**KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY**

***Department of Mechanical Engineering***

B. Sc. Engineering 2nd Year Backlog Examination, 2020

**Math 2105**

(Mathematics III)

Time: 3 Hours | Total 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) Represent graphically the set of values of z for which $\begin{vmatrix} z-5 \\ z+7 \end{vmatrix} = 3$, where $z = x+iy$. 08

1(b) Define Harmonic function. Prove that $u = 3x^2y + 2x^2 - y^3 - 2y^2$ is Harmonic function. Find $v$, where $v$ is harmonic conjugate such that $f(z) = u + iv$ is analytic. Also express $f(z)$ in terms of z. 18

1(c) Find each of the indicated roots and locate them graphically of $(-1+i)^{1/3}$ in the argaud diagram. 09

2(a) Define the following singularities with an example for each: (i) Pole, (ii) Removable singularity, (iii) Essential singularity and (iv) Isolated singularity. 12

2(b) Prove that $\lim_{z \to 0} \frac{\bar{z}}{z}$ does not exist? 08

2(c) Test the consistency and solve the system of equations if possible: 15

$$x + 2y + z = 2$$
$$3x + y - 2z = 1$$
$$4x - 3y - z = 3$$
$$2x + 4y + 2z = 4.$$

3(a) Define with example for each of the following matrices: 09
(i) Scalar Matrix, (ii) Hermitian Matrix, (iii) Symmetric Matrix.

3(b) Let $\vec{v}_1 = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$, $\vec{v}_2 = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$, $\vec{v}_3 = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}$. Determine if the set $\{\vec{v}_1, \vec{v}_2, \vec{v}_3\}$ is linearly independent. If 12
possible, find a linear dependence relation among $\vec{v}_1, \vec{v}_2, \vec{v}_3$.

3(c) Which one of the following matrices has inverse? Find the inverse of that matrix using row operations. 14

$$\begin{bmatrix} -2 & 4 \\ 2 & -4 \end{bmatrix}, \begin{bmatrix} 0 & 1 & -1 \\ 3 & 1 & 1 \\ 1 & 2 & -1 \end{bmatrix}.$$

4(a) Reduce the following matrix A to Ecelon form, Canonical form and normal form: 17

$A = \begin{bmatrix} 1 & 2 & 3 & -2 \\ 2 & -2 & 1 & 3 \\ 3 & 0 & 4 & 1 \end{bmatrix}$. Also find its rank.

4(b) Define eigen values and eigen vectors. Find the eigen values and eigen vector corresponding to 18
the largest eigen value for the matrix, $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$.

## SECTION-B

5(a) Suppose that the temperature at a point $(x, y, z)$ in space is given by $T(x,y,z)=80/\left(1+x^2+2y^2+3z^2\right)$, where T is measured in degrees Celsius and $x, y, z$ in meters. In which direction does the temperature increase fastest at the point (1, 1, −2). What is the maximum rate of increase? 15

5(b) A particle of mass $m$ moves along the path given by the parametric equations: $x(t)=t\cos t$, $y(t)=t\sin t$, *and* $z(t)=t^2$. Find the velocity vector, the kinetic energy and the acceleration vector. 15

5(c) Test the incompressibility of velocity field of a fluid motion given by $\vec{V}=(\sec x)\hat{i}+(\cos ecx)\hat{j}+0\hat{k}$. 05

6(a) Show that $\vec{F}=\left(2xy+z^3\right)\hat{i}+x^2\,\hat{j}+3xz^2\,\hat{k}$ is a conservative force field. Find the scalar potential. Also find the work done in moving an object in this field from (1, −2, 1) to (3, 1, 4). 19

6(b) State Green's theorem. Verify Green's theorem in the plane for $\int_C \left(xy+y^2\right)dx+x^2dy$, where c is the closed curve of the region bounded by $y=x$ and $y=x^2$ 16

7(a) Evaluate $\iint_s \hat{F}.\hat{n}\,ds$, where $\vec{F}=18z\,\hat{i}-12\hat{j}+3y\hat{k}$, and $s$ is the part of the plane $2x + 3y + 6z = 12$ located on the first octant. 13

7(b) Using Divergence theorem evaluate $\iint_s \vec{F}.\,d\vec{s}$, where $\vec{F}=xy\,\hat{i}+\left(y^2+e^{xz^2}\right)\hat{j}+\sin(xy)\hat{k}$ and $S$ is the surface of region bounded by the parabolic cylinder $z = 1-x^2$ and the planes $z = 0$ and $y+z=2$. 14

7(c) Find the expression for differential volume in cylindrical coordinates. 08

8(a) Verify Stoke's theorem for $\vec{A}=(2x-y)\,\hat{i}-yz^2\,\hat{j}-y^2z\,\hat{k}$ where s is the upper half surface of the sphere $x^2+y^2+z^2=1$ and c is its boundary. 20

8(b) Derive the expression for curl in orthogonal curvilinear coordinates and hence write the expression in cylindrical coordinates system. 15

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

***Department of Mechanical Engineering***

B. Sc. Engineering 2rd Year Backlog Examination, 2020

Hum 2105

(Industrial Environment and Sociology)

