L-1/T-2/ME **Date: 29/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **ME 171** (Computer Programming Language)

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**.

Assume any data if necessary. Symbols used have their usual meaning.

1. (a) Differentiate (i) Micro-controller vs. SBC, (ii) Desktop PC vs. Desktop Workstation (iii) Mainframe vs. Supercomputer. **(9)**

(b) What do you know about CISC and RISC CPUs? Where and why are they used? **(8)**

(c) What are the two main components which essentially define a 'computing platform'? Explain why the sense of 'computing platform' is necessary for a computer programmer. **(9)**

(d) Illustrate the limitations of using (i) a 32-bit CPU/OS, and (ii) FAT32 file system in a Hard Disk, in a computer. **(9)**

2. (a) What are the four steps to be followed to solve a real-world problem using a computer programming language? Which of these steps remain unchanged for a particular set of problems when a computer programmer switches to other programming languages? **(10)**

(b) List the six things to focus on to learn a computer programming language. Which of these things do a programmer have to learn again when (s)he switches to another programming language? **(7)**

(c) Are the following array declarations valid? If not, state reasons: **(6)**

```
(i)     float x[i];      /*  i is an integer variable    */
(ii)    x[N - 2]= 27;    /*  N is a constant (N > = 2)   */
(iii)   int m[][1][2][3] = {1,2,3,4,5,6};
(iv)    float n[][][2][3];
```

(d) Write a C program which generates 10 pseudo random integer numbers ranging from 1 to 180. **(12)**

Contd P/2

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3. (a) Illustrate with codes 'function call by value' and 'function call by reference' in C. **(12)**

(b) List all the elements with indices of the following array along with their stored values in contiguous memory sequentially: **(8)**

```
int s[][3][2]={1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12};
```

(c) Write a C program with two functions, one function gets a multi-digit integer number from its calling function, calculates the sum of the individual digits of the number and returns the sum to the calling function. Upon return, the calling function prints the sum. **(15)**

4. (a) Make a comparison between compiled versus interpreted programs. **(8)**

(b) What is Console IO? Mention the advantages of File IO based programming against console IO based one. **(7)**

(c) Write a C program which will read the student id and marks of five students in four CTs from an input file called "marks.txt". The program then takes the best three CT marks of each of the students, sum them and print the student id along with the corresponding sum in a output file called "cf60.txt". Show samples of your input and output text files. **(20)**

SECTION – B

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

5. (a) How does do-while loop differ from for and while loops in C? **(5)**

(b) What will be the output of the following C code segment: **(8)**

```
int number[10] = {1, 0, 0, 0, 0, 0, 0, 0, 0, 0};
    int i, j;
    for(j=0;j< 10; ++j)
        for(i=0; i<j; ++i)
            number[j] += number[i];
    for(j=0;j< 10; ++j)
        printf("%i\n", number[j]);
```

(c) Rewrite the following statement using if-else construct in C: **(5)**

```
x != 0? Y = 1/x : printf ("undefined");
```

(d) Use switch statement to implement the following block of statements: **(7)**

```
n = rand() % 10;
if (n == 0) exit(0);
elseif (n == 1) y = 10;
elseif (n == 2) y = 9;
else y = 8;
```

(e) Write a C program using structure that stores the information (name, student no., level and term (e.g., L1/T2), and CGPA (e.g., 3.42)) of 60 students. **(10)**

Contd P/3

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6. (a) Define a structure that contains the name, number of units & price per unit of 3 different items of a grocery store. Write a C-program that will take the details (name, number of units & price per unit) as input from the keyboard and print a categorized bill with total price. **(12)**

(b) What will be the output of the following code and why? **(6)**

```
union example{
    int a;
    int b;
};

int main(){
union example obj;
obj.a = 10;
printf("%d %d", obj.a, obj.b);
return 0;
}
```

(c) Find the values of the following expressions: **(10)**

(i) `3<3 && 0<5`
(ii) `4-1<=4 || -1 == 0-1`
(iii) `-(-4-1) == 5 || !(3==3) && -1 > 0-1`
(iv) `-(-4-1) == 5 && !(3==3) || -1 > 0-1`

