Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2021
Department of Biomedical Engineering

Math 2115
Transform 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.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) Define integral transform and find the kernel of this transform. Also find the kernel of Fourier sine transform. (10)

b) Define causal and non-causal system with example. Check whether the following system are causal or not. (12)
(i) $y(t) = x(t^2)$, (ii) $y(t) = x^2(t)$, (iii) $y(n) = x(n) - x(n-1)$

c) Define z-transform. Determine the z-transform of the signal $x(n) = sin\omega_n u(n)$ and hence using scaling property find the z-transform of the signal $x(n) = 2^n sin\omega_n u(n)$. (13)

2. a) Write down the condition for a system to be stable. (07)

b) Find the inverse z-transform of: (16)

$$X(z) = \frac{z}{(z-1)(z^2+1)}$$

Using residue method.

c) Find $x(n)$ by using convolution for: (12)

$$X(z) = \frac{1}{(1-\frac{1}{2}z^{-1})(1+\frac{1}{4}z^{-1})}$$

3. a) What is meant by Region of convergence (ROC) of z-transform? Write down the important properties of the ROC for z-transform. (12)

b) By applying the time shifting property determine the signal of: (08)

$$X(z) = \frac{z^{-1}}{1-3z^{-1}}$$

c) Determine the 4-point DFT and IDFT of the signal: (15)

$$x(n) = \begin{cases} 1; & 0 \le n \le 3 \\ 0; & elsewhere. \end{cases}$$

4. a) Solve the difference equation $u_{n+2} - 3u_{n+1} + 2u_n = 4^n$ using z-transform method. Given that $u_0 = 0, u_1 = 1$. (13)

b) Determine IDFT of $X(k) = \{3, (2+5), 1, (2-5)\}$. (12)

c) Find the Fourier cosine transform of (10)

$$f(x) = \frac{1}{1+x^2}$$

and hence derive Fourier sine transform of

$$\varphi(x) = \frac{x}{1+x^2}$$

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) Write down the assumption for the validity of Fourier series expansion. Find a series of sine and cosine multiple of x which represent $x + x^2$ in the interval $-\pi < x < \pi$ and deduce that, (22)

$$\frac{\pi^2}{6} = \sum_{n=1}^{\infty} \frac{1}{n^2}$$

b) Define odd and even function. If $f(t) = t^2, 0 < t < 1$. Find its half range Fourier sine series. (13)

6. a) Define Parseval's identity. Write Parseval's identity corresponding Fourier series of the function: (20)

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

b) Solve $\frac{\partial y}{\partial t} = 2\frac{\partial^2 y}{\partial x^2}$, subject to the condition $y(0,t) = 0 = y(5,t)$, $y(x,0) = 10sin4\pi x$ using Laplace transform method. (15)

7. a) Find the Fourier series representation of the function $f(x) = xsinx$; $0 < x < \pi$ with the property $f(x+\pi) = f(x)$. (17)

b) Find the Fourier integral representation of the function: (18)

$$g(x) = \begin{cases} 0 \ \ if & x < 0 \\ 1 \ \ if & 0 \le x \le 1 \\ 0 \ \ if & x > 1. \end{cases}$$

and show that

$$\int_0^{\propto} \frac{\sin\left(\frac{x}{2}\right)}{x} dx = \frac{\pi}{2}$$

8. a) Find the inverse Laplace transform of: (10)

$$\frac{2s-1}{s^2(s+1)^3}$$

b) Find: (10)

$$\mathcal{L}\{te^{2-t}\,u(t-2)\} + \mathcal{L}^{-1}\left\{\frac{e^{-s}}{s(s+1)}\right\}$$

c) Solve using Laplace transform: $y''(t) + 9y = 18t$, subject to $y(0) = 0, y\left(\frac{\pi}{2}\right) = 0.$ (15)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2021
Department of Biomedical Engineering

BME 2101
Human Anatomy

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.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) Name different planes of the body and explain how they divide the body. (12)

b) What is renal hilum and pelvis? What are the structures emit and exit through hilum of kidney? Mention the systemic renal blood circulation from renal artery to renal vein. (12)

c) List the layers of anterior abdominal wall, muscle and show the blood supply with diagram. (11)

2. a) Define greater sac and lesser sac. How they communicate with each other? Explain with proper figure. (12)

b) Draw and label the different parts of a stomach with 2 sphineter. List the arterial supply of stomach. (11)

c) Write short notes on: (12)
(i) Duodenal papillae
(ii) Portal triad of liver
(iii) Suprarenal gland.

