KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Energy Science and Engineering
B. Sc. Engineering 2nd Year 1st Term Examination, 2018
ME 2113
(Statics and Solid Mechanics)

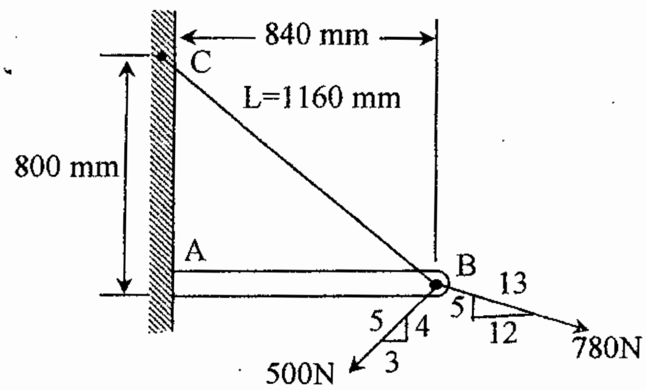
Time: 3 Hours. Full Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

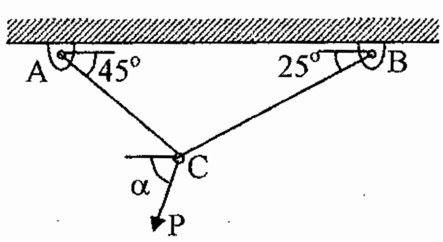
SECTION – A

1(a) State and explain the parallelogram law of addition of forces. 07

1(b) Knowing that the tension in cable BC is 725 N, determine the resultant of the three forces exerted at point B of beam AB. 14

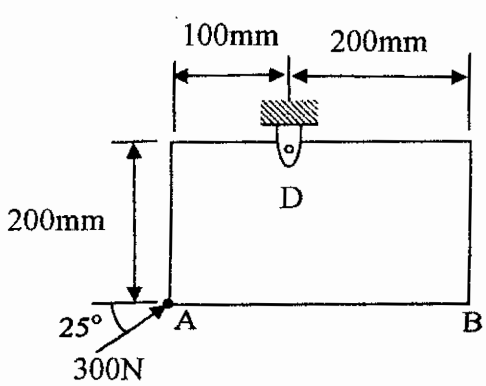


1(c) Two cables are tied together at C and loaded as shown. Knowing that P=500N and $\alpha=60^\circ$, determine the tension in (i) cable AC, (ii) cable BC. 14

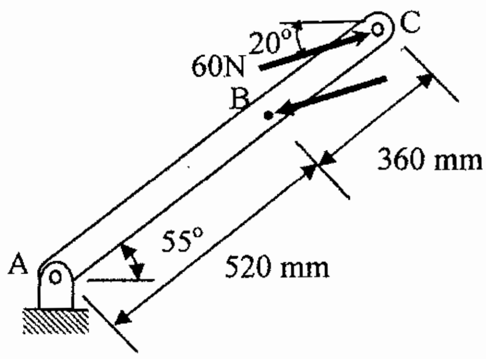


2(a) What is principle of transmissibility? 05

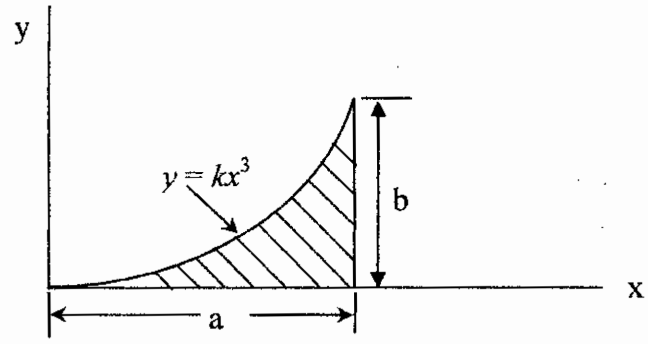
2(b) A 300 N force is applied at A as shown. Determine: 15
(i) The moment of the 300 N force about D,
(ii) The smallest force applied at B that creates the same moment about D.



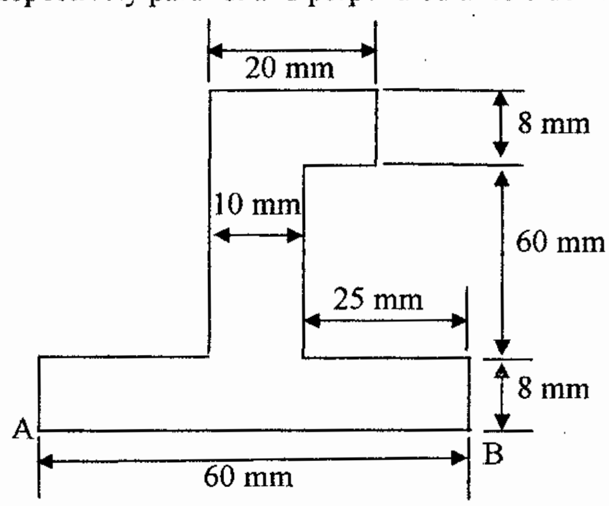
2(c) Two parallel 60 N forces are applied to a lever as shown. Determine the moment of the couple formed by the two forces. 15



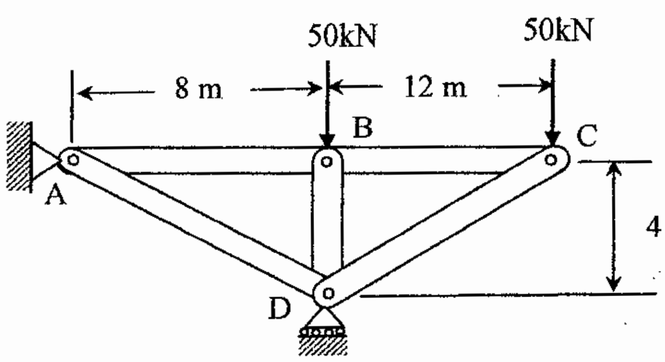
3(a) Determine the location of the centroid the area shown by direct integration. 17



