L-1/T-1/MME Date: ~~28/04/2024~~ 19/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B.Sc. Engineering Examinations 2022-2023

Sub: .**MME 101** (Materials Engineering Fundamentals)

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. Question 1 is **COMPULSORY**. Answer any **TWO** from the remaining three questions.

1. **[COMPULSORY]**

(a) What information can you get from phase diagram? Why is this so important? **(5)**

(b) When do you choose casting over other manufacturing methods? Which manufacturing method will you select for the following products (i) dental crown (ii) relatively small pieces, simple shape and thousands of castings/month (iii) steel deformed bar (iv) hollow bricks (v) ceramic tiles (vi) ceramic flower vase (vii) metal wire? Justify your answer. **(30)**

2. As a quality control expert you are requested to determine the type and presence, if any, of welding defects of welded pipeline. Suggest two suitable non-destructive testing methods, indicating clearly the reasons for such selection and explain how you would perform the tests? **(35)**

3. (a) Explain how we can get useful information on the fatigue property both for a ferrous and non-ferrous metal from the curve produced by a series of test results. Sketch a fatigue fractograph and label it. How can you prevent fatigue failures? **(20)**

(b) As temperature decreases, a ductile material can become brittle. Which term does best describe this transition? Draw a suitable diagram to show this transition. State how the transition can be measured. **(15)**

4. (a) Drying and firing techniques are critical for ceramic piece that has been formed. – Justify it with distinct differentiation between drying and firing operations. **(20)**

(b) Differentiate between dry and wet corrosion. Explain the oxidation processes that take place at a clean and reactive metal surface exposed to oxygen. **(15)**

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MME 101

SECTION – B

There are **FOUR** questions in this section. Question 5 is **COMPULSORY**. Answer any **TWO** from the remaining three questions.

5. (a) With recognizing the necessary chemical reactions, explain how the pig iron can be converted into steel, one of the most useful engineering materials. Why does steel show superior property with this processing of pig iron? **(7+3=10)**

(b) Distinguish between alloys and composite materials. Explain the functions of the major ingredients of a composite material. **(4+4=8)**

(c) Based on the reinforcement materials, discuss with relevant examples how you can combine various types of reinforcement materials for producing a composite material. Identify the various crucial aspects of the constituent materials that contribute to the final properties of composite materials. **(12+5=17)**

6. (a) Illustrate the interrelationship of four major components of the discipline of materials science and engineering, and explain how you can relate the differences in light-transmittance characteristics of aluminum oxide to these components. **(6+6=12)**

(b) Consider a Cu - Ni substitutional solid solution alloy where Cu is the solvent and Ni is the solute. Relate the features of Cu and Ni atoms that determine their solubility in each other. **(8)**

(c) With necessary figures, demonstrate the packing sequences of the close packed structures? Explain why FCC and HCP crystalline materials exhibit marked difference in their physical and mechanical properties. **(10+5=15)**

7. (a) Using necessary figures, explain the changes, a tough and ductile material such as steel experiences when tensile loading continues beyond the yield point to fracture. **(15)**

(b) Explain why ductile failure is always preferable than a brittle failure. Distinguish between the qualitative and the quantitative hardness tests. **(4+4=8)**

(c) Illustrate, with necessary figures, why the true stress differs from the engineering stress. Which one is used commonly in engineering practice? **(9+3=12)**

Contd..... P/3

8. (a) Express the most important characteristics and properties of ceramic materials with some relevant examples of ceramic materials. **(10)**

(b) What is the basic principle of strengthening the metallic materials? Explain how the deformation of a metallic material contributes to its strengthening process. **(3+9=12)**

(c) What are the boundary conditions of materials selection? Using a flow chart, explain the essential steps of a design process. **(5+8=13)**

L-1/T-1/MME Date: ~~04/05/2024~~ 25/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **PHY 125** (Physics I)

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) Define Lissajous' figures. How these figures are useful in the laboratory? **(5)**

   (b) Derive a general expression for the combination of two simple harmonic motions acting at the right angle to each other, having a frequency ratio of 2:1, and hence, find out the equation of a parabola. **(20)**

   (c) Two simple harmonic motions acting simultaneously on a particle are given by, $y_1 = \sin\left(\omega t + \frac{\pi}{6}\right)$, and $y_2 = 2\sin\omega t$. Find the equation of the resultant vibration. **(10)**

2. (a) What are the differences among free, damped and forced oscillations? **(7)**

   (b) Derive the differential equation of a damped harmonic motion and solve this equation. Discuss in detail the condition of under-damped motion. **(20)**