(d) Write a program in C to check whether a character is a digit or not. **(7)**

7. (a) Explain the differences between mutable and immutable objects in Python. **(5)**

(b) Write a program in Python using a function **"perfect()"** that determines if a number is a perfect number. Use this function to determine and print all the perfect numbers between 1 and 1000. [An integer number is said to be "perfect number" if sum of its factors, including 1 (but not the number itself) equals to the number itself. For example, 6 is a perfect number because 6 = 1+2+3]. **(14)**

(c) Write a Python program which will do the following tasks: the code will create a numpy array x having values from 0 to 4π with 100 datapoints. Then create an array, $y = \sin\left(\frac{2\pi x}{16}\right)\cos\left(\frac{2\pi x}{8}\right)$ and an array $z = \cos\left(\frac{\pi x}{9}\right)\sin\left(\frac{\pi x}{6}\right)$. Then plot y vs. x and z vs. x for $0 \le x \le 4\pi$ in a single plot. Scan arrays x, y and z and print the elements of x and y where both y and z are positive. **(16)**

Contd P/4

8. (a) What is Object Oriented Programming (OOP)? Discuss the differences between the Procedural programming and OOP. **(7)**

(b) Briefly discuss about the four pillars of OOP? **(8)**

(c) Create a Python class called **BankAccount** which represents a bank account, having following attributes: **accountNumber** (numeric type), **name** (name of the account holder as string type) and **balance** (float type). Create a constructor with parameters: **accountNumber**, **name**, **balance**. Create a **Deposit()** method which manages the deposit actions. Create a **Withdrawal()** method which manages withdrawals actions. Create a **display()** method to display account details. Create two instances of **BankAccount** class by creating two objects and display the account details. **(20)**

L-1/T-2/ME **Date: 12/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **HUM 101** (English)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

Symbols indicate their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section.

Answer any **THREE** questions including **Q. No. 1** as compulsory.

1. Read the following passage carefully and answer all the questions that follow: **(45)**

A strict vegetarian is a person who never in his life eats anything derived from animals. The main objection to vegetarianism on a long-term basis is the difficulty of getting enough protein - the body-building element in food. If you have ever been without meat or other animal foods for some days of weeks (say, for religious reasons) you will have noticed that you tend to get physically rather weak. You are glad when the fast is over and you get your reward of a succulent meat meal.

Proteins are built up from approximately twenty food elements called 'amino-acids', which are found more abundantly in animal protein than in vegetable protein. This means you have to eat a great deal more vegetable than animal food in order to get enough of these amino-acids. A great deal of the vegetable food goes to waste in this process and from the physiological point of view there is not much to be said in favor of life-long vegetarianism.

The economic side of the questions, though, must be considered. Vegetable food is much cheaper than animal food. However, since only a small proportion of the vegetable protein is useful for body-building purposes, a consistent vegetarian, if he is to gain the necessary 70 grams of protein a day, has to consume a greater bulk of food than his digestive organs can comfortably deal with. In fairness, though, it must be pointed out that vegetarians claim they need far less than 70 grams of protein a day.

Most nutrition experts today would recommend a balanced diet containing elements of all foods, largely because of our need for sufficient vitamins. Vitamins were first called 'accessory food factors' since it was discovered, in 1906, that most foods contain, besides carbohydrates, fats, minerals and water, these other substances necessary for health. The most common deficiencies in Western diets today are those of vitamins. The answer is variety in food. A well-balanced diet having sufficient amounts of milk, fruit, vegetables, eggs, and meat, fish or fowl (i.e. any good protein source) usually provides adequate minimum daily requirements of all the vitamins.

Contd P/2

HUM 101/ME

Contd.... for Q. No. 1

Questions:

(a) Why does 'vegetarianism on a long-term basis cast negative impacts on our health?

(b) How may the vegetarian fall short of required protein intake?

(c) Why do mot western diets lack required vitamins necessary for us?

(d) Why is the choice of 'to be or not to be a vegetarian' crucial for a healthy living?

(e) Give a suitable title to the passage and justify it.

(f) Write down the meanings of the following words as used in the passage:
Vegetarianism, succulent, abundantly, physiological, claim.