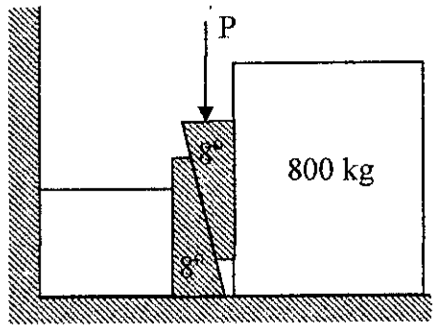
3(b) Determine the moments of inertia $\bar{I}_x$ and $\bar{I}_y$ of the area shown with respect to centroidal axes respectively parallel and perpendicular to side AB. 18



4(a) Using the method of joints, determine the force in each members of the truss shown. State whether each member is in tension or compression. 18



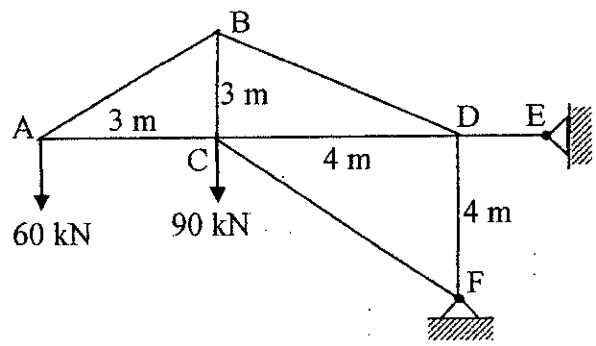
4(b) Two 8° wedges of negligible weight are used to move and position the 800 kg block. Knowing that the coefficient of static friction is 0.30 at all surfaces of contact, determine the smallest force P that should be applied as shown to one of the wedges. 17



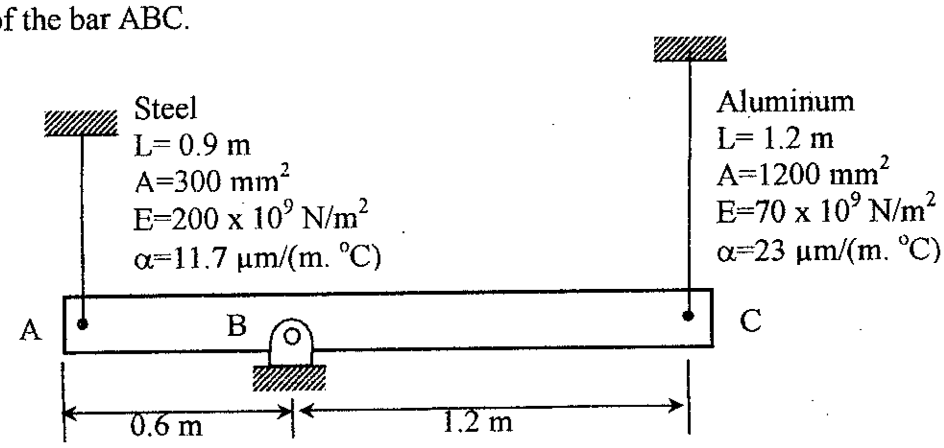
SECTION – B

5(a) Define: normal stress, shear stress and bearing stress. 06

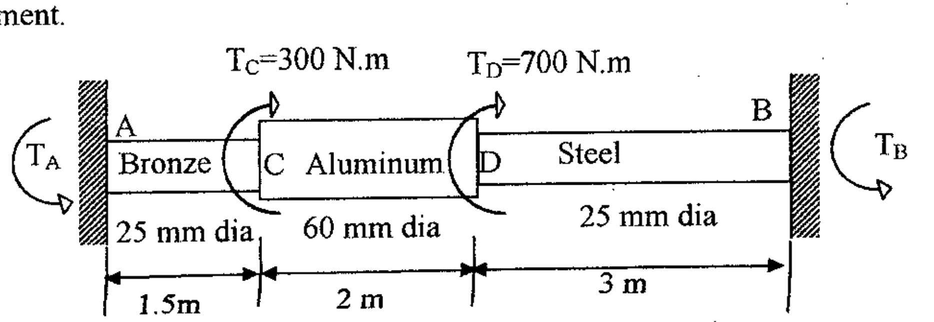
5(b) Find the stress in members BC, BD and CF for the truss shown in figure. Indicate the tension or compression. The cross-sectional area of each member is 1600 mm^2. 14



5(c) The rigid bar ABC in figure is pinned at B and attached to the two vertical rods. Initially, the bar is horizontal, and the vertical rods are stress-free. Determine the stress in the aluminum rod if the temperature of the steel rod is decreased by 40°C. Neglect the weight of the bar ABC. 15



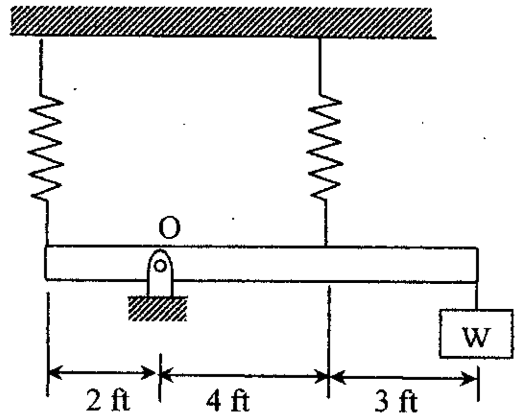
6(a) A shaft compressed of segments AC, CD and DB is fastened to rigid supports and loaded as shown in the figure. For bronze, G= 35 GPa; for aluminum, G= 28 GPa, and for steel G=83 GPa. Determine the maximum shearing stress developed in each segment. 17



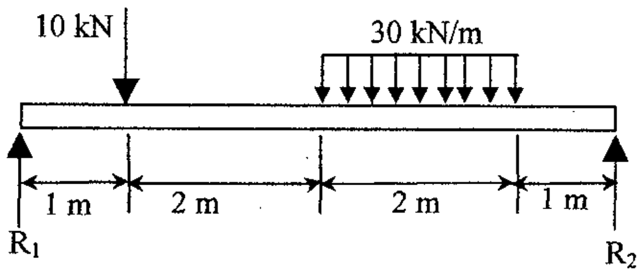
6(b) A rigid bar pinned at point O, is supported by two springs as shown in the figure. Each spring consists of 20 turns of ¾ inch diameter wire having a mean diameter of 6 inch. Shearing stress in the springs is limited to 2 ksi. Determine: 18

(i) The maximum load W that may be supported.

