

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 3rd Year 1st Term Examination, 2022

ME 3131

(Fluid Mechanics and Machinery)

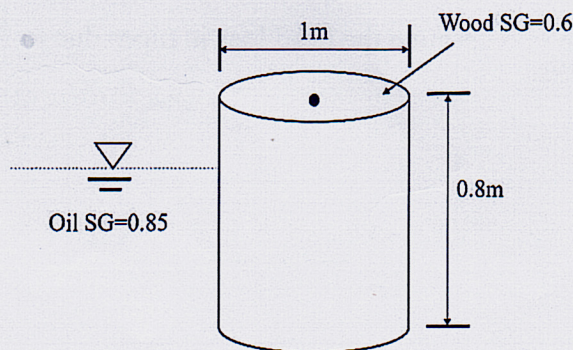
Time: 3.00 Hrs.

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 Newton's law of viscosity? Explain with velocity profile. 10
- 1(b) In the light of surface tension, explain why a liquid droplet takes spherical shape? Why the droplet will break down if more liquid is added? 10
- 1(c) A plate of 0.025 mm distant from a fixed plate moves at 60 cm/s and require a force of 3N/m² to maintain that speed. Determine the kinematic viscosity between the plates if the specific gravity of the fluid is 0.93. 15
- 2(a) What is meant by gauge pressure, vacuum pressure and absolute pressure? Show the relation between them. 10
- 2(b) Show that the center of pressure of an inclined surface immersed in a fluid is always below the centroid of the surface. 15
- 2(c) A wooden cylinder (SG=0.6) of 1m diameter and 0.8m long, floats in oil (SG=0.85). Would this cylinder be stable if placed to float with its axis vertical as shown in figure. 10



- 3(a) Define Path line and Streak line. 05
- 3(b) Show that liquid pressure on cylindrical container varies by an amount $\frac{w^2 r^2}{2g}$ when it is subjected to a constant angular rotation. Symbols have their usual meaning. 15
- 3(c) Derive Bernoulli's equation of motion. What are the assumptions needed to be considered for this equation? 15
- 4(a) Explain the mechanism of pitot tube. Write down its limitations. 08
- 4(b) Derive the expression for time required to empty a tank if an orifice exists at the bottom of the tank. 15
- 4(c) Water flows over a rectangular weir of 1m wide and 150mm deep, afterwards passes through a triangular right-angled weir. Taking coefficient of discharge for both weirs as 0.65, find the depth over the triangular weir. 12

SECTION-B

- 5(a) Why Pelton wheel is considered in the category of impulse turbine? Define different types of efficiencies of turbine. 10
- 5(b) Prove that the efficiency of Pelton wheel can be maximum if the velocity of flow at inlet is twice the velocity of vane. 17
- 5(c) Define degree of reaction and specific speed of a turbine. 08
- 6(a) What is priming of a centrifugal pump? Explain its significance. 08
- 6(b) Deduce an expression of minimum speed for starting a centrifugal pump. 10
- 6(c) What is NPSH? Write down the effects of insufficient NPSH. 06
- 6(d) Find the number of pumps required to take water from a deep well under a total head of 89m. All the pumps are identical and are running at 800 rpm. The specific speed of each pump is given as 25 while the rated capacity of each pump is $0.16 \text{ m}^3/\text{s}$. 11
- 7(a) What is negative slip? Why it is occurred? 05
- 7(b) Explain the working principle of a reciprocating pump with the help of theoretical indicator diagram. 15
- 7(c) A single-acting reciprocating pump runs at 60 rpm. The diameter of the plunger is 0.15m, and crank radius is 0.15m. The suction pipe is 0.1m in diameter and 5m long. Calculate the maximum permissible value of suction lift H_s if the separation takes place at 2.6m of water absolute. 15
- 8(a) Enlist the minor losses of flow in pipes. 05
- 8(b) Derive an equation of velocity of a laminar flow through a pipe. 15
- 8(c) Deduce an expression to determine the head loss in pipes due to friction. 15

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 3rd Year 1st Term Examination, 2022

MTE 3103

(Microprocessor, Microcontroller and Interfacing)

Time: 3.00 Hrs.

