cutting tool of good machinability from a full annealed hypereutectoid steel? — Justify your answer. **(15)**

   If not, then suggest an alternative way.

   (b) Describe the structural changes that occur during quenching of steel. **(8)**

   (c) What are the effects of tempering on structure and properties of quenched steel? **(12)**

Contd P/2

MME 291

SECTION – B

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

5. (a) Describe three types of commercially pure copper. **(8)**
   (b) Write down the basic principle of ultrasonic testing. Also, mention its major advantages and limitations. **(15)**
   (c) What do you understand by ductile to brittle transition temperature? Draw a schematic plot of impact strength vs test temperature, and label brittle and ductile regions and transition temperature. **(12)**

6. (a) Draw a typical creep curve and explain different regions of this curve. **(15)**
   (b) Briefly discuss the steps involved in cup-and-cone fracture observed when a material is failed in ductile manner. **(12)**
   (c) Using schematic diagrams of fracture surfaces, describe the typical features observed in a material after fatigue failure. **(8)**

7. (a) A tensile test is performed on a metal specimen, and it is found that a true plastic strain of 0.16 is produced when a true stress of 500 MPa is applied; for the same metal, the value of K is 825 MPa. Calculate the true strain that results from the application of a true stress of 600 MPa. **(5)**
   (b) A specimen of magnesium having a rectangular cross section of dimensions 3.2 mm × 19.1 mm is deformed in tension. Using the load-elongation data given in Table, complete parts (i) through (vi) **(30)**
   (i) Plot the data as engineering stress versus engineering strain.
   (ii) Compute the modulus of elasticity.
   (iii) Determine the yield strength at a strain offset of 0.002.
   (iv) Determine the tensile strength of this alloy.
   (v) Compute the modulus of resilience.
   (vi) What is the percent elongation?

8. (a) Consider a hypothetical A-B binary eutectic alloy system having eutectic at 70B (wt% basis). The alloy system is partly soluble in the solid state but is in complete solution in the liquid state. Maximum solubility of B in A is 30% (wt%) at the eutectic temperature. At room temperature, maximum solubility of B in A is at 10% (wt%). Draw the corresponding temperature vs wt% B (composition) equilibrium diagram in a plain graph paper. Also, label different phases, and lines clearly. **(10)**
   (b) For the phase diagram mentioned in question no. 7(a), consider an alloy having composition 95A-5B (wt%). Draw the microstructures of the alloy system that are evolved at various states of cooling from liquid to solid at room temperature. **(15)**
   (c) Write short notes on ferrite and pearlite. **(10)**

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for Question Number 7b → obtained from

Table 1 Load Vs Elongation Data obtainedfrom Tensile Test for Question Number 3(b)

Load, N	Length, mm
0	63.50
1380	~~53.53~~ → 63'53
2780	63.56
5630	63.62
7430	63.70
8140	63.75
9870	64.14
12850	65.41
14100 ←	~~65.58~~ → 66'68
14340	67.95
13830	69.22
12500	70.49
Fracture	

1st Front
08-01-13

L-2/T-2/ME Date : 08/01/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **MATH 263** (Complex Variables FS, H.F and PDE)

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 used have their usual meaning.

1. (a) Separate $\tan^{-1}(a + ib)$ into real and imaginary parts. **(10)**

   (b) Find complex numbers, except $z = 0$ that satisfies the condition $\bar{z} = z^2$. **(10)**

   (c) Find the image of the hyperbola $x^2 - y^2 = 1$ under the transformation $w = \frac{1}{z}$ and sketch the graph of the image. **(12)**

   (d) Find the bilinear transformation that maps the points $z_1 = -i$, $z_2 = 0$, $z_3 = i$ onto the points $w_1 = -1$, $w_2 = i$, $w_3 = 1$ respectively, and hence find the image of the y-axis. **(14⅔)**

2. (a) Prove that $\psi = \ln[(x-1)^2 + (y-2)^2]$ is harmonic in every region which does not include the point (1, 2). Find a function φ such that $\varphi + i\psi$ is analytic. Also express $\varphi + i\psi$ as a function of z. **(20)**