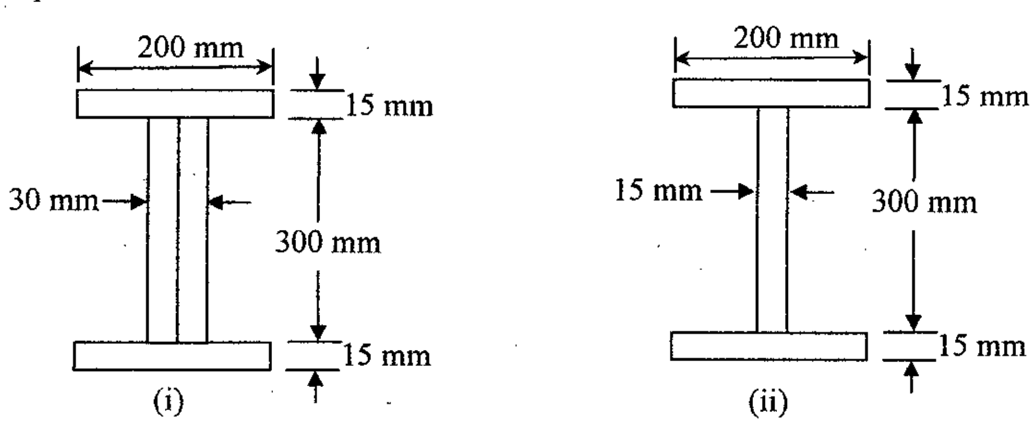
(ii) The deflection of load W when G = 83 GPa



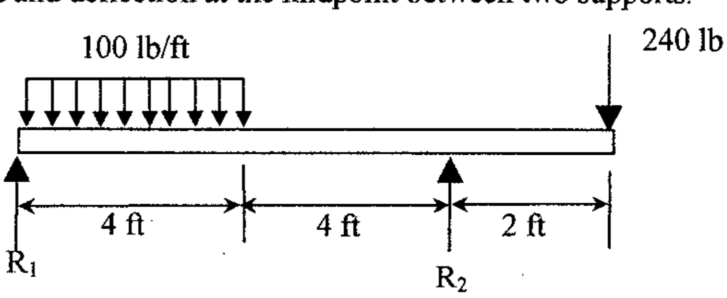
7(a) Write the shear and moment equations and draw the shear force and bending moment diagrams for the beam loaded as shown in the figure. 18



7(b) Two designs for a beam are to be considered. Determine which one will support a moment of M=150 kN.m with the least amount of bending stress. What is that stress? Explain the result. 17



8(a) For the bean loaded as shown in the figure, calculate the slope of the elastic curve over the right support and deflection at the midpoint between two supports. 17



8(b) What is critical load of a column? Select the lightest W shape that will act as a column 8m long with hinged ends and support an axial load of 270 kN with a factor of safety of 2.5. Assume that the proportional limit is 200 MPa and E= 200 GPa. 18

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Energy Science and Engineering
B. Sc. Engineering 2nd Year 1st Term Examination, 2018
CSE 2113
(Computer Programming)

Time: 3 Hours. Full Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION – A

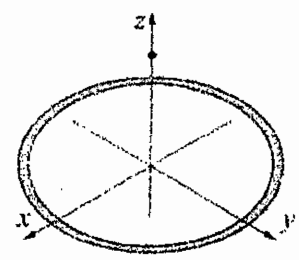
1(a). What is GNU Octave? What is GNU stand for? Write the application and limitation of GNU Octave. Compare Octave and MATLAB. 09

1(b). What are the different data types used in MATLAB language? What data types can store data from different classes. Give example of them. 08

1(c). What are the functions of the following Octave commands? 06
(i) find (ii) floor (iii) plot (iv) polyval

1(d). The electric field intensity, $E(z)$, due to a ring of radius R at any point z along the axis of the ring is given by 12

$$E(z) = \frac{\lambda}{2\varepsilon_0} \frac{Rz}{(z^2 + R^2)^{3/2}}$$



Here, λ is the charge density, $\epsilon_0 = 8.85 \times 10^{-12}$ is the electric constant, and R is the radius of the ring. Consider the case where $\lambda = 1.7 \times 10^{-7} C/m$ and $R = 6\ cm$. Write an Octave program to,

(i) Determine $E(z)$ at $z = 0,2,4,6,8,$ and $10\ cm$.

(ii) Determine the distance z where E is maximum. Do it by creating a vector z with elements ranging from $2\ cm$ to $6\ cm$ and spacing of $0.01\ cm$. Calculate E for each value of z and then find the maximum E and associated z with Octave's built-in function max.