3. a) Give the anatomical feature and nerve supply of Urinary bladder. (10)

b) What are the parts of uterus? Discuss about the ligaments of uterus. (10)

c) What is basal ganglia? What are the structures that contribute to the formation of basal ganglia? Give the function of basal ganglia? (15)

4. a) What is vocal cord? What are the cartilages of larynx? (06)

b) How the Bony labyrinth is formed? What is organ of corti? (07)

c) What are the histological layers of retina? What do you mean by pupillary light reflex? (10)

d) Write short notes on: (12)
(i) Arcuate fasciculus
(ii) Cross sectional view of midbrain
(iii) Lymbic system.

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) Describe the anatomical features of the following bone: (10
(i) Scapula
(ii) Humerus.

b) Give the origin, insertion, nerve supply and action of the following muscles: (15
(i) Coracobrachiales
(ii) Biceps brachii
(iii) Gluteus maximus.

c) Describe the boundary and contents of axilla. (1

6. a) What is pericardium? Write down the types of pericardium. (05

b) Which structures from the sternocostal surface of the heart? Draw and label the internal structure of human heart. (1(

c) Write down the origin and branches of arch of the aorta with diagram. (08

d) Write short notes on: (12
(i) Azygos vein
(ii) Thoracic duct
(iii) Arterial supply of breast.

7. a) Write down the boundary and contents of femoral triangle with proper diagram. (1(

b) What is meant by supination and pronation? Discuss about elbow joint. (1:

c) Write down the name of the muscles of thenar and hypothenar eminence. (1

8. a) What is carpal tunnel? List the contents of the carpal tunnel? (1

b) Discuss about the boundary and contents of Cubital fossa. (1

c) Name the surfaces of lung. Describe the medial surface of right lung. (1

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2021
Department of Biomedical Engineering

BME 2151
Numerical Methods and Statistics

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.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) What is Rate of Convergence in numerical computing? Estimate the relative error in $z = x - y$ when $x = 0.7345 \times 10^4$ and $y = 0.7125 \times 10^4$ as stored in a system with four digit mantissa. (12)

b) Find a root of the equation: $x^2 - 4x - 10 = 0$ using bisection method (up to 4th iteration). (12)

c) Find a root of the equation: $x^2 - 3x + 2 = 0$ in the vicinity of $x = 0$ using Newton-Raphson method. (11)

2. a) Solve the following 3×3 system using the basic Gauss elimination method: (10)

$$3x_1 + 6x_2 + x_3 = 16$$
$$2x_1 + 4x_2 + 3x_3 = 13$$
$$x_1 + 3x_2 + 2x_3 = 9$$

b) Find the Lagrange interpolation polynomial to fit the following data: (13)

i	0	1	2	3
x_i	0	1	2	3
$e^{x_i} - 1$	0	1.7183	6.3891	19.0855

Use the polynomial to estimate the value $e^{1.5}$.

c) Given the following set of data points, obtain the table of divided differences. Use the table to estimate the value of $f(1.5)$. (12)

i	0	1	2	3	4
x_i	1	2	3	4	5
$f(x_i)$	0	7	26	63	124

3. a) The Table 3(a) gives the values of distance travelled by a car at various time intervals during the initial running. Estimate velocity at time $t = 5$, $t = 7$, and $t = 9$; and acceleration at time $t = 7$s. (10)

Table 3(a)

Time t(s)	5	6	7	8	9
Distance travelled s(t) (km)	10.0	14.5	19.5	25.5	32.0

b) Use Simpson's 3/8 rule to evaluate: (10)

(i) $\int_1^2 (x^3 + 1)dx$

(ii) $\int_0^{\pi/2} \sqrt{sinx})dx$

c) Compute Romberg estimate R_{22} for $\int_1^2 \frac{1}{x} dx$. (15)