   (b) State and prove Liouville's theorem. **(16)**

   (c) Evaluate $\int_C (3xy + iy^2)\,dz$, where C is the straight line joining the points $z = i$ and $z = 2 - i$. **(10⅔)**

3. (a) Show that $\frac{1}{2\pi i}\oint_C \frac{e^{zt}}{(z^2+1)^2}\,dz = \frac{1}{2}(\sin t - t\cos t)$ if $t > 0$ and $C : |z| = \frac{3}{2}$. **(16⅔)**

   (b) Expand $f(z) = \frac{1}{(z+1)(z+3)}$ in Laurent's series valid for $1 < |z| < 3$. **(15)**

   (c) Evaluate $\oint_C \frac{dz}{\cosh z}$, where C: $|z| = 2$ by using Cauchy's residue theorem. **(15)**

4. Evaluate the following by using the method of contour integration: **(23⅓ ×2)**

   (i) $\int_{-\infty}^{\infty} \frac{dx}{x^6+1}$ (ii) $\int_0^{\pi} \frac{d\theta}{3+2\cos\theta}$.

Contd P/2

MATH 263(ME)

SECTION – B

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

5. Solve the following partial differential equations

(a) $p \cos(x + y) + q \sin(x + y) = z$ **(14)**

(b) $px + qy = z\sqrt{1 + pq}$ **(14)**

(c) $(2D_x^2 + 5D_xD_y - 12D_y^2)z = x^3 \cos(3x + y)$ **(18⅔)**

6. (a) Solve : $(D_x^2 - 4D_y^2)z = \frac{x}{y^2}$ **(10)**

(b) $(\frac{1}{x^2}D_x^2 - \frac{1}{x^3}D_x - \frac{1}{y^2}D_y^2 + \frac{1}{y^3}D_y)z = x^4y^4$ **(16)**

(c) $(2D_x - 5D_y + 6)(3D_x + 2D_y - 3)z = \sin(2x + 3y)$ **(20⅔)**

7. (a) Find the Fourier series for $f(x) = \begin{cases} -\pi, & -\pi < x < 0 \\ x, & 0 < x < \pi. \end{cases}$ **(16⅔)**

(b) Expand f(x) in a half-range Fourier cosine series, where

$$f(x) = \begin{cases} 1 - x, & 0 \le x < 2 \\ x - 3, & 2 \le x \le 4. \end{cases}$$

Also sketch the graph of $f(x)$. **(15)**

(c) Find the Fourier transform of $f(x) = \begin{cases} 1 - x^2, & |x| < 1 \\ 0, & |x| > 1. \end{cases}$ **(15)**

8. (a) Write down the Laplace's equation $\nabla^2 v(x, y) = 0$ in polar coordinates (r, θ) and find the circular harmonics of degree *0* and of degree *n*. **(30)**

(b) Find the temperature for a steady flow of heat in a semicircular plate of radius *r* where the diameter is kept at a temperature zero and the circumference at a temperature u_0. **(16⅔)**

L-2/T-2/ME

Date : 26/12/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **ME 261** (Numerical Analysis)

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) Use the Bisection Method to find a root of $f(x) = \cos x - x$ in the interval [0, 1] to four correct decimal places. Can you predict how many iterations will be needed for the required accuracy before starting the procedure? **(17)**

   (b) Use the Fixed Point Iteration technique to find a root of $f(x) = x^3 + x - 1$ with an initial guess of $x_0 = 0.5$. to four correct decimal places. **(18)**

2. (a) Use L-U factorization to solve the system $Ax = B$ **(17)**

   Where

$$A = \begin{bmatrix} 2 & 1 & 5 \\ 4 & 4 & -4 \\ 1 & 3 & 1 \end{bmatrix}, \qquad B = \begin{bmatrix} 5 \\ 0 \\ 6 \end{bmatrix}$$

   With partial pivoting. [Four decimal places accuracy required]

