L-I/T-I/MME

Date : 25/05/2022

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-I/T-I B. Sc. Engineering Examinations 2020-2021

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

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Define unit cell. With neat sketch, calculate the number of atoms per unit cell and atomic packing factor of a HCP crystal. **(3+7+7=17)**

   (b) Predict the crystal structure of CsBr. On the basis of crystal structure, calculate the theoretical density of CsBr. Atomic radius: $r_{Cs^+} = 0.170$ nm, $r_{Br^-} = 0.196$ nm. Atomic weight of Cs and Br are 132.91 g/mol and 79.90 g/mol, respectively. **(6+12=18)**

2. (a) What are grain boundaries? How do grain boundaries impede dislocation motion? Explain the variation of yield strength with grain size according to Hall-Petch relation. **(20)**

   (b) Suppose you have to cast a low volume and complex shape object e.g. jewelry. Which casting process will you choose and why? Briefly discuss the process with neat sketches. **(15)**

3. (a) Differentiate between advanced ceramics and traditional ceramics. Explain the time dependent removal of water from ceramic body. **(7+8=15)**

   (b) The melting points of metal A and metal B are 1000°C and 750°C respectively. A number of alloys are prepared by mixing different proportions of A and B, and the arrest points of cooling curve of each alloy are given in the following table. **(20)**

B in A, wt.%	5	10	20	30	40	50	60	70	80	90
First arrest point, °C	985	960	945	915	880	860	820	800	790	770
Second arrest point, °C	850	840	830	820	810	800	790	780	765	760

Construct the phase diagram for metal A and metal B in a piece of graph paper and label all lines, points and areas of the diagram.

For an alloy containing 50 percent B (i) give the temperature of initial solidification; (ii) give the temperature of final solidification; (iii) give the chemical composition and relative amounts of the phase present at 850°C.

Contd P/2

MME 101

4. (a) What general information can you get from the charts shown in Figure 1-3? With the help of these charts select materials for the following products and explain reasons for such selections. **(25)**

   (i) A disposable cup, (ii) Hammer, (iii) Car engine parts

   (b) Compare cast iron and steel based on composition, properties, and applications. **(10)**

SECTION – B

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

5. (a) What do you understand by strain hardening? Is forging (shaping a metal object by heating it in a fire or furnace and hammering it) a strain hardening process? – strengthen your opinion with logical explanation. **(15)**

   (b) How do S-N curves of ferrous and non-ferrous materials assist preventing a catastrophic and insidious phenomenon like fatigue? **(10)**

   (c) An aluminum rod is to withstand an applied force of 45,000 pounds. To assure a sufficient safety, the maximum allowable stress on the rod is limited to 25,000 psi. The rod must be at least 150 inches long but must deform elastically no more than 0.25 inches when the force is applied. Design an appropriate rod. **(10)**

6. (a) Difference between branched polymer and cross-linked polymer. **(10)**

   (b) Discuss the factors that influence mechanical properties of polymer. **(16)**

   (c) Two monomers of same proportions are polymerized to form a block co-polymer and a graft co-polymer separately. Among these two co-polymers, which one has higher density? Justify your answer. **(9)**

7. (a) Select and outline a suitable NDT method for detecting internal defect in a cast iron body. **(14)**

   (b) Compare and contrast ductile failure with brittle failure. **(13)**

   (c) Mention the importance of crystal structure in effecting ductile to brittle transition of a material. **(8)**

8. (a) Among the main classes of a material, which one has the highest potential for utilization in Bangladesh? Explain your answer. **(8)**

   (b) Deduce an equation for determining Young's modulus of a composite material assuming isostrain condition. **(15)**

   (c) The density of two polypropylene materials are 0.904 g/cm^3 and o.895 g/cm^3 respectively, while the associated percent crystallinity of those two materials are 62.8 and 54.4, respectively. Calculate (i) densities of totally crystalline and totally amorphous polypropylene and (ii) density of a specimen having 74.6% crystallinity. **(12)**