4. a) Given the equation $y'(x) = \frac{2y}{x}$ with $y(1) = 2$. Estimate $y(3)$ using Henn's method, using $h = 0.75$. (10)

b) Use the classical RK method to estimate $y(0.4)$ when $y'(x) = x^2 + y^2$ with $y(0) = 0$. Assume $h = 0.2$. (12)

c) Consider a steel plate of size $15cm \times 15cm$. If two of the sides are held at 100°C and other two sides are held at 0°C. What are the steady state temperature at interior points assuming a grid size of $5cm \times 5cm$. (13)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) What is probability? Give an example of it. A fair die is tossed twice. Find the probability of getting a 4, 5, or 6 on the first toss and 1, 2, 3, or 4 on the second toss. (10)

b) Define random variable. Classify it with examples. Find the distribution function and its graph for the random variable X, where X represents the number of boys in families with three children, assuming equal probability for boys and girls. (14)

c) A continuous random variable X having values only between 0 and 4 has a density function given by $P(X) = \left(\frac{1}{2} - aX\right)$, where a is a constant, (i) Calculate a and (ii) Find $P(1 < x < 2)$. (11)

6. a) What is meant by frequency distribution? Prove that the total area of the rectangles in a histogram is equal to the total area bounded by the corresponding frequency polygon and X-axis. (12)

b) Use the frequency distribution of heights in Table 6(b) to find the mean height of 100 male students at xyz university (use short and coding method). (12)

Table 6(b): Height of 100 male students of xyz university

Height (in)	No. of students
60-62	5
63-65	18
66-68	42
69-71	27
72-74	8
Total	100

c) What is standard deviation? Show that $s = \sqrt{\frac{\Sigma X^2}{N} - \left(\frac{\Sigma X}{N}\right)^2} = \sqrt{\overline{X^2} - \bar{X}^2}$ where the symbols have their usual meanings. (06)

d) Show that if each class mark X in a frequency distribution having class intervals of equal size c is coded into a corresponding value u according to the relation $X = A + cu$ (or, $X = A + d$), where A is given class mark, then the standard deviation: (05)

$$s = c\sqrt{\frac{\Sigma fu^2}{N} - \left(\frac{\Sigma fu}{N}\right)^2} = c\sqrt{\overline{X^2} - \bar{X}^2}$$

7. a) For an independent variable x, show that the equation of least square line can be written as $y = \left(\frac{\Sigma xy}{\Sigma x^2}\right)x$ or, $y = \left(\frac{\Sigma xY}{\Sigma x^2}\right)x$ where $x = X - \bar{X}$ and $y = Y - \bar{Y}$. (10)

b) Fit a least-square parabola having the form $Y = a_0 + a_1X + a_2X^2$ to given data table 7(b) (15)

Table 7(b)

X	1.2	1.8	3.1	4.9	5.7	7.1	8.6	9.4
Y	4.5	5.9	7.0	7.8	7.2	6.8	4.5	2.7

c) Define correlation. If the regression line of Y on X is given by $Y = a_0 + a_1X$, preve that the standard error of estimate $s_{Y.X}$ is given by $s^2_{Y.X} = \frac{\Sigma Y^2 - a_0\Sigma Y - a_1\Sigma XY}{N}$. (10)

8. a) Table 8(a) shows the respective heights x and y of a sample of 12 fathers and their oldest sons. Calculate the coefficient of rank correlation. (10)

Table 8(a)

Height X of father (in)	65	63	67	64	68	62	70	66	68	67	69	71
Height Y of son (in)	68	66	68	65	69	66	68	65	71	67	68	70

b) Two correlation coefficients obtained from samples of size $N_1 = 28$ and $N_2 = 35$ were computed to be $r_1 = 0.50$ and $r_2 = 0.30$, respectively. Is there a significant difference between the two coefficients at the 0.05 level? (Table for t-distribution should be provided on request) (10)

c) What is null hypothesis? Define type I & II error. (06)

d) Use the chi-square test to determine the goodness of fit of the data given Table 8(d). (Table for $\mathcal{X}^2$ distribution should be provided on request) (09)

Table 8(d)

Number of Heads(X)	Pr{X heads}	Expected Frequency	Observed Frequency
0	0.0332	33.2	38
1	0.1619	161.9	144
2	0.3162	316.2	342
3	0.3087	308.7	287
4	0.1507	150.7	164
5	0.0293	29.4	25

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2021
Department of Biomedical Engineering