   (b) Classify and define Matrix Norms. **(9)**

   (c) Find the Eigen values of the following matrix:

$$A = \begin{bmatrix} 3 & -1 & 5 \\ -1 & 2 & -1 \\ 0 & -1 & 3 \end{bmatrix}$$

3. (a) Find the exact solution $[x_1, x_2]$ of the following system

$$x_1 + x_2 = 2$$
$$1.0001\, x_1 + x_2 = 2.0001$$

   Now consider an approximate solution $x_a = [-1, 3.0001]$ for the above system and calculate backward error. $(b - Ax_a)$ and forward error $(x - x_a)$ for the approximate solution. Explain the results is the light of condition number. [Here x is solution vector, A is coefficient matrix and b is forcing function]. **(20)**

   (b) Apply Gauss Siedel method to the following system for solution: **(15)**

$$\begin{bmatrix} 3 & 1 & -1 \\ 2 & 4 & 1 \\ -1 & 2 & 5 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 4 \\ 1 \\ 1 \end{Bmatrix}$$

[Minimum four decimal places accuracy required].

Contd P/2

ME 261

4. (a) Derive a three point central difference formula for second derivative. Use the formula with h = 0.1 to approximate the second derivative of f(x) = 1/x at x = 2. (15)

(b) Using the data of the following Table for Q. No. 4(b) construct a divided difference table. Write a fourth order Newton's divided difference interpolatery polynomial ~~(P4).~~ (P_4) Use the polynomial to interpolate for x = 1.5. (20)

Table for Q. No. 4(b)

i	~~xi~~ x_i	~~f(xi)~~ $f(x_i)$
0	1.0	0.7651977
1	1.3	0.6200860
2	1.6	0.4554022
3	1.9	0.2818186
4	2.2	0.1103623

SECTION – B

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

Symbols have their usual meaning.

5. (a) Define the following with examples **(18)**

(i) Absolute error

(ii) Percentage error

Mathematically show that the relative error in subtraction of two approximate numbers is always greater than that in their addition.

(b)

x	0	1	2	3	4
y	10	12	18	28	42

Determine a least-square fit to the data points given using an approximation curve of the form $y = C_1 + C_2 x^2$

What is the sum of the squares of the residuals? Comment on the accuracy of fitting. **(17)**

6. (a) Determine the approximate area under the curve $y = 10 - x^3$ between x = 0 and x = 4 by Trapizoidal and Simp Son's methods with 4 subintervals. method **(17)**

Compare your answers with the corresponding results obtained by standard of calculus and discuss.

ME 261

(b) **(18)**

x	f(x)	x	f(x)
1.6	4.953	2.8	16.445
1.8	6.050	3.0	20.086
2.0	7.389	3.2	24.533
2.2	9.025	3.4	29.964
2.4	11.023	3.6	36.598
2.6	13.464	3.8	44.701

You are required to integrate the function tabulated in the above table over the interval from x = 1.8 to x = 3.4 using Trapizoidal method. The data in the table are basically generated from $f(x) = e^x$.

Find the value of the integral and associated absolute error. If the integral is required to be correct to five decimal places, how small must the step size (h) be?

7. (a) Give the mathematical and graphical interpretations of Ralston's method for solving ordinary differential equations. Show that Rlaston's method is a special case of the second-order Runge-Kutta method. **(18)**

(b) "Every version of second-order RK method would yield exactly the same results if the solution to the ODE is quadratic, Linear, or a constant" - explain in detail with necessary mathematical treatments. **(17)**