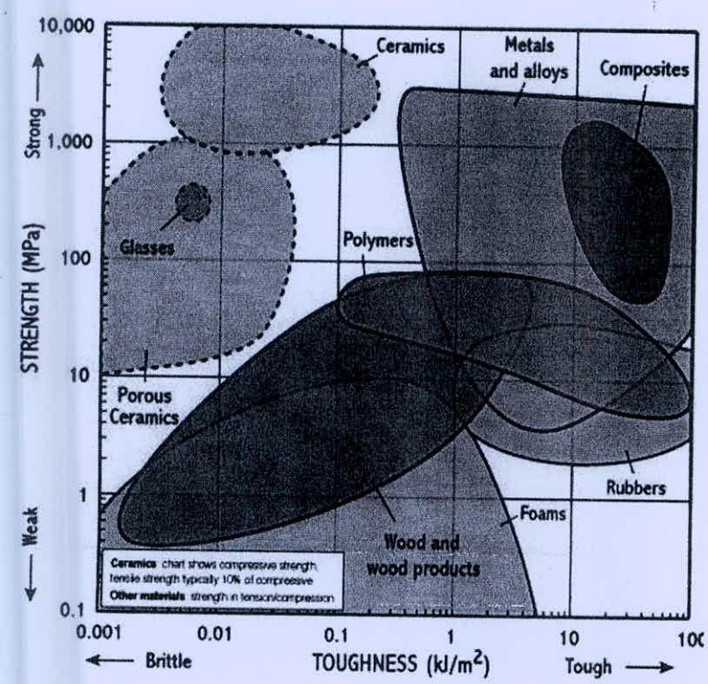

Figure 1

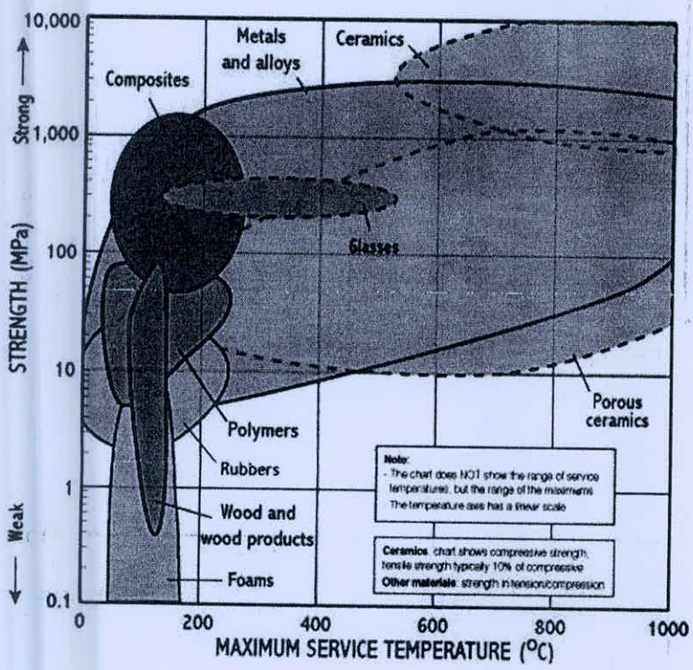

Figure 2

L-1/T-1/MME **Date: 22/05/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **HUM 123** (English)

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 **Q. No. 1** and any **TWO** from the rest.

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

(i) "It seemed dreadful to see the great beast Lying there, powerless to move and yet powerless to die, and not even to be able to finish him."

(ii) "All the same, it was as much an honest man's labor as any other, and he deserved the wages he carried home at the end of a day."

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

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

(i) Critically analyze the mother-son relationship in "The Rocking-Horse Winner".

(ii) Compare and contrast the characters of Ralph and Jack in "Fire on the Mountain".

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

(i) What is your opinion about the Astrologer?

(ii) How did the Burmese locals treat Orwell?

(iii) What does the Rocking horse symbolize?

(iv) What is the significance of the "Beastie" in "Fire on the Mountain"?

(v) Why did Orwell shoot the elephant?

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

(i) It's the best which I've seen.

(ii) Who of the two boys is the taller?

(iii) You can't avoid to make mistakes.

(iv) The man was trembling from cold.

(v) They were warned about the danger.

(vi) I've written the letter with ink.

(vii) According to my opinion, she's right.

(viii) Joe hasn't come also.

(ix) I'd reached the school before the rain started.

(x) The pupil gave his exam.

(xi) They came down from their horses.

(xii) He made an interesting lecture.

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

Gourmet, Lucid, Abomination, Demolition, Confidant, Anecdote, Bouquet, Fervent, Pristine, Apartheid, Zeal, Presumptuous.

Contd P/2

3. Amplify any **ONE** of the following: **(30)**

(a) "The butterfly counts not months but moments, and has time enough."

(b) "The woods are lovely, dark and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep.

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

Bonsai specimens are ordinary trees and shrubs that are dwarfed by a system of pruning roots and branches and training branches by tying with wire. The art originated in China, where perhaps over 1,000 years ago, trees were cultivated in trays, wooden containers, and earthenware pots and trained in naturalistic shapes. Bonsai, however, has been pursued and developed primarily by the Japanese. The direct inspiration for bonsai is found in nature. Trees that grow in rocky crevices of high mountains, or that overhang cliffs, remain dwarfed and gnarled through their existence. The Japanese prize in bonsai an aged appearance of the trunk and branches and a weathered character in the exposed upper roots. These aesthetic qualities are seen to embody the philosophical concept of the mutability of all things. Bonsai may live for a century or more and may be handed down from one generation to another as valued family possessions. Aesthetics of scale call for short needles on conifers and relatively small leaves on deciduous trees. Small-flowered, small-fruited varieties of trees are favoured. Open space between branches and between masses of foliage are also important aesthetically. In diminutive forests, the lower portions of the trunks should be bare. Good bonsai specimens are usually hardy species that can be kept outdoors the year round wherever winters are mild. They can be brought into the house occasionally for appreciation and enjoyment. In Japan they are customarily displayed in an alcove or on small tables in a living room and later returned to their outdoor bonsai stands. The selection of the appropriate container in which to cultivate a bonsai is an essential element of the art. Bonsai pots are usually earthenware, with or without a colourful exterior glaze. They may be round, oval, square, rectangular, octagonal, or lobed and have one or more drainage holes in the bottom. Containers are carefully chosen to harmonize in colour and proportion with the tree. If the container is rectangular or oval, the tree is planted not quite halfway between the midpoint and one side, according to the spread of the branches. In a square or round container, the tree is placed slightly off centre, except for cascade types, which are planted toward the opposite side of the container from which they overhang. Bonsai are trained to have a front, or viewing side, oriented toward the observer when on exhibit.

Contd P/3

SECTION – B

There are **FOUR** questions in this section. Answer **Q. No. 5** and any **TWO** from the rest.