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) Describe the architectural features of 8085 microprocessor. Explain the functions of flags and instruction pointer in the program control. 10
- 1(b) Draw the timing diagram of the instruction MOV A, 55H. Explain all the signals and activation of the signals. Is it wise to use same pins of 8085 to carry address and data information? 10
- 1(c) Specify the contents of the registers (A,B) and the flag status (S,Z,CY) as the following instructions are executed. 07
- ```
MVI A, F8H
SUB A
MOV B, A
DCR B
INR B
SUI 01H
HLT
```
- 1(d) Write an assembly language program to subtract two 8-bit numbers stored at memory addresses 2050H and 2051H in 8085 microprocessor and display borrow. Assume, the starting address of the program is taken as 2000H. 08
- 2(a) Which feature of microprocessor determines the size of it? 06
- 2(b) Define segmentation. Write down some benefits of segmentation in 8086 architecture. 07
- 2(c) What are the methods of addressing in 8086 microprocessor? Use MOV instruction to illustrate different types of addressing modes. 12
- 2(d) Describe the function of the 8086 instruction queue. How does the queue speed-up processing? 10
- 3(a) What is the difference between unconditional jump and conditional jump instruction? Consider the following delay loop. 11
- ```
MVI B, FFH
DLY1: MVI C, FFH
DLY2: DCR C
JNZ DLY2
DCR B
JNZ DLY1
HLT
```
- i. How many times the JNZ DLY1 instruction will execute?
ii. Calculate the amount of time delay generated by this program.
- 3(b) What do you mean by interrupt? Describe interrupt types in 8086 microprocessor with relevant examples. 06

- 3(c) Compare the actions of the following instructions: 08
- i. ADD and ADC
 - ii. INR and INX
 - iii. MVI and LXI
- 3(d) Describe the closely coupled configuration of multiprocessor mode in 8086 microprocessor. 10
Write down the significance of HOLD and HLDA signals by means of proper waveform.
- 4(a) What is direct memory access (DMA) data transfer? Briefly describe DMA data transfer 10
with figure.
- 4(b) Write an assembly language program to find a factorial of a given number in 8085 10
microprocessor. Assume, the starting memory address of the program is taken as 2010H and
memory is initialized with an 8-bit number A9H.
- 4(c) Discuss the function of segment register, instruction pointer and stack register in Intel 8086. 15
Draw a bit pattern of flag register in Intel 8086 and write down the function of each flag bit
in brief.

SECTION-B

- 5(a) What is a microcontroller? And how does it differ from a microprocessor? 05
- 5(b) Describe the three major criteria for choosing a microcontroller. 10
- 5(c) Design an AVR program to implement a digital thermometer using a temperature sensor 15
(DS18B20) connected in a one-wire configuration. Display the readings on Port B.
- 5(d) For a 10 bit ADC, calculate the $D_9 - D_0$ output if the analog input is i) 0.2 V and ii) 0 V. 05
How much is the variation between (i) and (ii)? Take $V_{ref} = 2.56$ V.
- 6(a) What is data memory and program memory of the AVR microcontroller? 05
- 6(b) What is the difference between $PORTC = \theta_x \theta \theta$ and $DDRC = \theta_x \theta \theta$? 05
- 6(c) Design an AVR program to implement a simple stopwatch using timer/counter1 in normal 15
mode. Use Port B, Pin θ as the start/stop button and display the elapsed time on LED's
connected to Port C.
- 6(d) Program Timer θ is to be an event counter. Use normal mode and display the binary count 10
on Port C continuously. Set initial count to 20.
- 7(a) List some of the interrupt sources in an AVR. 08
- 7(b) What happens if two interrupts are activated at the same time? 05
- 7(c) Assume that INT θ and INT1 are connected to two switches named S1 and S2. Write a 22
program in which, whenever S1 goes low, the content of Port C increases by one, and
when S2 goes low, the content of Port C decreases by one. Whenever the value of Port C
is bigger than 100, PD7 is high; otherwise it is low.
- 8(a) What is duty cycle? 02
- 8(b) Why do we put a driver between the microcontroller and the DC motor? 05
- 8(c) Implement an AVR program to control a servo motor using PWM signals. Connect the 20
servo motor to Port B, Pin 5 and adjust the duty cycle of the PWM signal to position the
servo motor at different angles within the range of θ to 18 θ degrees. Use a POT connected
to ADC θ pin to control the angle of the servo motor.
- 8(d) Write down the difference between the wave generated by phase-correct PWM and fast 08
PWM.

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 3rd Year 1st Term Examination, 2022

MTE 3105

(Linear Integrated Circuits and Digital Systems)

Time: 3.00 Hrs.