8. **(35)**

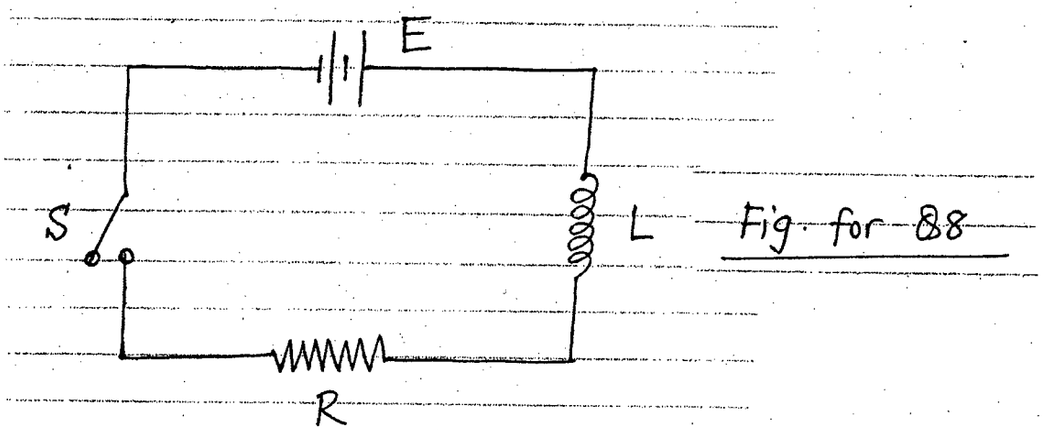

Fig. for 8

The CKT shown in Fig. for Q. No. 8 contains a source of emf, an inductance and a resistor. The magnitude of resistor varies with its temperature. Since the temperature of resistor increases with increasing current in the CKT, the resistance is a function of current, which can be expressed as

$$R = a + bI^2$$

Contd P/4

ME 261

Contd. Q. No. 8

Switch S is closed at time t = 0 and the current flow is desired as a function of time for t > 0.

Applying Kirchhoff's voltage law to the CKT loop, the differential equation that governs the current flow in the CKT is obtained as

$$E - L\frac{dI}{dt} - \left(a + bI^2\right)I = 0$$

Assume the parameter values for this example as E = 200 volts, L = 3 henries, a = 100 Ω, b = 50 Ω/amp^2.

Determine the current flow in the CKT for t = 0.002(0.002) 0.006 sec. using the Third-order RK method. Results should correspond to four decimal place accuracy.

L-2/T-2/ME

Date : 26/12/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **ME 261** (Numerical Analysis)

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) Use the Bisection Method to find a root of $f(x) = \cos x - x$ in the interval [0, 1] to four correct decimal places. Can you predict how many iterations will be needed for the required accuracy before starting the procedure? **(17)**

   (b) Use the Fixed Point Iteration technique to find a root of $f(x) = x^3 + x - 1$ with an initial guess of $x_0 = 0.5$. to four correct decimal places. **(18)**

2. (a) Use L-U factorization to solve the system $Ax = B$ **(17)**

   Where

$$A = \begin{bmatrix} 2 & 1 & 5 \\ 4 & 4 & -4 \\ 1 & 3 & 1 \end{bmatrix}, \qquad B = \begin{bmatrix} 5 \\ 0 \\ 6 \end{bmatrix}$$

   With partial pivoting. [Four decimal places accuracy required]

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3. (a) Find the exact solution $[x_1, x_2]$ of the following system

$$x_1 + x_2 = 2$$
$$1.0001\, x_1 + x_2 = 2.0001$$

   Now consider an approximate solution $x_a = [-1, 3.0001]$ for the above system and calculate backward error. $(b - Ax_a)$ and forward error $(x - x_a)$ for the approximate solution. Explain the results is the light of condition number. [Here x is solution vector, A is coefficient matrix and b is forcing function]. **(20)**

   (b) Apply Gauss Siedel method to the following system for solution: **(15)**

$$\begin{bmatrix} 3 & 1 & -1 \\ 2 & 4 & 1 \\ -1 & 2 & 5 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 4 \\ 1 \\ 1 \end{Bmatrix}$$

   [Minimum four decimal places accuracy required].

Contd P/2

ME 261

4. (a) Derive a three point central difference formula for second derivative. Use the formula with h = 0.1 to approximate the second derivative of $f(x) = 1/x$ at x = 2. (15)

(b) Using the data of the following Table for Q. No. 4(b) construct a divided difference table. Write a fourth order Newton's divided difference interpolatery polynomial (P_4). Use the polynomial to interpolate for x = 1.5. (20)

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i	x_i	$f(x_i)$
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SECTION – B

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

Symbols have their usual meaning.