5. Read the passage below carefully and answer the questions that follow: **(45)**

The power of the wind has been used for centuries to directly drive various machines to perform such tasks as grinding wheat or pumping water. Recently, however, the wind has joined other natural forces such as water and steam as a viable method of generating electricity. Traditional means of electricity generation using coal or oil-fuelled plants have two major drawbacks; they pollute the environment and the fuels they use are inefficient and non-renewable. In response to growing environmental awareness there have been calls for a greener alternative. Nuclear power, while more efficient and less polluting, is seen by many people as unacceptable, because of the danger of accidents such as those that happened at Chernobyl or Three Mile Island. Wind power, however, is clean, renewable and, with modern advances, surprisingly efficient.

In the 1970s Britain was in the forefront of research into wind power. The interest in wind diminished in the 1980s due to cheap North Sea oil, a strong pro-nuclear lobby and pricing structures that made it uneconomical to set up wind farms. Britain, the windiest country in Europe, had to wait until 1991 for its first wind farm. Located at Delabole in Cornwall, the farm was originally the idea of locals who opposed the construction of a nuclear plant nearby and decided to set up a private company to generate power for the area using the wind. They had to fight opposition from local government and other local residents, who thought the turbines would be noisy and might interfere with television signals, but eventually, after showing local officials working wind farms in Denmark, they won and now there are 10 huge white wind turbines on the Delabole hills.

It is in Germany and Denmark that the greatest advances in wind power have come. Germany alone produces half of the wind generated electricity in Europe every year. Germany adds 400 Megawatts (Mw) of capacity. In 2000 alone capacity expanded by 1669 Mw. Denmark now produces 30% of its electricity from wind power and this predicted to rise to 50% by 2010. Both countries have encouraged this growth by "fixed feed tariffs" which guarantee a good price for private wind power operates.

The use of wind power is far less advanced in the USA. Only 5% of America's power comes from the wind, although it is estimated that this could be increased to as high as 12% with no changes to the power grid. However, there is an increased interest in wind power. There are plans to build a huge offshore wind farm off the coast of Cape Cod on the North East seaboard. The farm will take up over 25 square miles, have 170 turbines and produce 420Mw at a cost of $600m. If constructed, it will be the world's second biggest wind farm, after the 520Mw farm planned in Ireland.

Contd P/4

HUM 123/MME

Contd... Q. No. 5

Questions:

(a) Compare nuclear and wind power.

(b) Why did the residents in Cornwall oppose wind power?

(c) How did Germany and Denmark promote the use of wind power?

(d) Comment on America's use of wind power.

(e) Give an appropriate title to the passage and justify it.

(f) Give the meanings of the following words as used in the passage:

Steam, renewable, offshore, predicted, uneconomical, diminished

6. (a) Discuss the key features of business communication. **(10)**

(b) Dhaka South City Corporation has decided to build an old home for the poor aged people. As the Managing Director of Square Pharmaceuticals, write a goodwill letter to the Mayor of Dhaka City Corporation offering your company's help. (Full Block) **(10)**

(c) Write phonetic transactions of any five of the following words: **(10)**

Sing, thank, wealthy, that, seed, she

7. (a) Briefly discuss the components of a paragraph. **(10)**

(b) Write a composition on any one of the following: **(10)**

(i) The Causes of Depression

(ii) Digital Wellbeing

(iii) Ensuring Social Equity

(c) Write a dialogue between you and your friend on Importance of Science Education. **(10)**

8. (a) Transform any five of the following sentences as directed: **(10)**

(i) I never drink tea. (make it interrogative)

(ii) When it was raining, he woke up. (make it simple)

(iii) Being honest, Jamil could not tell a lie. (make it compound)

(iv) The man took a cabin and it was small. (make it comlex)

(v) The rose is the finest of all flowers. (make it positive)

(vi) the sun had set and we returned home. (make it simple)

(b) Discuss the routine reports in brief. **(5)**

(c) Write short notes on any three of the following: **(15)**

(i) Abstract and summary

(ii) Thesis statement

(iii) Cohesiveness and coherence

(iv) Vowel and consonant sounds.

L-1/T-1/MME **Date: 19/05/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2020-2021

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

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

1. (a) Define equipotential line and equipotential surface. Draw electric field lines and cross sections of equipotential surface for i) the field due to a point charge, and ii) the field due to an electric dipole. **(7)**

(b) Consider a circular plastic disk of radius R that has a positive surface charge of uniform density σ on its upper surface. Calculate the electric field at a point *P*, which is at a distance z from the disk along its central axis. Explain the condition when (i) $R \rightarrow \infty$ and z is finite and (ii) $z \rightarrow 0$ and R is finite, respectively. **(20)**

(c) At what distance the magnitude of the electric field along the central perpendicular axis of a uniformly charged plastic disk of radius 0.750 m is equal to one-half of the magnitude of the field at the center of the surface of the disk? **(8)**

2. (a) Define magnetic field and hence show that the force $\overrightarrow{F_B}$ on a moving particle is given by $\overrightarrow{F_B} = q\vec{v} \times \vec{B}$, where the terms have their usual meaning. **(7)**

(b) Consider a write of arbitrary shape carrying current i. State and explain the Biot-Savart law by which you can measure the magnetic field $\vec{B}$ at a nearby point. Use this law to derive an equation for the magnitude of the magnetic field at a perpendicular distance *R* from a long (infinite) straight wire carrying current i. **(18)**