2(a). Define variable in computer programming. How is it different from variable used in mathematics. What does it mean to assign data to a variable in Octave? 08

2(b). Find and explain errors, and give corrections of the following Octave codes: 06

(i)
```
A = [2, 4, 5, 6, 4, 6];
B = [1; 4; 5; 7; 8; 9];
C = A + B;
```

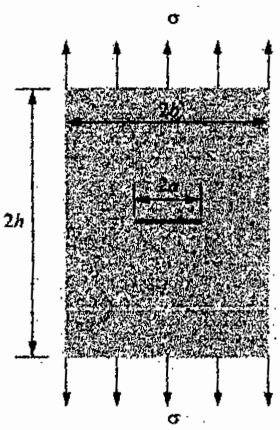
(ii)
```
var1 = 10: 9: 100
var2 = 1: 11;
addResult = var1 + var2;
sunResult = 1var - var2;
multiResults = var1 * var2
```

2(c). Mention the outputs of the following commands: 06

(i)
```
A = linspace(1,3,3);
B = [5; 6; 7];
Result1 = A * B
Result2 = A.* B
```

(ii)
```
x = [2, 3, 4, 5];
y = x + 1
z = y'
```

2(d). The stress intensity factor k is predicts the stress state (stress intensity) near a crack tip. For a plate with a crack and loading shown in the figure, k is given by – 08



$$k = \sigma\sqrt{\pi a}\left[\frac{1 - \frac{a}{2b} + 0.326\left(\frac{a}{b}\right)^2}{\sqrt{1 - \frac{a}{b}}}\right]$$

Write a Octave script to calculate the value of k with $\sigma = 12000\ psi$, $h = 5\ in$, $b = 4\ in$, and $a = 1.5\ in$.

2(e). Use a single command to create a row vector (assign it to a variable named a) with 6 elements such that the last element is 4.7 and the rest of the elements are $0s$. Do not type the vector elements explicitly. 07

3(a). What is meant by 'function'? Why do we need 'function'? Mention differences between function and script file. What is the prototype of a function? 06

3(b). What are scope, global variable, and workspace? Write short notes on: usage, warning, and error functions. 06

3(c). Write an Octave script to solve the following system of linear equations by checking whether the system is consistent. 06

$$\begin{cases} 4x - 2y + 6z = 8 \\ 2x + 8y + 2z = 4 \\ 6x + 10y + 3z = 0 \end{cases}$$

3(d). The following points are given: 10

x	1	2.2	3.7	6.4	9	11.5	14.2	17.8	20.5	23.2
y	12	9	6.6	5.5	7.2	9.2	9.6	8.5	6.5	2.2

Write Octave script for –

(i) Fit the data with a first-order polynomial. Make a plot of the points and the polynomial.

(ii) Fit the data with a second-order polynomial. Make a plot of the points and the polynomial.

(iii) Fit the data with a third-order polynomial. Make a plot of the points and the polynomial.

(iv) Fit the data with a fifth-order polynomial. Make a plot of the points and the polynomial.

3(e). The following matrix is defined in Octave. 07

$$N = \begin{bmatrix} 2 & 10 & 18 & 29 & 41 \\ 4 & 12 & 20 & 32 & 44 \\ 6 & 14 & 23 & 35 & 47 \\ 8 & 16 & 26 & 38 & 50 \end{bmatrix}$$

What will be displayed if the following commands are executed by Octave?

(i) $A = [N(1,1:4)', N(2,2:5)']$

(ii) $B = [N(:,3)', N(3,:)]$

4(a). Mention the Octave code to import and export data into and from an Excel file. 07

4(b). The factorial n! of a positive number (integer) is defined by 10
$n! = n.(n-1).(n-2)\ldots1$, where $0! = 1$. Write a user-defined function that calculates the factorial n! of a number. For function name and arguments, use $y = fact(x)$, where the input argument x is the number whose factorial is to be calculated and the output argument y is the value $x!$. The function displays an error message if a negative or non-integer number is entered when the function is called. Do not use Octave built-in function 'factorial.' Use fact with the following numbers: (i) 9! (ii) 8.5! (iii) 0! (iv) –5!

4(c). Draw flow chart for if-elseif-else-end structure and describe program for this construct. 08

4(d). What is meant by decision making operators? Show the syntax of Octave's different decision making operators. Draw the flow chart and write the code of finding whether a number x is prime or not. 10

SECTION – B

5(a). Explain exception handling in Octave with proper example. 10

5(b). What is wrong with the following code (find at least three mistakes)? 06

(i)
```
for n=1:10
  m=1;
  while m<=10
   printf("n is %d, m is %d \n", m, n);
  endfor
endwhile
```

(ii)
```
s=input("Enter a text string: ");
if ( s=="Hi" )
   disp("You entered Hi");
elseif
   disp("You did not enter Hi");
end
```

5(c). What is printed to the screen if the following commands are executed? 06

(i) printf("Hello World\r")
(ii) printf("Hello World\b \n")
(iii) printf("Hello World\b \t\n")
(iv) printf("%d\n", 2)
(v) printf("%f\n", 2)
(vi) printf("%e\n", 2)

5(d). Which of the following function definitions are erroneous? 06

(i)
```
a = fun(x)
a = sin(x);
endfunction
```

(ii)
```
function a = fun(x y z)
  a = x + y + z;
endfunction
```

(iii)
```
function fun()
  printf("Hello World\n");
end
```

(iv)
```
# my sine function
function a = fun(x)
# Usage: a = fun(x)
  a = sin(x);
endfunction
```

(v)
```
function [a, b] = fun(x)
  a = sin(x);
endfunction
```

(vi)
```
function a = fun(x, y)
  b = sqrt(x);
  c = sqrt(y)*b;
end
```

5(e). What is subplot, title, legend, surface plot, and contour plot? Show Octave code to execute those. 07

6(a). Create three row vectors: 10
a = [3 -1 5 11 -4 2], b = [7 -9 2 13 1 -2], c = [-2 4 -7 8 0 9]
(i) Use the three vectors in an Octave command to create a matrix in which the rows are the vectors a, b, c, and c.
(ii) Use the three vectors in an Octave command to create a matrix in which the columns are the vectors b, c, and a.