Time: 3 Hours | Total Marks: 210

**N.B.**: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

## SECTION-A

| | | |
|---|---|---|
| 1(a) | What is meant by population growth? Explain the relation between population growth and economic development with example from Bangladesh. | 18 |
| 1(b) | What is meant by Industrialization? What are the main challenges for industrialization in Bangladesh? | 17 |
| 2(a) | What are industrial hazardous wastes? Discuss with different characteristics. | 15 |
| 2(b) | What is environmental pollution? Discuss the environmental impact of solid waste management system in Bangladesh. | 20 |
| 3(a) | What is meant by sustainable development? | 05 |
| 3(b) | Explain how environmental engineering might help to achieve sustainable development goal (SDG). | 15 |
| 3(c) | Critically explain 'Bangladesh Environment Conservation Act- 1995'. | 15 |
| 4(a) | Define industrial policy. Discuss the major consideration of industrial policy 2010. | 15 |
| 4(b) | Discuss the main characteristics of Bangladesh Labour Act, 2006. | 10 |
| 4(c) | Discuss the function of ILO. | 10 |

## SECTION-B

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|---|---|---|
| 5(a) | What is meant by Sociology? Why sociology is important for Mechanical Engineers? | 15 |
| 5(b) | What is community? Distinguish between society and community. | 10 |
| 5(c) | Explain the elements of social structure of Bangladesh. | 10 |
| 6(a) | What is juvenile delinquency? Explain the causes and remedies of juvenile delinquency. | 15 |
| 6(b) | What is social group? Discuss the main characteristics of social group. | 10 |
| 6(c) | What is meant by culture? Mention the characteristics and elements of culture. | 10 |
| 7(a) | Discuss the five major social problems in Bangladesh. Indicate the causes and solutions to these problems. | 15 |
| 7(b) | Discuss the social history and culture of Bangladesh. | 15 |
| 7(c) | What is Cultural lag? Give example. | 05 |
| 8(a) | Discuss the trend of urbanization with social reference to Bangladesh. | 10 |
| 8(b) | Discuss the relation between industrialization and urbanization. | 10 |
| 8(c) | Explain the characteristics of social problem. When population is a problem rather than wealth for a society? | 15 |

**KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY**
**Department of Mechanical Engineering**
B. Sc. Engineering 2nd year Backlog Examination, 2020
ME 2213 / ME 3113 (Old)
(Fluid Mechanics II)

Time: 3 Hours. Total 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 are the laws of fluid friction for laminar and turbulent flow of fluid? 08

1(b) Explain major and minor losses when fluid flows through a pipe. Also, show that the head loss in pipes due to friction can be expressed in terms of the velocity head for a given pipe geometry. 15

1(c) A pipe 0.16 m diameter taking off from a reservoir suddenly expands to 0.3 m at the end of 18 m and continues for another 16 m. If the head above the inlet of the pipe is 4.8 m, determine the actual velocity at the exit taking into consideration all the losses. Assume $f = 0.04$ for the whole pipe line. 12

2(a) Deduce the Hagen-Poiseuille equation for laminar flow through the circular pipes. 18

2(b) A laminar flow of fluid having viscosity 1.766 Pa.sec in a 0.25 m diameter pipe, the velocity distribution is parabolic with a maximum point velocity of 2.5 m/sec at the centre of the pipe. Calculate the shear stresses at the pipe wall and within the fluid 42 mm from the pipe wall. 17

3(a) Derive the expression of velocity distribution for the flow in the annulas region of a co-axial pipes. 18

3(b) Two parallel plates kept at 0.20 m apart have laminar flow of oil between them with a maximum velocity of 2.5 m/sec. Calculate the discharge per unit width, the shear stress at the plates and the pressure difference between two points 20 m apart. 17

4(a) Deduce Prandtl's boundary layer equations for two-dimensional steady flow of incompressible fluids. 18

4(b) In a laminar boundary layer at zero pressure gradient over a flat plate is described by the velocity profile: 17
$\frac{u}{u_\infty} = \frac{3}{2}\frac{y}{\delta} - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$, show that the boundary layer thickness $\delta$ and wall shear stress $\tau_w$ are given by,
$\delta = \frac{4.64x}{\sqrt{Re_x}}$ and $\tau_w = \frac{0.332\rho u_\infty^2}{\sqrt{Re_x}}$

## SECTION - B

5(a) Show that the efficiency of a free jet striking normally on series of flat plates mounted on the periphery of a wheel never less than 50%. 1

5(b) A jet of water moving at 15 m/sec on a symmetrical curved vane shaped to deflect the jet through $115^o$. If the vane is moving at 6 m/sec, find the angle at the jet so that there is no shock at inlet. Also, determine absolute velocity at exit with direction and the work done. 1

6(a) How separation of flow is affected by pressure gradient. Explain with sketches. 0

6(b) Distinguish between friction drag and form drag. Also, sketch the flow characteristics over an infinite circular cylinder for increasing Reynolds number. 1

6(c) Determine the total drag, shear drag and the pressure drag that exerts on 2 m length of a circular cylinder, which has a diameter equal to 40 mm. Air of density 1.235 kg/m$^3$ flows past the cylinder with a velocity 3.5 m/sec. Take total drag coefficient equals to 1.4 and shear drag coefficient equals to 0.185. 1

| | | |
|---|---|---|
| 7(a) | Derive the expression of maximum mass flow rate for a compressible fluid through a converging-diverging duct. | 13 |
| 7(b) | For an adiabatic flow through a constant area duct of diameter 25 mm, the Mach number at the inlet is 1.70. Calculate the critical length of pipe. Assume, $f = 0.005$. | 12 |
| 7(c) | Show that for incompressible flow, velocity of sound is directly proportional to the square root of absolute temperature of the fluid. | 10 |
| 8(a) | Derive the relation between the upstream and downstream Mach number of the normal shock wave in a pipe. | 17 |
| 8(b) | A shock occurs in a duct carrying out air where the upstream Mach number is 2 and upstream temperature and pressure are 15°C and 20 kPa (absolute). Calculate Mech number, pressure, temperature and velocity after the shock. Also, find the shock length. | 18 |