(c) Figure for Q. No. 2 (c) shows two long parallel wires carrying currents i_1 and i_2 in opposite directions. Calculate the magnitude and direction of the net magnetic field at point P. Assume the following values: $i_1 = 20$ A, $i_2 = = 30$ A, and $d = 4.5$ cm. **(10)**

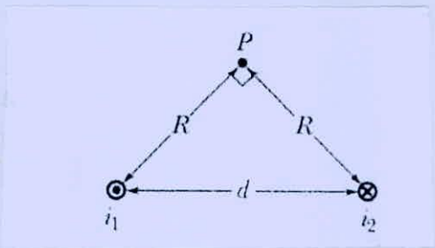

Fig. for Q. No. 2 (c)

Contd P/2

PHY 125

3. (a) Define capacitance of a capacitor. Derive an expression for the capacitance of a cylindrical capacitor using Gauss law. **(10)**

(b) Consider an *RC* series circuit consisting of a capacitor of capacitance *C*, an ideal battery of emf ξ, and a resistor of resistance *R*. When the capacitor is fully charged, the battery is disconnected and discharged through the resistor. Draw a circuit diagram to describe the discharging of the capacitor and hence show that the equations of charge, q(*t*) and current, i(*t*) at any instant of discharging time *t* are given by $q(t) = q_0 e^{-t/RC}$ and $i(t) = -\left(\frac{q_0}{RC}\right)e^{-t/RC}$, respectively. Draw the current vs time curve for charging and discharging of the capacitor. **(20)**

(c) A capacitor with initial charge q_0 is discharged through a resistor. What multiple of the time constant τ the capacitor takes to lose the first one-third of its charge? **(5)**

4. (a) Distinguish between simple harmonic and forced harmonic oscillations. **(5)**

(b) A particle executing damped harmonic motion is subjected to an external periodic force. Establish the differential equation for the motion of the particle and solve it to obtain the expression for its maximum amplitude and discuss the sharpness of resonance. **(22)**

(c) A damped harmonic oscillator having a mass of 250 g. The force constant is 85 N/m and the damping coefficient is 70 g/s. **(8)**

(i) What is the period of the motion?

(ii) How long does it take for the amplitude of the damped oscillations to drop to half of its initial value?

SECTION – B

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

5. (a) Discuss the characteristics of simple harmonic motion. Show that the motion of a torsion pendulum is simple harmonic. **(10)**

(b) Show that the total mechanical energy remains conserved for a body executing simple harmonic motion. **(15)**

(c) An oscillating mass-spring system has a mechanical (total) energy of 2 joule, amplitude of 0.2 m and maximum speed of 2 m/s. Find (i) the force constant of the spring, (ii) the mass, and (iii) the frequency of oscillation. **(10)**

Contd P/3

PHY 125

6. (a) Distinguish between progressive and standing waves. **(7)**

(b) Show that no energy is transferred across any section of the medium in the case of a stationary wave. **(20)**

(c) A plane progressive harmonic wave is traveling with a velocity of 340 m/s in a fluid medium of density 0.0012 g/cc. If the amplitude of the wave be 10^4 cm and its frequency 300 cycles obtain the values of the energy density and energy current. **(8)**

7. (a) Distinguish between constructive and destructive interference of lights. **(7)**

(b) Draw an optical schematic diagram of Newton's rings experiment. Why do you use monochromatic source instead of white light in this experiment? How can you determine the refractive index of a liquid using newton's rings experiment? **(20)**

(c) In a Newton's rings experiment, the diameter of the 15^{th} rings was found 0.59 cm and that of the 5^{th} ring was 0.33 cm. If the radius of the plano-convex lens is 100 cm, calculate the wavelength of light used. **(8)**

8. (a) Write down the intensity distribution function of the Fraunhofer diffraction due to double slits and explain each of the terms. Why analyzer is used to identify polarized light? Explain – Malus' law. **(18)**

(b) Find the equivalent focal length of two thin co-axial lenses separated by a finite distance. **(10)**

(c) Write a short note on 'chromatic aberration'. **(7)**

L-1/T-1/MME **Date : 28/05/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 155** (Electrical Engineering Fundamentals)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

All the symbols have their usual meanings.

Assume reasonable values for missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Determine v_0 in the circuit of Fig. for Q. No. 1(a). (17)

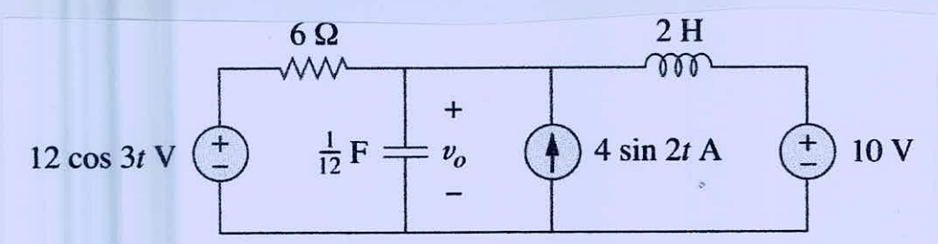

Fig. for Q. No. 1(a)

(b) Find V_0 for the circuit shown in Fig. for Q. No. 1(b). Also calculate the complex power of the independent source. (18)