ECE 2115
Digital Electronics and Logic Design

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.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) Describe De Morgan's theorem. Using the theorem, calculate the complement of function F, where $F = A(BC + \bar{B}\bar{C})$ (10)

b) Represent the decimal number 7405 in (i) BCD (ii) excess-3 (iii) $821\bar{0}$ and (iv) 5211 (08)

c) Perform the following operations using 2's complement method. (12)
(i) $(2A)_{16} - (15)_{16}$
(ii) $(40)_{10} - (48)_{10}$
(iii) $(1011)_2 - (010)_2$
(iv) $(-8)_{10} - (5)_{10}$

d) Define self complementary code. Justify –Excess-3 code is a self-complementary code. (05)

2. a) Simplify the following Boolean functions to a minimum number of literals: (10)
(i) $(A + C + D)(A + C + D')(A + C' + D)(A + B')$
(ii) $y(wz' + wz) + xy.$

b) Implement the following Booleans function using NOR gate: (10)
$$F = A(B'C + D) + CD'.$$

c) Simplify the following Boolean function in i) sum of products and ii) product of sum: (08)
$$F(A, B, C, D) = \sum(0, 1, 2, 5, 8, 9, 10).$$

d) Find a simplified switching expression and logic network for the logic circuit as shown in Fig. 2(d). (07)

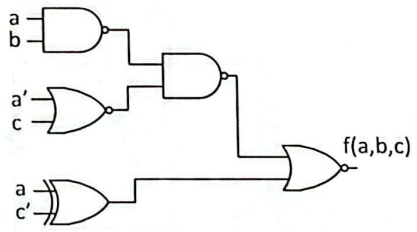

Fig. 2(d)

3. a) Show that "A half-adder can be converted into a half subtractor". (06)

b) Show that $A \odot B \odot C \odot D = \sum(0, 3, 5, 6, 9, 10, 12, 15)$. (08)

c) Define combinational circuit. Design a combinational circuit whose input is a four-bit number and whose output is the 2's complement of the input number. (15)

d) What is decoder? Implement the following function using Decoder: (06)
$$F(A, B, C, D) = \sum(0, 1, 3, 4, 8, 9, 10, 11).$$

4. a) Design a 4 to 1 line multiplexer using NOR gates. (10)

b) What is ROM? Implement the following Boolean functions using ROM: (12)
$$F_1(A, B) = \sum(0, 1, 3)$$
$$F_2(A, B) = \sum(2, 3).$$

c) Design a logic system that will perform the following function for an automobile seatbelt system. In a- two- seat car an alarm is to be sounded if a person is seating in a seat without a seatbelt fastened and with the driver present. (13)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) What is meant by sequential logic circuit? How does it differ from combinational circuit? (05)

b) What is flip flop? Why flip flop is called one bit memory cell. (10)

c) Write down the characteristics tables and excitation tables of RS, JK, D, and T Flip Flops. (12)

d) Why race around condition occurs in JK Flip Flop? How this problem can be overcome? (08)

6. a) Design a Johnson Counter that generates 10 unique timing signal. (12)

b) A sequential circuit has one input and one output. The state diagram is shown in Fig. 6(b). Design the sequential circuit with JK flip flops. (14)

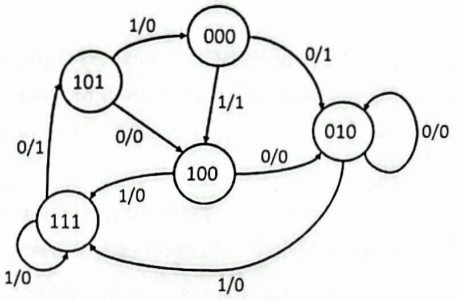

Fig. 6(b).

c) Define TTL logic family. Design a NOR gate using TTL logic. (09)

7. a) Design a 4 bit binary up and down counter. Show the necessary control circuit with truth table. (10)

b) Design a synchronous counter that counts $(2)_8$, $(4)_8$, $(7)_8$, $(11)_8$, $(13)_8$ and repeat using T flip flop. (15)

c) Describe the operation of the Fig. 7(c) and find out the output value of y for all possible combination of input A, B, and C. (10)

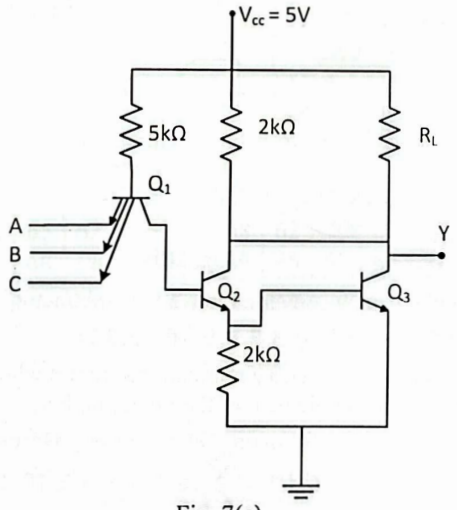

Fig. 7(c)