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) Define the following for an Ideal Op-Amp IC 741. 10
i) Input bias current ii) CMRR iii) Large signal voltage gain and iv) Slew rate
- 1(b) Design a circuit to perform the following integro-differential operation. 10
- $$y(t) = \frac{1}{2}x(t) + \frac{1}{100} \int x(t)dt + \frac{0.1dx(t)}{dt}$$
- 1(c) Calculate the output voltages for the following circuits. 10

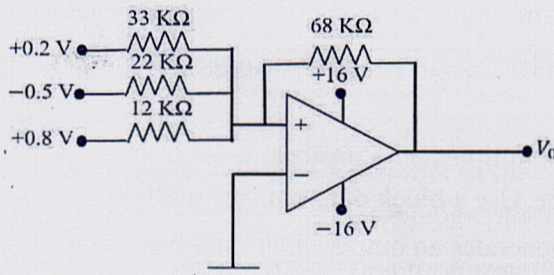


Fig. 1

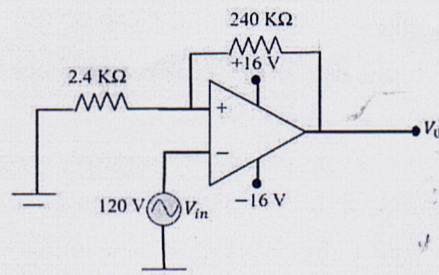


Fig. 2

- 1(d) How can we convert the input current to a proportional output voltage by using an op-amp? 05
- 2(a) How can we make the output voltage waveforms square wave using Schmitt trigger? Discuss in details. 10
- 2(b) Define zero-crossing detector. List the important characteristics of a comparator. 05
- 2(c) Design and draw a phase-shift oscillator where gain is 29, input resistance is 33 KΩ, frequency of oscillation is 50 Hz and capacitor in the cascaded network is 3.3 μF. 10
- 2(d) Explain the circuit diagram and operation of a 555 timer-based astable multivibrator. If the values of RA, RB and C are given by 4.7 KΩ, 1 KΩ and 1 μF respectively, determine the on time, off time, free running frequency and duty cycle of the output waveform. 10
- 3(a) Define phase-locked loop (PLL). Draw the block diagram of basic PLL and explain its operation in brief. 10
- 3(b) Write down the disadvantages of basic differential amplifier circuit. With necessary equation, explain the steps to measure the output voltage from a Wheatstone bridge circuit by means of an instrumentation amplifier. 12
- 3(c) Mention the three basic differences between active and passive filter. Design an active 2nd order low-pass Butterworth filter with a DC gain of 5 and a corner frequency of 500 Hz. Assume necessary data. 13
- 4(a) What is meant by quantization? Explain the working principle of a successive approximation A/D converter. 10
- 4(b) The analog output voltage of a 5-bit D/A converter for a digital input of 00001 is found to be 10 mV. Find its maximum full-scale output and percent resolution. 08
- 4(c) Draw an op-amp circuit to convert a ramp signal to a square-wave signal and derive its output voltage equation. 10

- 4(d) What is voltage-controlled oscillator (VCO)? Draw the pin-diagram of LM 566 VCO IC and write down its applications. 07

SECTION-B

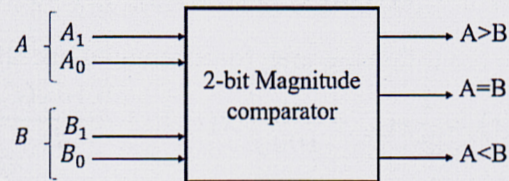
- 5(a) Why NAND and NOR gates are called universal gates? Explain your answer with example. 10
- 5(b) Minimize the following function in SOP and POS form. Also draw the logic circuit using minimum no. of gates. 12

$$f = f_1 \oplus f_2$$

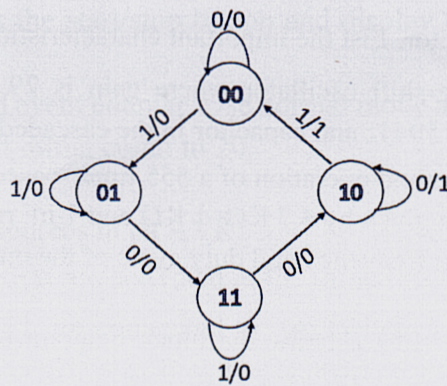
$$\text{Where, } f_1 = x_1'x_4 + x_2x_3 + x_2'x_3'x_4' + \sum_d(1,2,11,13,14,15)$$

$$\text{and } f_2 = \Pi(0,2,4,8,9,10,14). \Pi_d(1,7,13,15)$$

- 5(c) Design a 2-bit magnitude comparator which provides the result of comparing two 2-bit unsigned numbers as shown below. 10