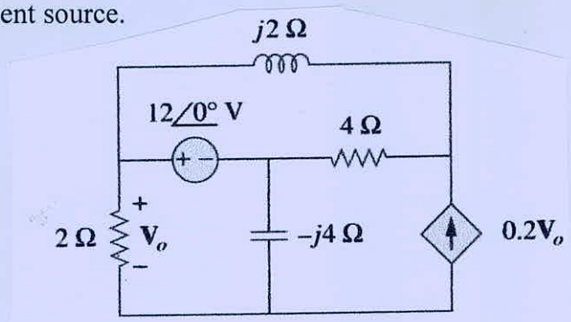

Fig. for Q. No. 1(b)

2. (a) A 220 V 50 Hz source is supplying two loads connected in parallel as shown in Fig. for Q. No. 2(a). If a 460 μF capacitor is connected in parallel, the overall power factor improves from 0.6 (lagging) to 0.8 (lagging). Determine the Real and Reactive Power of the second Load. (17)

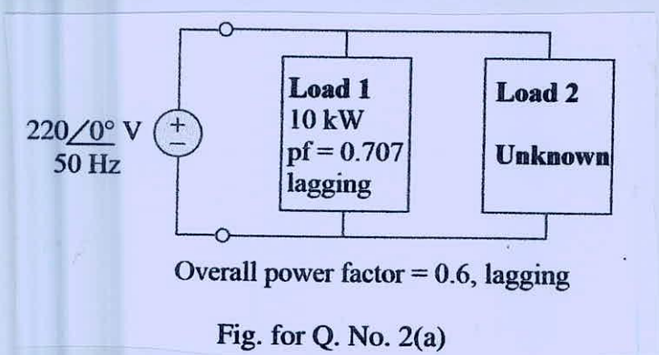

Fig. for Q. No. 2(a)

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EEE 155/MME

Contd ... Q. No. 2

(b) Find the Thevenin Equivalent at the terminal a-b of the circuit shown in Fig. for Q. No. 2(b). Calculate the purely resistive load at which maximum power transfer occurs. Determine this power. (18)

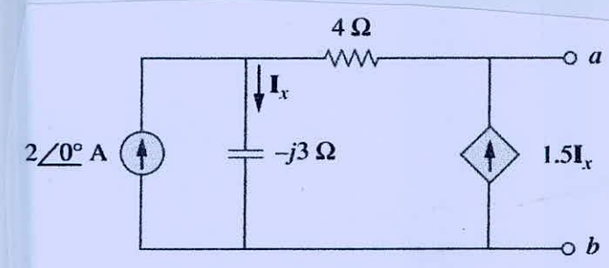
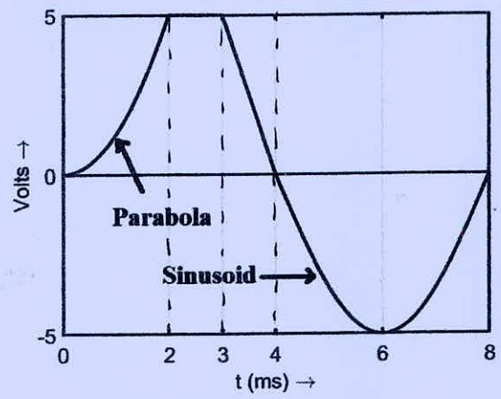


Fig. for Q. No. 2(b)

3. (a) Find the following parameters for the periodic signal shown in Fig. for Q. No. 3(a) – (20)

rms value, average value, form factor, peak factor



One complete period is shown

Fig. for Q. No. 3(a)

(b) Draw the Bode plot (magnitude and Frequency response) of a filter with the following transfer function: (15)

$$H(\omega) = \frac{10^3 j}{(1 + 10^3 j)}$$

Comment on the type of the filter.

4. (a) Derive the expression for the cutoff frequencies of a series RLC resonant circuit. From that, show (20)

$$BW = \frac{f_s}{Q_s}$$

Where the symbols have typical meaning.

Contd P/3

EEE 155/MME

Contd ... Q. No. 4

(b) A series R-L-C circuit is designed to resonant at $\omega_s = 10^5$ rad/s, have a bandwidth of 1.5 ω_s, and draw 16 W from a 120 V source at resonance. (15)

(i) Determine the value of R.

(ii) Find the bandwidth in hertz.

(iii) Find the nameplate values of L and C.

(iv) Determine the Qs of the circuit.

SECTION – B

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

5. (a) Determine the equivalent resistance R_{ab} at terminals a-b for the circuit shown in Fig. for Q. 5(a). Here, all resistors have a value of 30 Ω. (17)

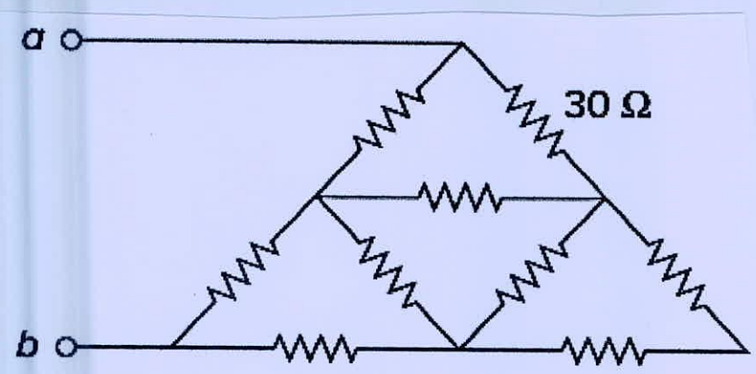


Fig. for Q. 5(a)

(b) In the circuit of Fig. for Q. 5(b), find v_1, v_2 and v_3 using nodal analysis. (18)