6(b). Create the following matrix A - 10

$$A = \begin{bmatrix} 36 & 34 & 32 & 30 & 28 & 26 \\ 24 & 22 & 20 & 18 & 16 & 14 \\ 12 & 10 & 8 & 6 & 4 & 2 \end{bmatrix}$$

By writing one command and using the colon to address range of elements (do not type individual elements explicitly), use the matrix A to:

(i) Create a six-element row vector named ha that contains the elements of the second row of A.

(ii) Create a three-element column vector named hb that contains the elements of the sixth column of A.

(iii) Create a five-element row vector named hc that contains the first two elements of the third row of A and the last three element of the first row of A.

6(c). The position as a function of time $(x(t), y(t))$ of a projectile fired with a speed of v_0 at angle α is given by – 15

$$x(t) = v_0 \cos(\alpha t) \; and \; y(t) = v_0 \sin(\alpha t) - \frac{1}{2} g t^2$$

where $g = 9.81 \, m/s^2$. The polar coordinate of the projectile at time t are $(r(t), \theta(t))$, where $r(t) = \sqrt{x(t)^2 + y(t)^2}$ and $\tan(\theta) = y(t)/x(t)$. Consider the case where $v_0 = 162 \, m/s$ and $\alpha = 70°$. Write a script to determine $r(t)$ and $\theta(t)$ for $t = 1,6,11, \ldots, 31 \; sec.$

7(a). The balance of a loan, B, after n monthly payments is given by 15

$$B = A\left(1 + \frac{r}{1200}\right)^n - \frac{P}{r/1200}\left[\left(1 + \frac{r}{1200}\right)^n - 1\right]$$

Where A is the loan amount, P is the amount of a monthly payment, and r is the yearly interest rate entered in % (e.g., 7.5% entered as 7.5). Consider a 5-year, $20,000 car loan with 6.5% yearly interest that has a monthly payment of $391.32. Calculate the balance of the loan after every 6 months (i.e., at n = 6, 12, 18, 24, ..., 54, 60). Each time, calculate the percent of the loan that is already paid. Display the results in a three-column table, where the first column displays the month and the second and third columns display the corresponding value of B and percentage of the loan that is already paid, respectively.

7(b). Write a script to plot the function $f(x) = \frac{x^2-5x-12}{x^2-x-6}$ in the domain $-1 \leq x \leq 7$. Notice that the function has a vertical asymptote at $x = 3$. Plot the function by creating two vectors for the domain of x. The first vector (name it x1) includes elements from –1 to 2.9, and the second vector (name it x2) includes elements from 3.1 to 7. For each x vector create a y vector (name them y1 and y2) with the corresponding values of y according to the function. To plot the function make two curves in the same plot (y1 vs. x1, and y2 vs. x2). Format the plot such that the y-axis ranges from –20 to 20. 15

7(c). Define vector space and write its axioms. 05

8(a). Define eigenvalue and eigenvectors. What is the geometric interpretation of eigenvalues? 10

8(b). A linear transformation is given by following matrix – 15

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 4 & -17 & 8 \end{bmatrix}$$

Find its eigenvalues. Also find any one eigenvector corresponding to any eigenvalue you found.

8(c). A matrix T is given by – 10

$$T = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 3 & 0 \\ -4 & 13 & -1 \end{bmatrix}$$

Use Octave commands to find its eigenvalues and eigenvectors in a single statement.

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Energy Science and Engineering
B. Sc. Engineering 2nd Year 1st Examination, 2018
ME 2115
(Fluid Mechanics)

Time: 3 Hours. Full Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION – A

1(a). Describe how fluid can be considered as continuum. 08

1(b). Describe no-slip and no-temperature jump condition for a fluid. 08

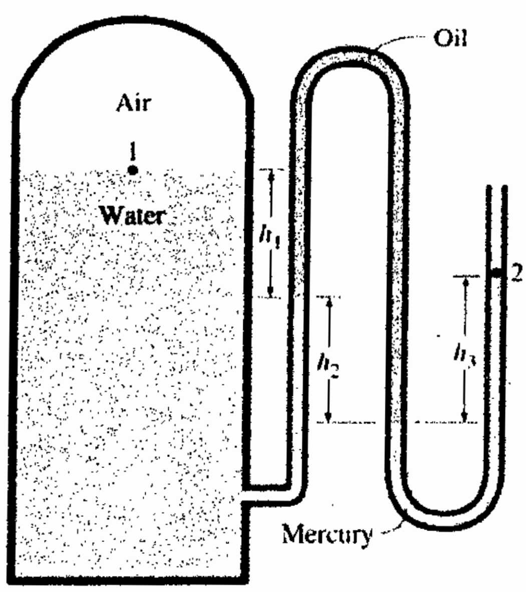
1(c). Describe Newton's law of viscosity. Show that $\tau_{xy} = \mu\left(\frac{\partial u}{\partial y}\right)$, where symbols have their usual meaning. 13

1(d). Write short notes on – 06
(i) Vapor pressure (ii) Absolute pressure (iii) Gage pressure

2(a). Show that $\frac{dP}{dz} = -\rho g$, where symbols have their usual meaning. 15

2(b). What is meant by center of pressure? 05

2(c). The water in a tank is pressurized by air, and the pressure is measured as shown in the figure. The tank is located on a mountain at an altitude of $1400\ m$ where atmospheric pressure is $85.6\ kPa$. Determine air pressure in the tank if $h_1 = 0.1\ m, h_2 = 0.2\ m$, and $h_3 = 0.35\ m$. Take the density of water, oil, and mercury to be $1000\ kg/m^3, 850\ kg/m^3$, and $13600\ kg/m^3$, respectively. 15



3(a). Derive the expression for the center of pressure on a vertical plane surface. 15

3(b). Differentiate between Lagrangian and Eulerian method of fluid motion. 08

3(c). Define the following terms – 12
(i) Streamlines (ii) Stream tube (iii) Pathlines (iv) Streaklines