2. (a) What are the principles of writing a business letter? **(10)**

(b) As the Purchase Officer of an organization you had ordered 20 dozen bedsheets after examining the samples sent by the wholesaler. When the consignment arrives you find neither in texture nor in shaded do the sheets conform to the samples you had approved. Write a claim letter demanding their replacement. (Provide necessary details from your own.) **(10)**

(c) Write phonetic transcription of the following words: (Any Five) **(10)**
Table, thank, among, son, page, exam.

3. (a) What is a Report? Discuss in brief the functions of any five components of 'Front Matter' of a report. **(10)**

(b) Write a short essay on any ONE of the following: **(10)**

(i) Good Health: A Gift of God

(ii) Hot Temper: A Threat to a Healthy Social Life

(iii) Noise Pollution in Dhaka City: An Issue to be addressed

(c) Write a dialogue between two students of ME Department about their plan for joining in BUET Debate Club. **(10)**

4. (a) What are the characteristic features of a Sales letter? **(10)**

(b) Transcribe the following sentences as directed: (Any Five) **(10)**

(i) If you don't move an inch you will die. (Compound)

(ii) Where there is life there is hope. (Simple)

(iii) I knew about his previous activities. (Complex)

(iv) He was respected by all on account of his virtue. (Compound)

(v) I wish your success. (Complex)

(vi) He was sincere, and so he gained prominence. (Simple)

(c) Write short notes on any <u>THREE</u> of the following: **(10)**

(i) The Diphthongs

(ii) Difference between amplification and explanation

(iii) Importance of 'List of Reference' in academic writing

(iv) Barriers to Communication

Contd P/3

SECTION – B

There are **FOUR** questions in this section.

Answer any **THREE** questions including **Q. No. 5** as compulsory.

5. (a) Explain with reference to the context any TWO of the following: **(15)**

(i) "... every white man's life in the East, was one long struggle not to be laughed at."

(ii) "He had a working analysis of mankind's troubles: marriage, money, and the tangles of human ties."

(iii) "There must be more money! There must be more money!"

(b) Answer any ONE of the following: **(15)**

(i) How did the astrologer get rid of the mental burden he had so long been bearing upon himself?

(ii) Explain Orwell's ambivalence as a police officer in Burma in the story "Shooting an Elephant".

(c) Answer any THREE of the following: **(15)**

(i) Why did the children in 'Fire on the Mountain' decide to light fire?

(ii) What was the opinion of the Europeans about the writer's shooting the elephant?

(iii) Why was a peculiar 'restlessness" in the household of the family as described in the story "The Rocking-Horse Winner"?

(iv) Describe the professional equipment of the astrologer.

6. (a) Recast and correct any TEN of the following sentences: **(15)**

(i) Salma is an alumnus of BUET.

(ii) I have great confidence to you.

(iii) The rain prevented me to go.

(iv) Robin talks as if he knows everything.

(v) She made me several questions.

(vi) Turn the page for farther instructions.

(vii) I am glad that the news are good.

(viii) I met him sometimes in last summer.

(ix) Nazrul occupies a most unique place in literature.

(x) Neither you or he are to blame.

(xi) I was disinterested in the story.

(xii) My mother, along with others, were worried.

(b) Give the meaning and make sentences with any TEN of the following words: **(15)**

Admonish, Beneficiary, Chilly, Deliberately, Eloquence, Feud, Glossary, Impromptu, Jeopardy, Keen, Lustrous, Menace.

Contd P/4

7. Amplify the idea in any ONE of the following: **(30)**

(a) "However mean your life is, meet it and live it; do not shun it and call it hard names."

(b) "All's well that ends well."

8. Write a précis of the following passage with a suitable title: **(30)**

All the virtues depend on the virtue of perseverance. It is lack of perseverance, not lack of ability, that is the cause of most of the sad failures that stain the history of mankind. It is because men do not persevere in overcoming one difficulty at a time, that they fail. Instead of sticking to one aim in life until it is realized, they hesitate, get discouraged at every small rebuff, change from one aim to another, and so create for themselves such a series of difficulties as can never be overcome by human power. Hence, they fail to accomplish anything. Even a small stream will carve out for itself a deep and wide channel simply by constantly flowing. Without perseverance, all the other virtues are deceitful fairy gold of the fairy-tales, which turns to worthless stones when you try to use it as money in the shops.