- 6(a) Explain how a full adder can be used as a full subtractor using some necessary gates. 11
- 6(b) What is the function of parity checker circuit? Design an even parity generator and even parity checker circuit. 10
- 6(c) What do you mean by multiplexer and demultiplexer? Construct a 5×32 decoder with four 3×8 demultiplexers and a 2×4 decoder. Use a block diagram construction. 08
- 6(d) A ROM circuit accepts 3-bit number and generates an output binary number equal to the square of the input numbers. Design the logic circuit. 06
- 7(a) What is flip-flop? "JK flip-flop is called the refinement of the RS flip flop", justify the statement. 10
- 7(b) Define a sequential circuit. Design a clocked sequential circuit using T flip flops for the following state diagram. 14



- 7(c) Show the operation of D-type edge-triggered flip-flop with necessary diagram. 11
- 8(a) What is a register? Describe the operation of a 4-bit bidirectional shift register using the logic diagram. 12
- 8(b) What is a counter? Design a BCD ripple counter using JK flip-flops. 11
- 8(c) Design a 3-bit synchronous up counter using T flip-flops. 12

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 3rd Year 1st Term Examination, 2022

MTE 3107

(Software Development)

Time: 3.00 Hrs.

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 are the built-in data types available in python? What is the difference between a list and a tuple in python? 10
- 1(b) How can you convert a string to an integer in python? Discuss the various operation that can be performed on a string and list in python with example. 15
- 1(c) Illustrate the difference between “break” and “continue” statements in python loops with proper example. How can you iterate over both the index and elements of a list using a “for” loop in python? Use range () and len () to accomplish this task. 10
- 2(a) Explain the difference between parameters and arguments in python functions. 05
- 2(b) Write a python function that takes a list of numbers and returns a new list with only the even numbers. 10
- 2(c) Discuss the “try/except” mechanism in python. Write a python program showing the appropriate use of “try/except”. 10
- 2(d) Explain in detail about 10
- i) Creating a dictionary
 - ii) Accessing values in dictionary
 - iii) Updating a dictionary
- 3(a) What is object-oriented programming (OOP)? Why OOP is used instead of structural programming? 07
- 3(b) Define class and object. 03
- 3(c) What is constructor? Why do we need constructor? Explain it with proper python code. 10
- 3(d) Create a python class called “BankAccount” with attributes account number and balance. Implement methods to deposit and withdraw money from the account. 15
- 4(a) What is inheritance? Explain with an example. 10
- 4(b) Explain data encapsulation with python code. 10
- 4(c) Open a file “mte.txt” and read it line by line. For each line, split the line into a list of words using split () method. The program should build a list of words. For each word on each line, check to see if the word is already in the list and if not, append it to the list. When the program completes, sort and print the resulting words in alphabetical order. 15

SECTION-B

- | | | |
|------|---|----|
| 5(a) | Define software development life cycle. Why do we need it? | 08 |
| 5(b) | Six students of MTE Dept. are assigned to develop a library management software for the KUET library and given 1 month of time. Which software process should they consider for the project? Briefly describe the process. Mention the reasons for choosing that particular mode. | 15 |
| 5(c) | Briefly describe different types of prototyping. | 12 |
| 6(a) | Briefly describe the key activities of requirement engineering. | 14 |
| 6(b) | Write short notes on the following terms with example.
(i) Functional requirement
(ii) Non-functional requirement
(iii) Implementational requirement | 09 |
| 6(c) | Briefly describe different requirement validation technique. | 12 |
| 7(a) | Define the following terms in the view of software design.
i) Abstraction
ii) Refinement
iii) Cohesion
iv) Coupling
v) Modularity | 10 |
| 7(b) | Briefly describe three common software architectural styles with proper figure. | 12 |
| 7(c) | Briefly describe three golden rules of interface design. | 13 |
| 8(a) | Briefly describe the notations and levels of data flow diagram (DFD). | 12 |
| 8(b) | What is white box and black box testing? Briefly describe a type from each testing method. | 14 |
| 8(c) | Define the following terms:
i) Quality assurance
ii) Quality control
iii) Software reliability | 09 |

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

B.Sc. Engineering 3rd Year 1st Term Examination, 2022

MTE 3113

(Numerical Analysis and Statistics)

Time: 3.00 Hrs.

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) Normal distribution table will be given on request.