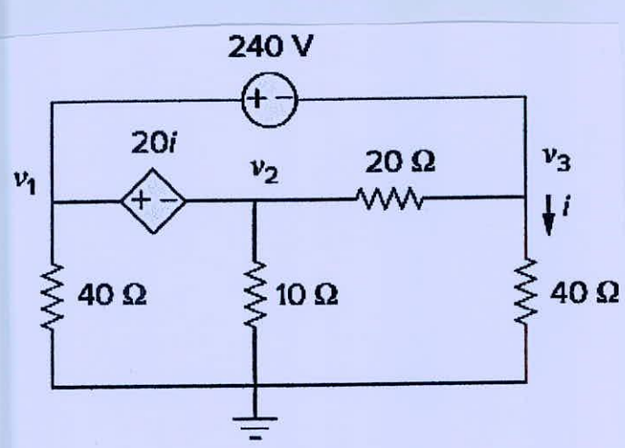


Fig. for Q. 5(b)

Contd P/4

EEE 155/MME

6. (a) The voltage across and current through a device are shown in Fig. for Q. 6(a). (17)

(i) Sketch the power versus t plot for $0 \leq t \leq 10$ s.

(ii) Calculate the total energy delivered to the device in the period of $0 \leq t \leq 10$ s.

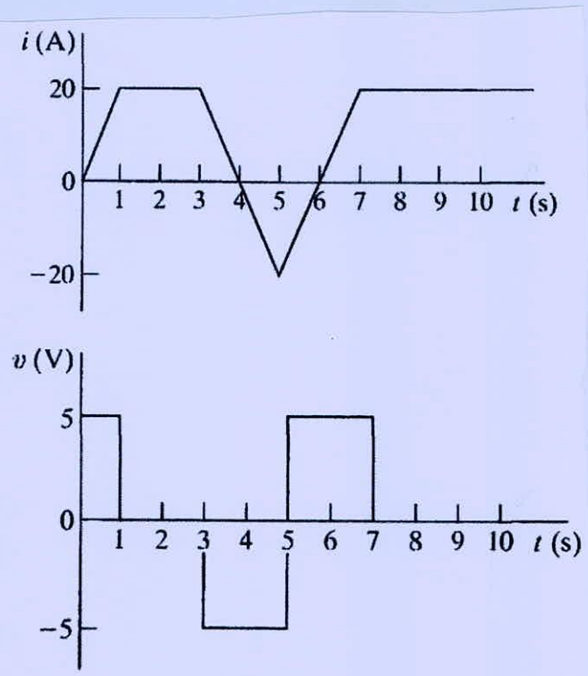


Fig. for Q. 6(a)

(b) Use a series of source transformations to find i_0 in the circuit of Fig. for Q. 6(b). (18)

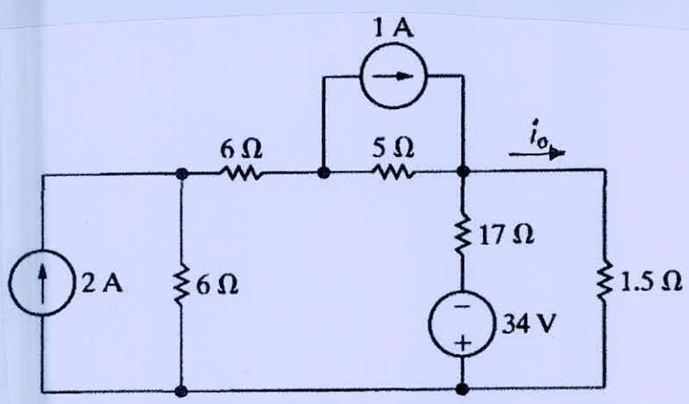


Fig. for Q. 6(b)

7. (a) Use the principle of superposition to find the voltage v in the circuit of Fig. for Q. 7(a). (17)

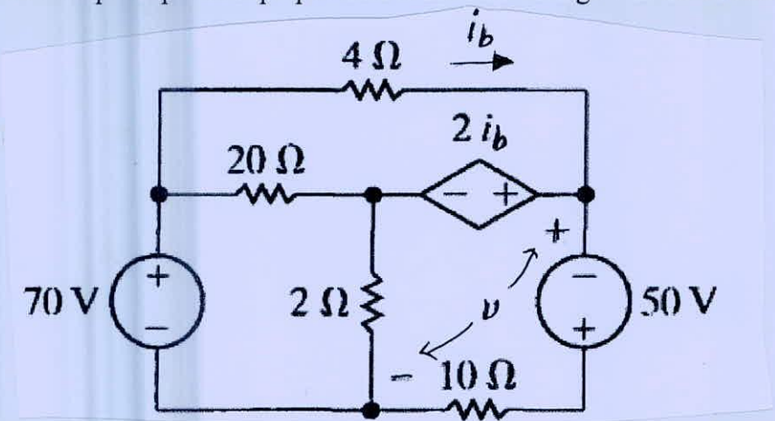


Fig. for Q. 7(a)

Contd P/5

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Contd ... Q. No. 7

(b) Obtain the Norton equivalent at terminals a-b of the circuit in Fig. for Q. 7(b). (18)