L-1/T-2/ME **Date: 12/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **HUM 103** (Economics)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

Symbols indicate their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. Consider the production function, $Y = K^{2/3}L^{1/3}$ where Y denotes output, K capital and L labor. You are also given the price of labor, w = 50, price of capital, r = 100 and Total cost = 150000

   (a) Find the equilibrium amount of labor, capital and output. **(20)**

   (b) How do the equilibrium amount of labor, capital and output change if w = 75 and r = 150 and total cost = 150000. **(15)**

2. A firm producing two goods "A" and "B" has the profit function

   $$Z = 3200A - 100A2 + 200AB - 200B2 + 1600B - 700$$

   (a) What are the profit-maximizing level of output for each of the two goods? **(20)**

   (b) Test whether profits are maximized. What is the maximized amount of profit? **(15)**

3. (a) Which market structure (perfectly competitive market or monopoly market) gives us more society's surplus (consumer surplus plus producer surplus) and less welfare loss (dead weight loss)? Use the following equations to answer the question. **(20)**

   $$TC = 600 + 150\,Q + 30Q^2$$
   $$TR = 600\,Q - 30Q^2$$

   Where Q = Quantity of a commodity, TC = Total cost, and TR = Total revenue

   Show your answer graphically too.

   (b) Explain and show graphically super normal profit, abnormal loss and normal profit in case of monopolistically competitive market. **(15)**

4. (a) Consider any arbitrary economy. Using the following table, calculate Consumer Price Index (CPI) in 2019, 2020, 2021 and 2022 (Currency in Taka). **(20)**

Contd P/2

HUM 103/ME

Contd.... for Q. No. 4

Product	Base Year (2016) Quantity	Base Year (2016) Per Unit Price	2019 Expenditures (on base-year quantities)	2020 Expenditures (on base-year quantities)	2021 Expenditures (on base-year quantities)	2022 Expenditures (on base-year quantities)
Vaccination	200	500	100100	100500	110500	130500
Masks	400	50	25000	27000	30000	45000
Hand sanitizer	300	20	10000	11000	11000	14000
Pulse Oximeter	1000	1000	1020200	1030200	1050200	1058200
Books	600	100	70000	71000	71900	81000
Lemons	2000	10	20500	22500	25500	27500

(b) Using the CPI you created in question 4(a), estimate inflation rate from 2019 to 2020, from 2020 to 2021, and from 2021 to 2022. **(15)**

SECTION – B

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

5. (a) Define supply function. **(5)**

(b) What are the factors that influence the shifting of the demand curve? **(10)**

(c) How would you derive the market demand curve of a commodity? Explain graphically. **(10)**

(d) What are the exceptions to the law of demand? **(10)**

6. (a) Define Income elasticity of demand and price elasticity of demand. **(10)**

(b) Show that price elasticity of demand varies from zero to infinity along any straight line demand curve. Explain graphically. **(15)**

(c) From the following table calculate elasticity of demand if you move from point B to C and explain what you understand from the result. **(10)**

POINT	Px	Qy
A	300	12
B	400	15
C	500	18

Contd P/3

HUM 103/ME

7. (a) What is an indifference curve? Explain the properties of an indifference curve. **(15)**

(b) Explain consumer's equilibrium with the help of budget line and indifference curve. **(10)**

(c) From the following budget line and the utility function, calculate the amount of two commodities that maximizes satisfaction. What is the maximum amount of satisfaction? **(10)**

$$3000 = 20X + 30$$
$$U = 400\, X^{0.7} Y^{0.6}$$

8. (a) How is price determined in an open economy under competition? What will happen to the price and quantity due to simultaneous change in demand and supply? **(15)**

(b) From the following demand and supply functions, calculate equilibrium price and quantity and show the result in a graph. **(20)**

$$P = 0.50\,Q + 150$$
$$P = -0.40Q + 300$$

(i) What will happen to the equilibrium price and quantity if government imposes a unit tax of TK 3 per unit?