4(a). What is particle image velocimetry (PIV)? 05

4(b). Derive Bernoulli equation along a streamline. What are the necessary assumptions needed to applying this equation to a fluid dynamic problem? 10

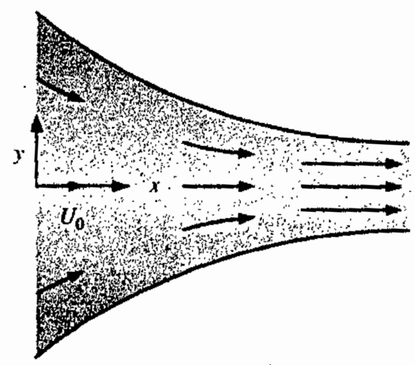
4(c). A velocity field is defined by the following equation – 10

$$\vec{V} = (U_0 + bx)\hat{e}_x - by\hat{e}_y$$

Where, U_0 is the horizontal speed at $x = 0$. Calculate the material acceleration for fluid particle. Give your answer in two ways:

i. As acceleration components a_x and a_y

ii. As acceleration vector $\vec{a}$



4(d). Velocity field of an incompressible fluid is given by – 10

$$\vec{V} = (6xt + yz^2)\hat{e}_x + (3t + xy^2)\hat{e}_y + (xy - 2xyz - 6tz)\hat{e}_z$$

i. What is the dimension of the flow?

ii. Is it a steady flow? Give reasons.

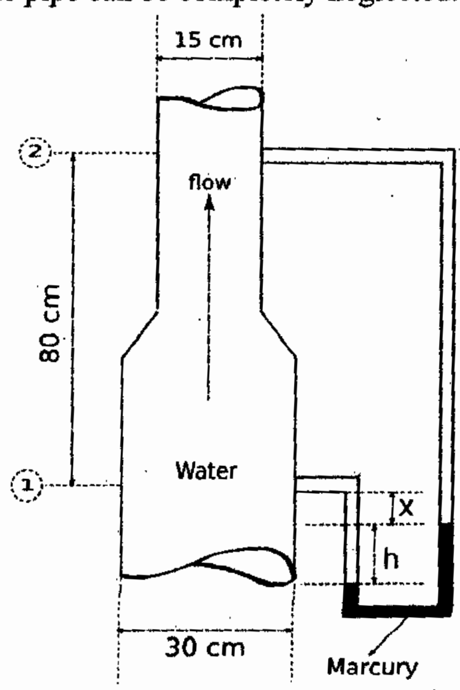
iii. Show that $\vec{\nabla} \cdot \vec{V} = 0$. What does this equation tell us about the flow physics?

SECTION – B

5(a). Using Bernoulli equation describe how Pitot tube is used to measure fluid velocity in closed conduits. (

5(b). Derive Reynold's Transport Theorem and describe what each term in the equation mean.

5(c). Water flows up a tapered pipe as shown in the figure. Find the magnitude and direction of the deflection h of the differential mercury manometer corresponding to a discharge of 120 L/s. The friction in the pipe can be completely neglected.



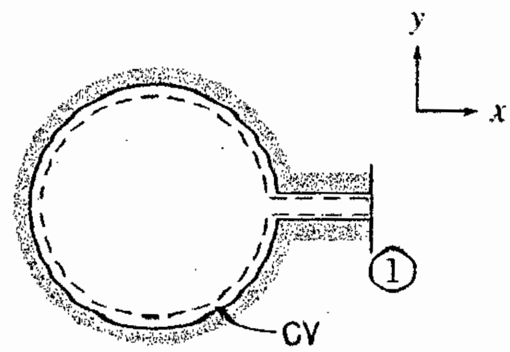
6(a). Derive Euler equation for fluid flow using material derivative from Newton's law $\sum \vec{F} = m\vec{a}$. 10

6(b). Using Reynold's Transport Theorem derive conservation of mass for open system showing 10

$$\frac{\partial}{\partial t}\int_{cv} \rho\, dV + \int_{cs} \rho\vec{V}\cdot\hat{n}\; dA = 0$$

What does the term $\int_{cs} \rho\vec{V}\cdot\hat{n}\; dA$ measure?

6(c). A tank of $0.05\, m^3$ volume contains air at $800\, kPa$ (absolute) and $15\,°C$. At $t = 0$, air begins escaping from the tank through a valve with a flow area of $65\, mm^2$. The air passing through the valve has a speed of $300\, m/s$ and a density of $6\, kg/m^3$. Determine the instantaneous rate of change of density in the tank at $t = 0$. 15



7(a). Derive the momentum integral equation for boundary layer and show – 20

$$\frac{\tau_w}{\rho} = \frac{d}{dx}(U^2\theta) + \delta^* U \frac{dU}{dx}$$

Where, symbols have their usual meaning.

7(b). Define boundary layer. Derive an expression for the displacement and momentum thickness in a flow over a flat plate assuming $\frac{u}{u_\infty} = \sin\left(\frac{\pi}{2}\frac{y}{\delta}\right)$, where u_∞ is the free stream velocity. 15

8(a). What are meant by drag force and lift force? 08

8(b). Differentiate between friction and pressure drag. 08

8(c). Explain drag can be reduced by streamlining. 08

8(d). If the power to overcome aerodynamic drag of an aircraft remains the same, what percentage increase in velocity is reflected by 15% reduction in the drag coefficient? 11

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Energy Science and Engineering
B. Sc. Engineering 2nd Year 1st Term Examination, 2018
Math 2113
(Linear Algebra and Vector Analysis)

Time: 3 Hours. Full Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION – A

1(a) What is trivial solution of a linear equation? Find a polynomial that fits the points $(1,4), (2,0)$, and $(3,12)$. 10

1(b) Let $A = \begin{bmatrix} 4 & -1 & 1 & 6 \\ 0 & 0 & -3 & 3 \\ 4 & 1 & 0 & 14 \\ 4 & 1 & 3 & 2 \end{bmatrix}$ 12

Find: (i) M_{21} and C_{21} of A (ii) M_{44} and C_{44} of A
Where, M if for minor and C is for co-factor.