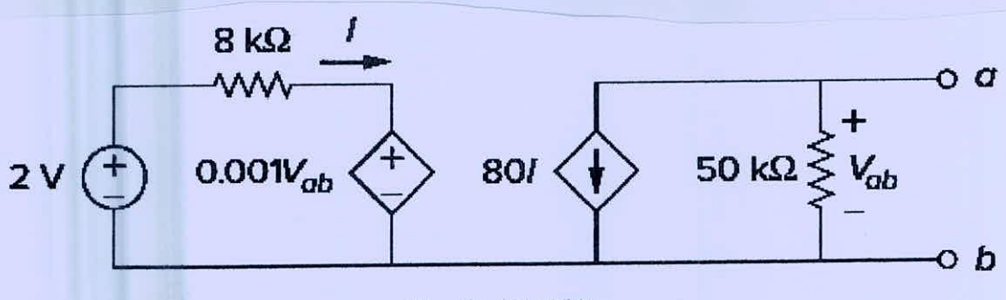


Fig. for Q. 7(b)

8. (a) Determine the value of R_L that will draw the maximum power from the rest of the circuit in Fig. for Q. 8(a). Also calculate the maximum power. (18)

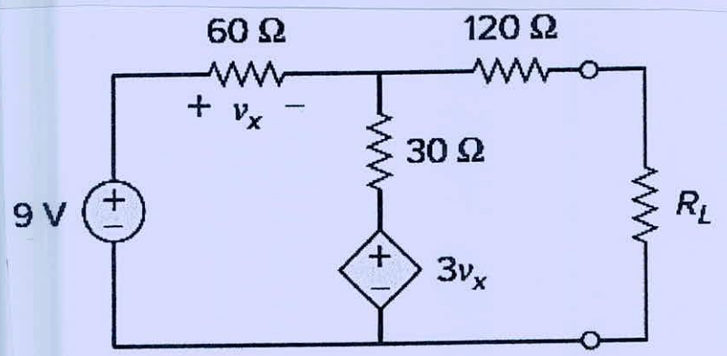
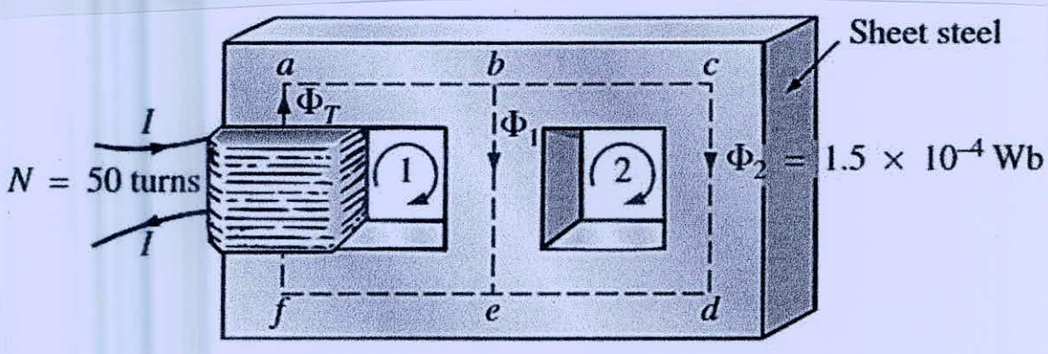


Fig. for Q. 8(a)

(b) Determine the current I required to establish a flux of 1.5×10^{-4} Wb in the section of the core indicated in Fig. for Q. 8(b). (17)



$l_{bcde} = l_{efab} = 0.2$ m
$l_{be} = 0.05$ m
Cross-sectional area $= 6 \times 10^{-4}$ m^2 throughout

Fig. for Q. 8(b)

Contd ----- P/6

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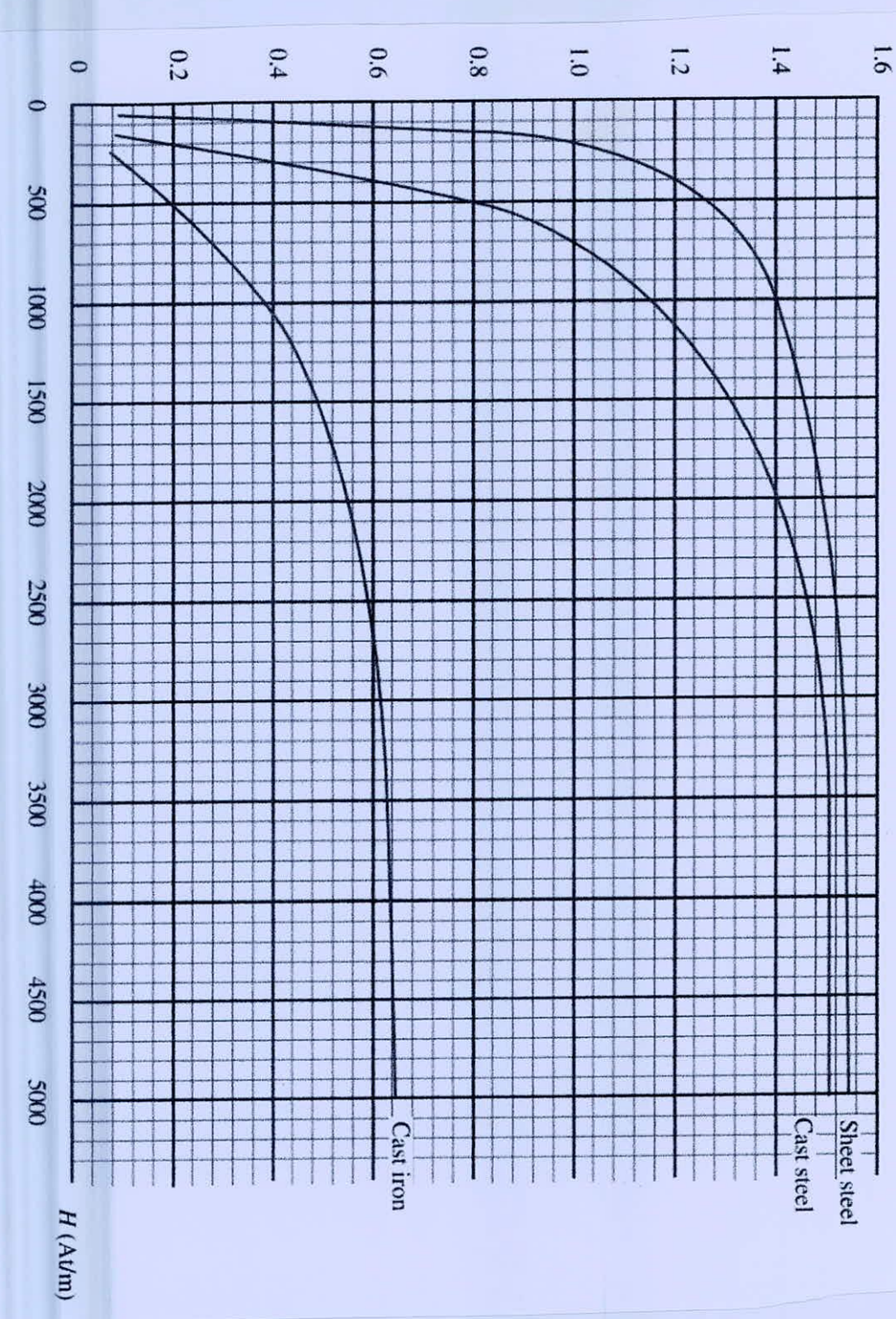
Contd ... Q. No. 8