(ii) What will happen if government gives a subsidy of TK 5 per unit?

(iii) Describe the change in equilibrium. Show the equilibrium coordinates on the same graph.

L-1/T-2/ME **Date: 18/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **CHEM 141** (Chemistry in Engineering Materials)

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) Write the common properties of plastics? Differentiate thermoplastic and thermosetting plastic. **(12)**

   (b) Draw the chemical structures of Teflon, polystyrene, polyacrylamide, poly(methyl acrylate) and butyl rubber. Write the steps of the formation of poly(vinyl chloride) from its monometer. **(12)**

   (c) How melamine is formed from urea? Describe the characteristics and applications of melamine. **(11)**

2. (a) Draw the typical stress-strain graphs to identify ductile, tough and brittle polymeric materials. How the strain hardening can affect in toughening polymeric materials? **(12)**

   (b) Write the factors that affect the glass transition temperature of polymeric system. How the changes of polymeric system in glass transition temperature are different from its melting? **(12)**

   (c) Explain the changes in behavior of viscoelastic polymers during the increase in temperature. **(11)**

3. (a) Discuss the function of different ingredients of paints. What are the coloring pigments used for black, yellow, green and red? **(12)**

   (b) Identify different defects of painting and their causes. **(12)**

   (c) How thermal spalling affect the durability of refractory materials? Find some ways to reduce thermal spalling. **(11)**

4. (a) Write the chemical constitution and composition of natural rubber. Outline the steps of the preparation of natural rubber. **(12)**

   (b) How is vulcanization performed in rubber? Justify that vulcanization changes the mechanical behavior of rubber materials. **(12)**

   (c) Identify and explain the characteristics of good lubricant. **(11)**

Contd P/2

SECTION – B

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

5. (a) What is hydraulic cement? Write a note on piezoelectric ceramic. **(3+7=10)**

   (b) Starting from the raw materials briefly describe the manufacturing process of ceramic product? **(15)**

   (c) How does a recuperative furnace work? Make a comparison between tank and pot furnace used for glass making. **(4+6=10)**

6. (a) What is annealing? Write the reactions involved in glass manufacturing when the batch contains salt cake, limestone, silica and carbon. **(3+7=10)**

   (b) Why coagulating agents are used during water treatment? Elaborate on different hardness removal processes for boiler feed water. **(4+11=15)**

   (c) How could you manufacture Pyrex glass and safety glass? **(10)**

7. (a) Define specific volume ratio. Elucidate the factors affecting erosion corrosion. **(3+7=10)**

   (b) How pits cathodically protect rest of the part of any metal? Briefly describe the mechanism of this autocatalytic nature. **(15)**

   (c) What are the factors you should consider to minimize corrosion while selecting a metal-alloy and designing a mechanical device? **(10)**

8. (a) What is mercerization? All fibers are polymer but all polymers are not fiber— Explain. **(3+7=10)**

   (b) With a detailed flow chart briefly describe the manufacturing process of Teflon filament. **(15)**

   (c) How would you develop activated carbon from carbonaceous materials? Write the uses of activated carbon and graphite. **(5+5=10)**

L-1/T-2/ME **Date: 07/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **PHY 159** (Waves and Oscillations, Geometrical Optics and Wave Mechanic)

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) Establish the differential equation of simple harmonic motion and solve it to obtain an expression for the displacement when there is an initial displacement y_0 only. **(10)**

   (b) The displacement of a vibrating particle at any instant is $x = A\cos(\omega t + \alpha)$. Show that total mechanical energy remains conserved. Draw the energy curve as a function of position. **(15)**

   (c) A body of mass 5 kg is suspended at the end of a spring of mass 0.5 kg which is stretched by 0.1 m when the body is attached. It is then displaced downward by 0.05 m and released. Find the amplitude and time period of the oscillator. **(10)**

2. (a) Establish the differential equation of a damped harmonic oscillation and solve it for oscillatory damped condition to obtain an expression for the displacement of the oscillatior. **(15)**

   (b) What is log-decrement of a damped oscillatory motion? How damping coefficient can be determined of such a system? **(10)**