5. (a) Define the following with examples **(18)**

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(ii) Percentage error

Mathematically show that the relative error in subtraction of two approximate numbers is always greater than that in their addition.

(b)

x	0	1	2	3	4
y	10	12	18	28	42

Determine a least-square fit to the data points given using an approximation curve of the form $y = C_1 + C_2 x^2$

What is the sum of the squares of the residuals? Comment on the accuracy of fitting. **(17)**

6. (a) Determine the approximate area under the curve $y = 10 - x^3$ between x = 0 and x = 4 by Trapizoidal and Simp Son's methods with 4 subintervals. **(17)**

Compare your answers with the corresponding results obtained by standard method of calculus and discuss.

Contd P/3

ME 261

(b) **(18)**

x	f(x)	x	f(x)
1.6	4.953	2.8	16.445
1.8	6.050	3.0	20.086
2.0	7.389	3.2	24.533
2.2	9.025	3.4	29.964
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2.6	13.464	3.8	44.701

You are required to integrate the function tabulated in the above table over the interval from x = 1.8 to x = 3.4 using Trapizoidal method. The data in the table are basically generated from $f(x) = e^x$.

Find the value of the integral and associated absolute error. If the integral is required to be correct to five decimal places, how small must the step size (h) be?

7. (a) Give the mathematical and graphical interpretations of Ralston's method for solving ordinary differential equations. Show that Rlaston's method is a special case of the second-order Runge-Kutta method. **(18)**

(b) "Every version of second-order RK method would yield exactly the same results if the solution to the ODE is quadratic, Linear, or a constant" - explain in detail with necessary mathematical treatments. **(17)**

8. **(35)**

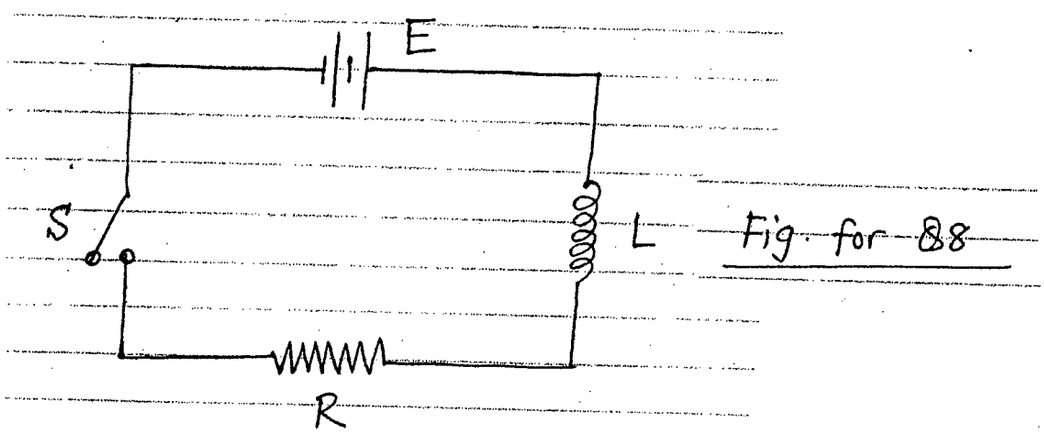

Fig. for 8

The CKT shown in Fig. for Q. No. 8 contains a source of emf, an inductance and a resistor. The magnitude of resistor varies with its temperature. Since the temperature of resistor increases with increasing current in the CKT, the resistance is a function of current, which can be expressed as

$$R = a + bI^2$$

Contd P/4

ME 261

Contd. Q. No. 8

Switch S is closed at time t = 0 and the current flow is desired as a function of time for t > 0.

Applying Kirchhoff's voltage law to the CKT loop, the differential equation that governs the current flow in the CKT is obtained as

$$E - L\frac{dI}{dt} - \left(a + bI^2\right)I = 0$$

Assume the parameter values for this example as E = 200 volts, L = 3 henries, a = 100 Ω, b = 50 Ω/amp^2.