   (c) The equation for the displacement of a damped harmonically oscillating particle is given by, $x = 5e^{-0.25t}\sin\left(\frac{\pi}{2}\right)t$ meter. Find the velocity of the oscillating particle at $t = \frac{T}{4}$ and T, where T is the time period of the oscillator. **(8)**

3. (a) How do the progressive waves differ from the stationary waves? **(7)**

   (b) A string is closed at both ends in which a stationary wave is generated by reflection. Deduce the equations of particle displacement, particle velocity, acceleration, and strain for the resultant stationary wave. Explain the condition for the formation of nodes and antinodes. **(18)**

   (c) A string vibrates forming stationary waves represented by, $y = 0.48 \sin 0.16x \cos 12t$, where x and y are expressed in meters and t in sec. What are the amplitude and velocity of the individual waves whose superposition gives rise to this vibration? **(10)**

4. (a) Define optical activity and specific rotation. On what factors do they depend? **(10)**

   (b) Describe the construction and working of a polarimeter and explain how it can be used to determine the specific rotation of sugar. **(18)**

   (c) A solution of an optically active solute produces a rotation of 20 degrees of the plane of polarization in a path length of 10 cm when the concentration is 20 g/liter. What is the concentration in a solution that produces a rotation of 30 degrees in a path length of 5 cm? **(7)**

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PHY 125

SECTION – B

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

5. (a) What are coherent sources and how will you produce them in the case of Fresnel biprism? **(10)**

   (b) Discuss the effect of introducing a transparent thin film in the path of one of the interference beams in a biprism experiment and hence derive an expression for the displacement of the fringes. **(15)**

   (c) In a biprism experiment, the eyepiece is placed at a distance of 1.2 m from the source. The distance between the virtual sources was found to be 7.5×10^{-4} m. Find the wavelength of light, if the eyepiece is to be moved transversely through a distance of 1.9 cm for 20 fringes. **(10)**

6. (a) Define the circle of least chromatic aberration and dispersive power of the material of the lens and how will you relate them with the diameter of the lens aperture. **(10)**

   (b) Derive the condition of achromatism for two thin lenses placed in contact and discuss the validity of the condition for the choice of the type and material of the lenses. **(15)**

   (c) An achromatic double of focal length 20 cm is to be formed out of a combination of crown and flint glasses. The radius of curvature of the faces in contact is 15 cm. Calculate the radius of curvature of the other faces, given the dispersive power of the crown and flint glasses as 0.02 and 0.04 and their respective refractive indices are 1.52 and 1.65. **(10)**

7. (a) Write down the relationship between the electric field and electric lines of force. Draw electric field lines between $+2Q$ and $-Q$ charges. **(8)**

   (b) Find the electric field intensity at a point P on the axis at a distance 'x' from the centre of a uniformly charged circular ring. What will be the field intensity when $x = 0$? **(15)**

   (c) Two charges of $+20 \times 10^{-9}$ C and -20×10^{-9} C are placed 6 m apart. Calculate the electric field intensity at point 5 m from the centre of the electric dipole **(12)**

   (i) on axial line

   (ii) on equatorial line.

8. (a) State Faraday's law and Lenz's law for electromagnetic induction. **(8)**

   (b) A circuit contains an inductance L and a resistance R placed in series with a battery of emf E. Obtain an expression for the growth and decay of current in the circuit. What is the time constant of the circuit? How does the current depend on it? **(15)**

   (c) A coil of resistance 10 ohms and inductance 0.6 H is switched on to a 60 V supply. Calculate the rate of increase of the current **(12)**

   (i) at the instant of closing the switch

   (ii) after one time constant

   (iii)Find the steady state current in the circuit.

L-1/T-1/MME **Date: 18/04/2024**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **MATH 171** (Calculus and Ordinary Differential Equations)

Full Marks: 210 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. (a) Estimate values of the constants k and m, if possible, that will make the function f continuous everywhere. **(14)**

$$f(x)=\begin{cases} x^2+5, & x>2 \\ m(x+1)+k, & -1<x\le 2 \\ 2x^3+x+7, & x\le -1 \end{cases}$$

Hence discuss the differentiability of the function at x = 2.