   (c) A plane progressive wave train of frequency 350 Hz has a phase velocity of 420 m/s. How far are the two points with 45° out of phase? **(10)**

3. (a) Show that at the steady state, the rate of supply of energy by the driving force is equal to the rate of energy dissipated by the frictional force. **(15)**

   (b) Give the theory of decay of sound intensity inside a hall room. Hence obtain an expression of Sabine's reverberation formula. **(10)**

   (c) A lecture hall of volume 3×10^5 m^3 is found to have a reverberation time of 2 seconds. What is the total sound absorbing power of all the surfaces in the hall? If the area of all the sound absorbing surface is 4×10^4 m^2, what is the absorption coefficient? **(10)**

4. (a) Write down some of the fundamental postulates of statistical mechanics. **(7)**

   (b) Write down the mathematical expressions of the three statistical distribution functions by mentioning each term. Draw schematically these functions for the same value of normalized exponential (α). What comments can be drawn on their probability of occupancy at a higher thermal energy? **(18)**

   (c) Find the Fermi energy in copper on the assumption that each copper atom contributes on free electron to the electron gas. The density of copper is 8.94×10^3 kg/m^3 and its atomic mass is 63.5 u. **(10)**

Contd P/2

SECTION – B

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

5. (a) Explain a physical phenomenon that cannot be explained in terms of classical mechanics, however, can be explained only in terms of quantum mechanics. **(10)**

(b) Write down the required characteristics of the wave function. Draw schematically the wave function and the probability density function for different quantum states for an electron bound in an infinite square potential well. What conclusions can be drawn from these schematic diagrams? **(15)**

(c) Derive the infinite square well energy quantization law, directly from the de Broglie relation $p = h/\lambda$, fitting an integral number of half de Broglie wavelengths $\lambda/2$ into the width 'a' of the well. **(10)**

6. (a) Write down the expressions for the momentum operator and energy operator. Is it possible to derive the Schrödinger equation by using quantum mechanical operators? Justify your answer. **(10)**

(b) Explain the 'Quantum Mechanical Tunneling' effect and write down its important applications in device fabrication. **(15)**

(c) Estimate the penetration distance Δx for a very small dust particle of radius 10^{-6} m, density 10^4 kg/m^3, velocity 10^{-2} m/sec, if the particle impinges on a potential step of height equal to twice its kinetic energy in the region to the left of the step. **(10)**

7. (a) Draw the schematic ray diagrams to show the defects of coma and astigmatism. Explain briefly how spherical aberration can be minimized. **(10)**

(b) Deduce a condition for achromatism of two thin lenses separated by a finite distance. **(15)**

(c) Two thin convex lenses of the same material of focal lengths 24 cm and 8 are placed at a certain distance apart to form an achromatic combination. Will the combination satisfy the condition for minimum spherical aberration? Justify your answer. **(10)**

8. (a) Define visual angle and angular magnification. Distinguish between magnification and resolution for an optical instrument. **(10)**

(b) With a suitable ray diagram, explain the action of a compound microscope and discuss its resolving power. **(15)**

(c) A compound microscope consists of an objective lens with a focal length of 1 cm and an eyepiece with a focal length of 5 cm. An object is placed 1.1 cm from the first lens and the final image is formed at 25 cm from the second lens. Find the resultant magnification and the separation between the objective and eyepiece. **(10)**

L-1/T-2/ME **Date: 02/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **MATH 163** (Integral Calculus and differential Equations)

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. Carry out the following:

(a) $\int e^{6x}\sin\left(e^{2x}\right)dx$. **(15)**

(b) $\int \frac{dx}{x\sqrt{9x^2+4x+1}}$. **(15)**

(c) $\int \frac{1+2\cos x}{1+2\sin x}dx$. **(16⅔)**

2. (a) Evaluate $\lim_{n\to\infty}\frac{\left[(n+1)(n+2)\cdots\cdots(n+n)\right]^{\frac{1}{n}}}{n}$. **(13)**

(b) State and prove Walli's cosine formula and hence use the formula to evaluate $\int_0^{\pi/2}\cos^7 x\,dx$. **(15)**