Determine the current flow in the CKT for t = 0.002(0.002) 0.006 sec. using the Third-order RK method. Results should correspond to four decimal place accuracy.

L-2/T-2/ME **Date : 20/11/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **ME 243** (Mechanics of Solids)

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) A bronze bar is fastened between a steel bar and an aluminum bar as shown in Figure 1(a). Axial loads are applied at the positions indicated. Find the largest value of P that will not exceed an overall deformation of 3.0 mm, or the following stresses: 140 MPa in the steel, 120 MPa in the bronze, and 80 MPa in the aluminum. Assume that the assembly is suitably braced to prevent buckling. Use E_{st} = 200 GPa, E_{al} = 70 GPa, and E_{br} = 83 GPa. **(20)**

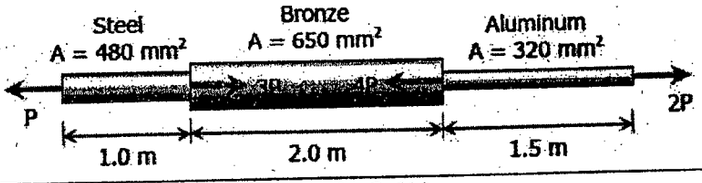

Figure for Q. 1(a)

(b) The three suspender bars in Figure 1(b) are made of the same material and have equal cross-sectional area A. Determine the average normal stress in each bar if the rigid beam ACE is subjected to the force **P**. **(15)**

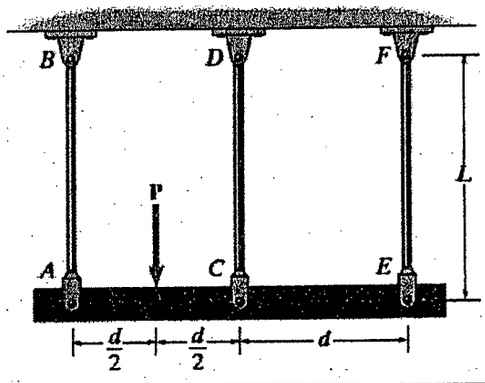

Figure for Q. 1(b)

2. (a) Derive the expression for shear stress and angle of twist for a circular member under torsion. List necessary assumptions. **(15)**

Contd P/2

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Contd Q. No. 2

(b) A rigid bar, hinged at one end, is supported by two identical spring as shown in Figure 2(b). Each spring consists of 30 turns of 10 mm wire having mean diameter of 120 mm. Compute the maximum shearing stress in the springs. Neglect the mass of the rigid bar. **(20)**

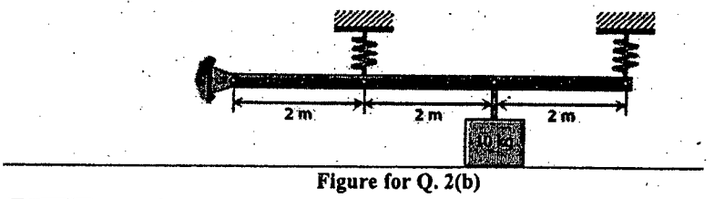

Figure for Q. 2(b)

3. (a) The circular spring clamp produces a compressive force of 3 N on the plates. Determine the maximum bending stress produced in the spring at A. The spring has a rectangular cross section as shown in Figure 3(a). **(20)**

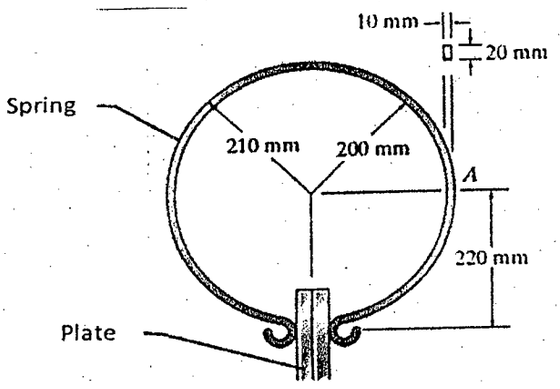

Fig. for Q. 3(a)