SECTION-A

- 1(a) Write short notes on i) Significant digits, ii) Round-off error, iii) Truncation error and iv) Transcendental quantity. 08
- 1(b) Find a real root of the equation $x^2 + \ln x - 2 = 0$ by using false position method. 14
- 1(c) Define interpolation. The following table shows the area A of a circle of diameter d. Find the area of the circle of diameter 42. 13

d	30	35	40	45	50	55	60
A	1963	2376	2827	3318	3848	2200	2000

- 2(a) Use Secant method to find a real root of the following equation. 15
 $f(x) = \cos x + 2\sin x + x^2$; Stopping criterion $\epsilon_s = 0.4\%$
- 2(b) What are the methods of solution for linear algebraic equation? Describe LU decomposition method. 12
- 2(c) Show that the first differentiation $f'(x_0)$ based on equal interval interpolation is $\frac{f_1 - f_0}{h}$. 08
- 3(a) What is more accurate between Runge-Kutta method and Euler's method? Why? Use Euler's modified method to compute y for $x=0.05$ and $x=0.1$. Given that, $\frac{dy}{dx} = x + y$ with the initial conditions $x_0 = 0, y_0 = 1$. Give the correct result upto four decimal places. 17
- 3(b) Show that, the following equations are self-consistent and solve them by Gauss-Seidal iteration method. 18

$$\begin{aligned}x - y - z + u &= 0 \\2x + z &= 8 \\-y - 2z &= -8 \\3x - 3y - 2z + 4u &= 7\end{aligned}$$

- 4(a) Solve the following equation with 4th order Runge-Kutta method from $x=0$ to $x=2$ using $h=0.5$. 18
 $y'' + 0.5y' + 7y = 0$, where, $y(0) = 4$ and $y'(0) = 0$
- 4(b) Estimate the r.m.s. value of $f(x) = \sin x - \log x + e^x$ starting from 0.2 to 1.4 using (i) Trapezoidal, (ii) Simpson's 1/3 and (iii) Simpson's 3/8 rules. Also, compare them with the true value. Use no less than 8 equal divisions of the interval. 17

SECTION-B

- 5(a) What is the role of studying statistics in Mechatronic Engineering? Define Sample, Population, Grouped data and Ungrouped data. 12
- 5(b) Define dispersion. What are the ways of measuring dispersion? Explain with example. 08

- 5(c) 12 persons of varying ages were weighted and the following weights in Kg were recorded. 15
 65, 75, 78, 68, 67, 82, 69, 77, 71, 70, 80 and 52.
 Compute Semi-interquartile range, 3rd decile, 2nd quartile and 25th percentile of this dataset.

- 6(a) Establish the following relationship for coefficient of correlation. 15

$$r = \frac{\text{cov}(x, y)}{\sigma_x \sigma_y}$$

Where, the symbols have their usual meaning. From above relationship, derive the expression of rank correlation coefficient.

- 6(b) The correlation between the numbers of times absent and a final grade is -0.575 . There are eleven pairs of data. Test the significance of this correlation. 05

- 6(c) Define skewness and kurtosis. Find coefficient of skewness and kurtosis from the frequency distribution of following table showing the age of 102 workers in a factory. 15
 Also, comment on the shape of data distribution.

Age	No of workers
20-29	12
30-39	35
40-49	5
50-59	7
60-69	15
70-79	26
80-89	2

- 7(a) Construct a scatter diagram from the following data: 07

x	3	4	5	6	8	12	10	9	8
y	8	5	6	4	3	4	5	7	9

- 7(b) Determine the constants a_0 and a_1 by the least square method such that $y = ae^x$. Also, fit the following data. 11

x	2	4	6	8	10	12	14	16
y	4.077	11.084	30.128	81.897	222.620	13.000	95.000	84.000

- 7(c) Following table shows the height distribution of MTE students from KUET. Find Harmonic mean, Mode, Median, Standard deviation and coefficient of variance. 17

Height (cm)	No of students
150-160	17
160-170	23
170-180	42
180-190	100
190-200	78
200-210	3
210-220	2

- 8(a) In a sack of mixed grain seeds, the probability that a seed is ryegrass is 0.35. Find the probability that in a random sample of 450 seeds from this sack, 15
 i) less than 120 are ryegrass seeds.
 ii) more than 170 are ryegrass seeds.
 iii) between 120 and 150 are ryegrass seeds.
 iv) 160 are ryegrass seeds.

- 8(b) Write down the properties of binomial probability distribution. 06

- 8(c) A study shows that some companies violate federal population regulations with regard to dumping a particular product. 20 firms are under suspicion but all can't be inspected. Suppose, 3 of the firms are in violation. 14

- i) What is the probability that inspection of 5 firms find no violation?
 ii) What is the probability that the plan above will find 2 violations?