(c) Define Gamma function and Beta function. Find the value of (i) $\Gamma\left(\frac{1}{2}\right)$, (ii) $\Gamma\left(\frac{7}{2}\right)$, (iii) $\Gamma\left(-\frac{7}{2}\right)$ and (iv) $\Gamma\left(\frac{10}{3}\right)$. **(18⅔)**

3. (a) Evaluate $\int_0^{\infty}\frac{1}{\sqrt{x}(x+1)}dx$. **(15)**

(b) Test the convergence of the integral $\int_0^1 \frac{dx}{x^{\frac{1}{2}}(1-x)^{\frac{1}{3}}}$ and hence evaluate it. **(15)**

(c) A trunnion of diameter 12.363" has to be cooled from a room temperature of 80°F before it is shrink fit into a steel hub. The equation that gives the diametric contraction, in inches of the trunnion in dry ice (boiling temperature is –108°F) is given by: **(16⅔)**

$$\Delta D = 12.363\int_{80}^{-108}\left(-1.2278\times10^{-11}T^2+6.1946\times10^{-9}T+6.015\times10^{-6}\right)dT$$

(i) Use Simpson's 1/3 Rule to find the appropriate value of ΔD.

(ii) Find the true error, E_t, for part (i).

(iii) Find the absolute relative true error for part (i).

4. (a) A solid has, as its base, the circular region in the xy-plane bounded by the graph of $x^2+y^2=a^2$ with $a>0$. Find the volume of the solid if every cross section by a plane perpendicular to the x-axis is an equilateral triangle with one side in the base. **(16⅔)**

(b) Find the surface area of the solid obtained by revolving the asteroid $x^{\frac{2}{3}}+y^{\frac{2}{3}}=a^{\frac{2}{3}}$ about x-axis. **(15)**

(c) Find the arc length of the cycloid $x=a(t-\sin t)$, $y=a(1-\cos t)$. **(15)**

Contd P/2

MATH 163/ME

SECTION – B

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

5. (a) Find the differential equation of the family of curves, $y = e^x(A\cos x + B\sin x)$, where A and B are arbitrary constants, hence find its degree and order. **(15)**

(b) Solve the initial value problem: **(16⅔)**

$$(y^2 + xy^3)dx + (5y^2 - xy + y^3\sin y)dy = 0;\ y(0) = 1$$

(c) Find an equation of the curve that has slope of the form: **(15)**

$$(e^{2y} - y\cos xy)dx + (2xe^{2y} - x\cos xy + 2y)dy = 0$$

6. (a) Solve the differential equation using suitable method: **(15)**

$$\frac{dy}{dx} - 2 = \sqrt{y - 2x + 3}$$

(b) Solve: **(16⅔)**

$$xy(1 + xy^2)\frac{dy}{dx} = 1$$

(c) Initially 100 milligrams of a radioactive substance was present. After 6 hours the mass had decreased by 3%. If the rate of decay is proportional to the amount of the substance present at time t, derive the differential equation to find the amount remaining after 24 hours. **(15)**

7. (a) Solve: $2\frac{d^5y}{dx^5} - 7\frac{d^4y}{dx^4} + 12\frac{d^3y}{dx^3} + 8\frac{d^2y}{dx^2} = 0$. **(15)**

(b) Solve the following differential equation: **(16⅔)**

$\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 9y = x^2e^{3x}\cos 2x$ using appropriate technique.

(c) A mass weighing 8 pounds stretches a spring 2 feet. Assuming that a damping force numerically equal to 2 times the instantaneous velocity acts on the system, determine the equation of motion if the mass is initially released from the equilibrium position with an upward velocity of 3 ft/s. **(15)**

8. (a) Solve the Cauchy-Euler differential equation **(15)**

$x\frac{d^2y}{dx^2} + \frac{dy}{dx} - \frac{1}{x}y = \ln x$ by using the method of variation of parameters.

(b) Solve: $xy'' + (x-1)y' - y = 0$ by the method of factorization of operator. **(16⅔)**

(c) Solve: $y\frac{d^2y}{dx^2} - \left(\frac{dy}{dx}\right)^2 = y^2\ln y$. **(15)**