(b) The composite beam is made of aluminum (A) and brass (B). If the height h = 40 mm, determine the maximum moment that can be applied to the beam if the allowable bending stress for aluminum is 128 MPa and for brass 35 MPa. The Young's moduli of aluminum and brass are 70 GPa and 120 GPa respectively. **(15)**

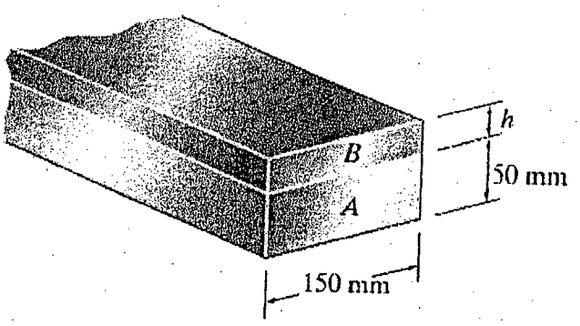

Figure for Q. 3(b)

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4. (a) For the stress element shown in Figure 4(a), determine the principal stresses, maximum shear stress and principal plane. Show the principal stresses and maximum shear stress on sketches of stress elements. Solve the problem using Mohr's circle. **(25)**

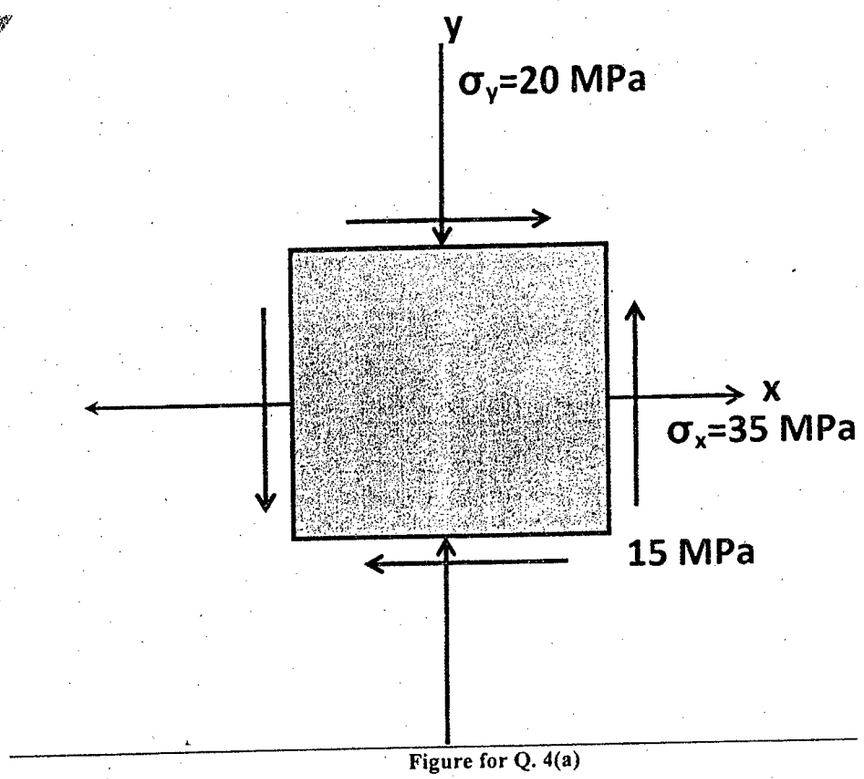

Figure for Q. 4(a)

(b) Prove that the longitudinal stress is one half the value of the tangential stress in a thin-walled pressure vessel. **(10)**

SECTION – B

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

Symbols carry their usual meaning. Reasonably assume any missing data.

5. (a) Draw shear force and bending moment diagrams for the beam as shown in Fig. for Q. 5(a). Label maximum bending moment and inflection point. Ignore beam's self-weight. **(15)**

(b) Calculate the maximum normal and shear stresses at fixed end of the Cantilever beam shown in Fig. for. Q. 5(b). **(15)**

Also, with a plot show the stress distributions over the beam's cross-section. The beam has solid rectangular cross-sections (b = 200 mm, h = 300 mm). Ignore beam's self-weight.