8. a) Describe the read and write operations of RAM with proper timing waveform. (08)

b) Design a combination circuit using ROM that accepts four bit numbers and outputs a binary number equal to $(1-x)^{-2}$, where x is the successive even decimal input value and where higher order terms are neglected. (15)

c) Design a PLA circuit using Pseudo-NMOS NOR-NOR to realize the following sum of product functions: (12)

$$F_0 = A'B' + AC'$$
$$F_1 = AB + AC'$$
$$F_2 = A'B' + BC'$$
$$F_3 = AC + B.$$

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2021
Department of Biomedical Engineering

ME 2115
Basic Mechanics and Thermodynamics

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.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) Determine the force developed in each cable used to support the 40N crate shown in Fig. 1(a). (17)

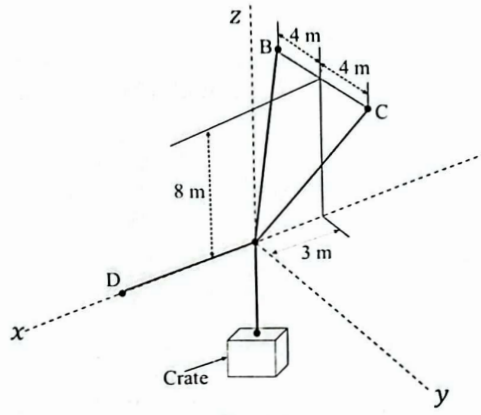

Fig. 1(a)

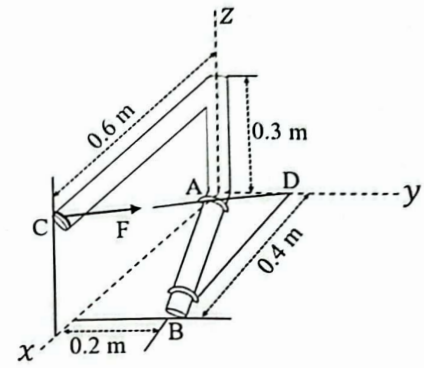

Fig. 1(b)

b) The rod shown in the above Fig. 1(b) is supported by two bracket at A and B. Determine the moment M_{AB} produced by $F = \{-600\hat{\imath} + 200\hat{\jmath} - 300\hat{k}\}$N, which tends to rotate the rod about the AB axis. (18)

2. a) A force of 280N is applied at the end C of 600mm rod AC attached to a bracket at A and B as shown in Fig. 2(a). Replace the force with (18
(i) An equivalent force-couple system at B,
(ii) An equivalent system formed by two parallel forces applied at A and B.

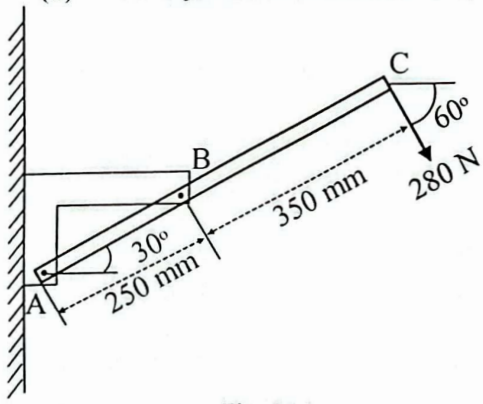

Fig. 2(a)

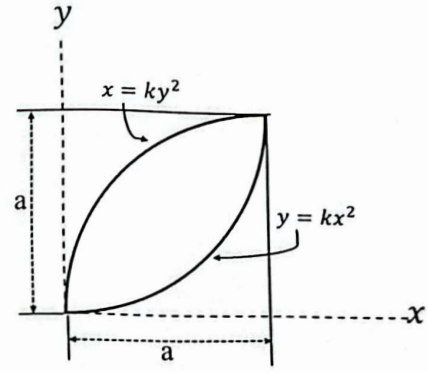

Fig. 2(b)

b) Determine the centroid of the above Fig. 2(b) by integration. (1

3. a) Explain the 'continuum' assumption of classical fluid mechanics. Using the Rheological (
diagram, explain the characteristics of different types of fluid.

b) When a fluid flows over an object (e.g. airfoil), how the viscous flow region can be separated (
from the inviscid flow region? Explain with sketch.

c) The system in the following Fig. 3(c) is used to estimate the pressure P_1 in the tank by (
measuring the 15 cm height of liquid in the 1mm diameter tube. Calculate the true fluid height in the tube and the percent error due to capillarity if the fluid is (i) Water and (ii) mercury. Assume the SG of mercury is 13.6.