1(c) Determine for which values of λ the following set of vectors are linearly dependent. 13

$$v_1 = \left(\lambda, -\frac{1}{2}, -\frac{1}{2}\right); \qquad v_2 = \left(-\frac{1}{2}, \lambda, -\frac{1}{2}\right); \qquad v_3 = \left(-\frac{1}{2}, -\frac{1}{2}, \lambda\right)$$

2(a) Define rank of a matrix. Find the rank of a matrix B 10

where, $B = \begin{bmatrix} 1 & -1 & 2 & 1 \\ 3 & 0 & 2 & 2 \\ 2 & 1 & -1 & 1 \\ 1 & 0 & 1 & 1 \end{bmatrix}$.

2(b) Define subspace of a vector space. Find the basis and dimension of the subspace S defined below – 12

$$S = \{(x, y, z, t) : x + y = z, t = 2y\}$$

2(c) Find all the eigenvalues and an eigenvector corresponding to largest eigenvalue of the following matrix – 13

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

3(a) What is Nullity? Find the basis of $N(A)$, where – 10

$$A = \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & 3 \\ 4 & 5 & -3 \end{bmatrix}.$$

3(b) State Cauchy-Schwartz inequality. Verify it for $u = (1, -1, 3)$ and $v = (2, 0, -1)$. 10

3(c) Orthonormalize the family of vectors $\{v_1 = (1,1,1), v_2 = (0,-1,1), v_3 = (0,1,1)\}$ by using Gram-Schmidt orthonormalize process. Also verify the result for orthogonality and orthonormality. 15

4(a).	What is a symmetric matrix? Express the matrix A as sum of a symmetric and a skew-symmetric matrix where – $$A = \begin{bmatrix} 3 & 3 & -1 \\ 0 & 3 & -2 \\ -1 & 2 & 2 \end{bmatrix}$$	10
4(b).	Find the standard matrix for the stated composition in $\mathbb{R}^3$: A rotation of 30° about the x-axis, followed by a reflection about yz plane followed by an orthogonal projection onto xy plan. Hence find image of (1,2,3).	12
4(c).	When does a system of linear equations is said to be consistent or inconsistent? Solve the following system of linear equations if possible – $$x_1 + x_2 + x_3 + x_4 = 0$$ $$x_1 + 3x_2 + 2x_3 + 4x_4 = 0$$ $$2x_1 + x_3 - x_4 = 0$$	13

SECTION – B

5(a).	Given the space curve $x = 3\cos(t)$, $y = 3\sin(t)$, and $z = 4t$. Find the curvature κ and the torsion τ.	16
5(b).	Find the equation for the tangent plane and normal line to the surface $z = x^2 + y^2$ at the point $(1, -1, 2)$.	14
5(c).	Find the unit tangent vector to any point on the curve $x = t^2 + 1$, $y = 4t - 3$, $z = 2t^2 - 6t$.	05
6(a).	Find the directional derivative of $\Phi = x^2yz + 4xz^2$ at $(1, -2, -1)$ in the direction $2\underline{i} - \underline{j} - 2\underline{k}$.	10
6(b).	Prove that for every vector field $\vec{V}$, $\nabla \cdot (\nabla \times \vec{V}) = 0$.	08
6(c).	Define solenoidal vector and conservative vector field. Check whether $\vec{F} = (2xy + z^3)\hat{\imath} + x^2\hat{\jmath} + 3xz^2\hat{k}$ is conservative or not. If conservative, then find the scalar potential.	17
7(a).	If $\vec{A} = (3x^2 + 6y)\,\hat{\imath} - 14yz\,\hat{\jmath} + 20xz^2\,\hat{k}$, evaluate $\int_C \vec{A} \cdot d\vec{r}$ from (0,0,0) to (1,1,1) along the following paths C: the straight line from (0,0,0) to (1,0,0), then to (1,1,0), and then to (1,1,1).	12
7(b).	Evaluate $\iint_S \vec{A} \cdot \hat{n}\, dS$, where $\vec{A} = 18z\,\hat{\imath} - 12\,\hat{\jmath} + 3y\,\hat{k}$ and S is that part of the plane $2x + 3y + 6z = 12$ which is located in the first octant.	15
7(c).	Use Gauss's divergence theorem to evaluate $\iint_S \vec{F} \cdot \hat{n}\, ds$ where – $\vec{F} = 4xz\,\hat{\imath} - y^2\,\hat{\jmath} + yz\,\hat{k}$ and S is the surface of the cube bounded by $x = 0, x = 1$ $y = 0,\ y = 1,\ z = 0,\ z = 1$.	08
8(a).	Verify Green's theorem in the plane for $\oint_C (xy + y^2)dx + x^2dy$, where C is the closed curve of the region bounded by $y = x$ and $y = x^2$.	12
8(b).	Write the statement of Stokes' theorem and verify it for $\vec{A} = (2x - y)\,\hat{\imath} - yz^2\,\hat{\jmath} + y^2z\,\hat{k}$, where S is the upper half of the sphere $x^2 + y^2 + z^2 = 1$ and C is its boundary.	14
8(c).	Prove that $\nabla^2(\ln r) = \frac{1}{r^2}$, where $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$.	09

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Energy Science and Engineering
B. Sc. Engineering 2nd Year 1st Term Examination, 2018
EE 2113
(Electrical Machines)