L-1/T-1/MME **Date: 16/05/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2020-2021

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

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** questions.

1. (a) If the function $f(x)=\begin{cases} x^2+mx-3 & for\ x\le 1 \\ 3x+n & for\ x>1 \end{cases}$ is continuous and differentiable on its entire domain, then find the values of m and n. Also, plot the graph of $f(x)$ using these values. **(18)**

(b) If $y=tan^{-1}\dfrac{\sqrt{1+x^2}-1}{x}$ then find y_n. **(17)**

2. (a) State and prove Leibnitz's theorem. If $f(x)=tan\,x$ then find the value of $[f^n(0)-n_{C_2}f^{n-2}(0)+n_{C_4}f^{n-4}(0)-\cdots\ \ldots\ \ldots\ \ldots]$ using this theorem. **(18)**

(b) If H be a homogeneous function of x, y, z of degree n and if $u=\left(x^2+y^2+z^2\right)^{-\frac{1+n}{2}}$, then evaluate $\left[\dfrac{\partial}{\partial x}\left(H\dfrac{\partial u}{\partial x}\right)+\dfrac{\partial}{\partial y}\left(H\dfrac{\partial u}{\partial y}\right)+\dfrac{\partial}{\partial z}\left(H\dfrac{\partial u}{\partial z}\right)\right]$. **(17)**

3. (a) Show that the subtangent of the parabola $y^2=4bx$ at any point is divided into two by the vertex and subnormal is constant. Also, find the length of the subnormal. **(18)**

(b) Define point of inflexion with a graph. Assuming that the petrol burnt per hour in driving a motor boat varies as the cube of its velocity, show that the most economical speed going against a current of 'C' km/hour is $\dfrac{3}{2}C$ Km/hour. **(17)**

4. Evaluate the integrals:

(a) $\int\dfrac{dx}{(1-2x^2)\sqrt{1-x^2}}$, **(11)**

(b) $\int x(x-1)b^{x-2}dx$, and **(12)**

(c) $\int sin^{-1}\sqrt{\dfrac{x}{x+a}}dx$. **(12)**

Contd P/2

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SECTION – B

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

5. (a) Find a reduction formula for $I_{m,n} = \int cos^m x \cos nx \, dx$ and hence find $\int_0^{\frac{\pi}{2}} cos^3 x \cos 2x \, dx$. **(15)**

(b) Evaluate $\int_0^{\frac{\pi}{4}} ln(1+\tan\theta)\, d\theta$. **(10)**

(c) Evaluate $\int_0^{\infty} ln\left(1+\frac{1}{x}\right)\frac{dx}{1+x^2}$. **(10)**

6. (a) Find the area of a region bounded by the curve $x^{2/3} + y^{2/3} = a^{2/3}$. **(17)**

(b) Find the volume of the solid formed by the revolution of the loop of the curve $y^2(a-x) = x^2(x+a)$ about x-axis. **(18)**

7. Solve the following differential equations:

(a) $y\left[1+e^{\frac{x}{y}}\right]dx + e^{\frac{x}{y}}(y-x)\,dy = 0$. **(12)**

(b) $(y^4+2y)dx + (xy^3+2y^4-4x)dy = 0$. **(12)**

(c) $x\frac{dy}{dx} = y(1-x\tan x) + x^2(\cos x + \sec x)$. **(11)**

8. Solve the following:

(a) $(D^2-2D+1)y = e^x + \sin 2x$. **(11)**

(b) $\frac{d^2y}{dx^2} + 16y = \sec 4x$. **(12)**

(c) $x^2\frac{d^2y}{dx^2} - x\frac{dy}{dx} + 2y = \cos(\ln x) + x\sin(2\ln x)$. **(12)**