(b) A heating oil distributor has set the following price schedule, \$1.30 per gallon for 100 or fewer gallons; \$1.15 per gallon for more than 100 but no more than 150 gallons; \$1.00 per gallon for more than 150 but fewer than 200 gallons; \$0.85 per gallon for 200 or more gallons. Describe the function C(x) that gives the cost (\$) for purchasing x gallons of heating oil. Also sketch the graph of C(x) to locate the point of discontinuity. **(8)**

(c) Apply L' Hospital's Rule to calculate the following limit. **(13)**

$$\lim_{x\to 0}\left[\frac{1}{x^2}-\frac{1}{\sin^2 x}\right].$$

2. (a) Using De Moivre's theorem find the nth derivative of $y=\sin^5 x\cos^3 x$. **(12)**

(b) If $y=p\sin(\ln x)+q\cos(\ln x)$, then find the value of $x^2y_{n+2}+(2n+1)xy_{n+1}+(n^2+1)y_n$ using Leibnitz theorem. Here p, q are constants. **(11)**

(c) Validate Euler's theorem for $u=\dfrac{x^{\frac{1}{4}}+y^{\frac{1}{4}}}{x^{\frac{1}{3}}+y^{\frac{1}{3}}}$. **(12)**

3. (a) The number of major crimes committed in the city of Dhaka from 2010 to 2017 is approximated by the function $N(t)=-0.1t^3+1.5t^2+100,\ 0\le t\le 7$; **(11)**

where $N(t)$ denotes the number of crimes committed in year t, with $t = 0$ corresponding to the beginning of 2010. Examine where the function N is increasing and is decreasing using first derivative.

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(b) If the line $x\cos\alpha + y\sin\alpha = p$ touches the curve $\left(\frac{x}{a}\right)^m + \left(\frac{y}{b}\right)^m = 1$, show that

$(a\cos\alpha)^{\frac{m}{m-1}} + (b\sin\alpha)^{\frac{m}{m-1}} = p^{\frac{m}{m-1}}$. **(12)**

(c) If $V = \sqrt{x^2 + y^2 + z^2}$ then show that $V_{xx} + V_{yy} + V_{zz} = 2/V$. **(12)**

4. Evaluate the following integrals:

(a) $\int \frac{4\cos x + 5\sin x}{7\cos x + 6\sin x} dx$ **(12)**

(b) $\int \frac{x^2 + 1}{x^4 + x^2 + 1} dx$ **(11)**

(c) $\int \frac{1 - 2x\sin x - \cos x}{x(1 - \cos x)} dx$ **(12)**

SECTION – B

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

5. (a) Derive the reduction formula for $\int e^{ax}\cos^n x dx$ and hence evaluate $\int e^{2x}\cos^4 x dx$. **(15)**

(b) Use definite integral properties to evaluate $\int_0^{\pi} \frac{x\sin x}{1 + \cos^2 x} dx$. **(10)**

(c) Evaluate $\underset{x\to\infty}{Lt}\left[\left(2 + \frac{1}{n^2}\right)^{\frac{1}{n^2}}\left(2 + \frac{2^2}{n^2}\right)^{\frac{2}{n^2}}\left(2 + \frac{3^2}{n^2}\right)^{\frac{3}{n^2}} \ldots\ldots\ldots\ldots \left(2 + \frac{n^2}{n^2}\right)^{\frac{n}{n^2}}\right]$. **(10)**

6. (a) Find the area common to the cardioid $r = a(1 + \cos\theta)$ and the circle $r = \frac{3}{2}a$. **(15)**

(b) Find the volume and the surface area of the solid generated by revolving the region enclosed by the astroid $x^{2/3} + y^{2/3} = a^{2/3}$ about the x-axis. **(20)**

7. (a) Is the differential equation $y^2 dx + (x^2 - xy - y^2)dy = 0$ exact? If not make it exact and solve. **(11)**

(b) Find the particular solution of the following differential equation **(12)**

$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = \cos 2x$, given that $y = 1/8$ and $\frac{dy}{dx} = 4$ when $x = 0$.

(c) A thermometer is removed from a room where the temperature is 70°F and is taken outside, where the air temperature is 10°F. After one-half minute the thermometer reads 50°F. **(12)**

(i) Formulate the corresponding ordinary differential equation from the above data.

(ii) How long will it take for the thermometer to reach 15°F?

8. (a) Solve: $x^2\left(\frac{dy}{dx}\right)^2 + 3xy\frac{dy}{dx} + 2y^2 = 0$. **(10)**

(b) Reduce the differential equation $x^2\frac{d^2y}{dx^2} - x\frac{dy}{dx} + 4y = x^2\cos(\log x)$ into linear form with constant coefficients and then solve it. **(13)**

(c) A mass weighing 16 pounds is attached to a 5 feet long spring. At equilibrium the spring measures 8.2 feet. If the mass is initially released from rest at a point 2 feet above the equilibrium position, **(12)**

(i) find the differential equation that represent the model and

(ii) find the displacements $x(t)$ if it is further known that the surrounding medium offers a resistance numerically equal to the instantaneous velocity.