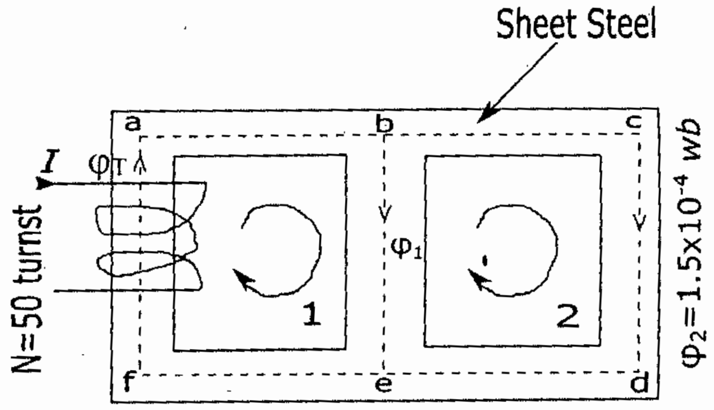
Time: 3 Hours. Full Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION – A

1(a)	Explain flux density, permeability, and reluctance. What do you mean by magnetizing force and hysteresis?	10
1(b)	Derive the equation of voltage induced in the armature of a DC generator. Discuss the effect of field resistance on induced voltage.	15
1(c)	Explain the 'Build-up' process of a DC generator. What is long shunt and short shunt compound generator.	10
2(a)	What is degree of compounding? Explain the characteristics of different types of compound generator.	12
2(b)	'A series generator can be used as a constant current source or a series booster' – justify the statement.	11
2(c)	Explain the effects of armature reaction in a DC generator. List some methods to minimize the effect of armature rection.	12
3(a)	Explain how loads will be shared between two shunt DC generator connecting in parallel.	10
3(b)	Derive the equation of force on a current carrying conductor in a magnetic field. How the direction of force can be determined?	10
3(c)	What is back emf ? A 5 hp, 240 V DC motor has full load current 20.4 $Amps$ and field resistance of 202 Ω. If the armature resistance is 0.71 Ω, determine – (i) Power delivered to the motor (ii) Power dissipated in shunt field (iii) Power dissipated in armature circuit (iv) Electrical power converted into mechanical power .	15
4(a)	Dicuss the torque-armature current and speed-armature current characteristics of shunt, compound and series DC motor.	13
4(b)	State and explain Ampere's circuital law for magnetic circuit.	07

4(c) Determine the current I required to established a flux of $1.5 \times 10^{-4}\ wb$ in the section the core indicated in the figure below –



$l_{bcde} = l_{efab} = 0.2\ m$
$l_{be} = 0.05\ m$
Cross section area = $6 \times 10^{-4}\ m^2$ through out
For sheet steel
$H = 40\ At/m$ for $B = 0.25\ T$
$H = 160\ At/m$ for $B = 0.97\ T$
$H = 150\ At/m$ for $B = 0.93\ T$
$H = 400\ At/m$ for $B = 1.22\ T$

SECTION – B

5(a) Explain construction of single-phase transformer. Write short notes on the construction of core type and shell type transformers. 10

5(b) Describe the elementary theory of an ideal transformer. Deduce the E.M.F. equation of a transformer. 10

5(c) Draw the vector diagram of a transformer with resistance and leakage reactance, for different kinds of loads. Why is the transformer rating in KVA ? 05

5(d) A 100 KVA transformer has 400 turns on the primary and 80 turns on the secondary. The primary and secondary resistances are $0.3\ \Omega$ and $0.01\ \Omega$ respectively and corresponding leakage reactances are $1.1\ \Omega$ and $0.035\ \Omega$ respectively. The supply voltage is $2200\ V$. Calculate – 10
- (i) equivalent impedance referred to primary
- (ii) the voltage regulation and the secondary terminal voltage for full load having a power factor of 0.8 leading.

6(a) What are the advantages of delta/delta connection? 08
Write short notes on:
- (i) star/star connection and
- (ii) delta/delta connection of 3-phase transformer.

6(b) What are the advantages and disadvantages of induction motor? 0

6(c) Describe construction of an induction motor. 0

6(d) A 440 V, $3-\phi$, 50 Hz, 4 pole, Y connected induction motor has a full-load speed of 1425 rpm. The rotor has an impedance of $(0.4 + j\,4)$ ohm and rotor/stator turn ratio of 0.8. Calculate – 15

(i) full-load torque,
(ii) rotor current and full-load rotor Cu loss,
(iii) power output if windage and friction losses amount to 500 W,
(iv) maximum torque and the speed at which it occurs,
(v) starting current,
(vi) starting torque

7(a) What is slip of an induction motor? How the rotating field in an induction motor is produced in case of three-phase supply? 07

7(b) Why does the rotor rotate in an induction motor? Deduce the equation of torque of the rotor of an induction motor under running condition. 1

7(c) Discuss about the torque/speed curve of an induction motor. Show the power stages in an induction motor. Explain complete torque/speed curve of a three-phase machine. 0

7(d) The star connected rotor of an induction motor has a standstill impedance of $(0.4 + j\,4)$ ohm per phase and the rheostat impedance per phase is $(6 + j\,2)$ ohm. 1
The motor has an induced e.m.f of 80 V between slip-rings at standstill when connected to its normal supply voltage. Find –

(i) rotor current at standstill with the rheostat is in the circuit,
(ii) when the slip-rings are short-circuited and motor is running with a slip of 3%.

8(a) Deduce the equation for actual induced voltage/phase in an alternator. Show the vector diagrams of a loaded alternator.

8(b) What is voltage regulation of an alternator? Mention some methods to determine voltage regulation. Explain one of the methods in detail.

8(c) What is armature reaction? Explain the effect of armature reaction in an alternator for different loads.

8(d) In a 2000 V, single phase generator a full load current of 100 A is produced on short circuit by a field excitation of 2.5 A, an e.m.f of 500 V is produced on open circuit by the same excitation. The armature resistance is 0.8 Ω. Determine the voltage regulation when the generator is delivering a current of 100 A at (i) unity $p.f.$ and (ii) 0.8 $p.f.$ lagging.