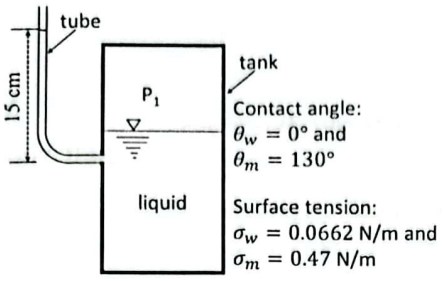

Fig. 3(c)

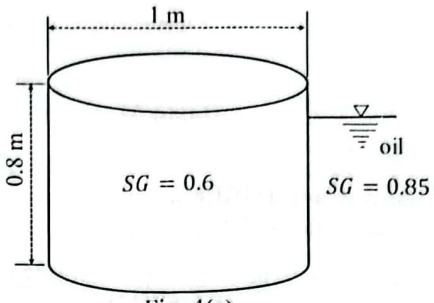

Fig. 4(c)

4. a) What are gage fluids of manometer? With neat sketch, explain how pressure can be measured by U-tube manometer? (08)

   b) Show that the resultant hydrostatic force on inclined plane surface is independent of the inclination angle and is equal to the pressure at the centroid of area multiplied by the total area. (15)

   c) A wooden cylinder (SG=0.6) of 1m in diameter and 0.8m long as shown in the above Fig. 4(c). Would this cylinder be stable if placed to float with its axis vertical in oil (SG=0.85)? (12)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) Why the Reynolds Transport Theorem is needed for analysis of fluid problems? Derive the mass conservation continuity equation using the theorem. (12)

   b) What are static, dynamics, stagnation, and total pressure? Explain with the help of Bernoulli equation. How these pressure can be measured? (13)

   c) Water flows under a sluice on a horizontal bed at the inlet to a flume. Upstream from the gate, the water depth is 45cm and the speed is negligible. At the vena-contracta downstream from the gate, the flow streamlines are straight and the depth is 5cm. Determine the flow speed downstream from the gate and the discharge. Assume the width of the gate is 15cm. (10)

6. a) How thermodynamics and heat transfer are related? Explain the physical mechanism of heat transfer by conduction, convection, and radiation with sketches. (14)

   b) What are the conditions that should be fulfilled to achieve thermodynamic equilibrium? Explain. (09)

   c) How macroscopic form of energy differs from microscopic form of energy? "Macroscopic energy is much more useful than microscopic energy" –establish the validity of the above statement. (12)

7. a) "Heat is energy in transition"-justify the statement. (06)

   b) What is meant by displacement work? Derive the expressions of workdone for both isothermal process and polytropic process. (14)

   c) How 2nd law of thermodynamics eradicates the limitations of 1st law of thermodynamics? (08)

   d) "A process must satisfy both the first and second laws of thermodynamics to proceed" – Explain. (07)

8. a) What is meant by PMM-1 and PMM-2? Construct a PMM-1 from conventional steam power plant. (10)

   b) What is major difference between refrigerator and heat pump? Show that COP of heat pump is greater than COP of refrigerator by unity. (07)

   c) What is meant by internally and externally reversible process? Why do we study the reversible process? (07)

   d) Air is contained in a vertical piston-cylinder assembly fitted with an electric resistor. The atmosphere exerts a pressure of 1 atm on the top of the piston, which has a mass of 45 kg and a face area of $0.1m^2$. Electric current passes through a resistor, and the volume of the air slowly increases by $0.05m^3$ while its pressure remains constant. The mass of the air is 0.3kg and its specific internal energy increases by 42kJ/kg. The air and the piston are at rest initially and finally. The piston-cylinder material is a ceramic composite and thus a good insulator. Friction between the piston and cylinder wall can be ignored, and local acceleration of gravity is $9.8m/s^2$. Determine the heat transfer from the resistor to the air for a system consisting of the air alone. (11)