(c) Sketch 2 typical economic cross-sections of beams. **(5)**

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6. (a) A simple beam having a self-weight 'W' is subjected to a point load 'P' at mid-span. Using double integration method calculate, in terms of P, W, EI and L the maximum slope and maximum deflection of the elastic curve (17

(b) Calculate slope and deflection (in terms of 'E, 'I', 'a' and 'W_o') of tip of the cantilever beam shown in Fig. for Q. 6(b). Ignore beam's self-weight. Use area-moment method. (18

7. (a) Briefly discuss followings with necessary plots: (17

(i) 'Axial compressive load - transverse deflection at mid-span' relation for a pinned-pinned slender column.

(ii) 'Critical load - slenderness ratio' relation of a pinned-pinned column.

(b) An ideal column has following data: L = 2 m, cross-section is solid rectangular (6 mm × 4 mm), E = 200 GPa. Calculate: Slenderness ratio and buckling load if the column has one end clamped and the other end pinned. Also plot the buckled shape of the column. (1

8. (a) Calculate strain energy due to bending for the beam shown in Fig. for Q. 8(a), in terms of EI, P_1, P_2 and a. (1

(b) Three strain gages are placed on the surface of a stressed machine part. The strain gage readings in 3 different directions are as follows: (1

$$\varepsilon_{0^\circ} = 30\times10^{-6},\ \varepsilon_{45^\circ} = -40\times10^{-6},\ \varepsilon_{90^\circ} = 50\times10^{-6}$$

Given: E = 200 GPa, μ = 0.30.

Calculate: (i) the principal stresses

(ii) the maximum shear stress

(iii) the required yield strength for a safety factor of 3, if the material is brittle.

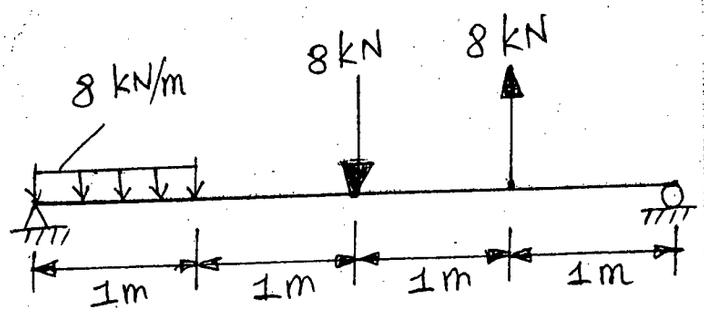

FIG. for Q.5(a)

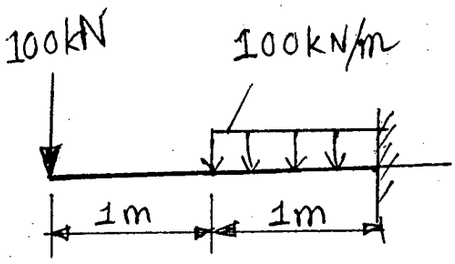

FIG. for Q.5(b)

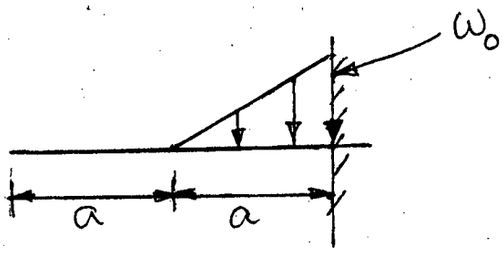

Fig. for Q.6(b)

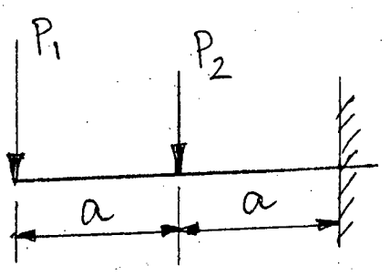

Fig. for Q.8(a).