BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2014-2015

Sub : **EEE 163** (Introduction to Electrical Engineering)

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) For the circuit shown in Fig. for Q. No. 1(a) calculate the power supplied by each voltage source and current source. Also verify the fact that summation of total power supplied by each element of the circuit is zero. **(17)**

   (b) Find the equivalent resistance between terminal 'a' and 'b' in the circuit shown in Fig. for Q. No. 1(b). **(18)**

2. (a) In the circuit shown in Fig. for Q. No. 2(a), find all node voltages and current, I_0 using nodal analysis. **(18)**

   (b) Find I_0 and V_0 using mesh analysis for the circuit shown in Fig. for Q. No. 2(b). **(17)**

3. (a) Find the Thevenin equivalent of the circuit shown in Fig. for Q. NO. 3(a) at terminal 'ab'. **(17)**

   (b) In an experiment, the circuit shown in Fig. for Q. No. 3(b) was used to find the value of unknown resistance, R. The load resistance, R_L was varied and corresponding power dissipation in that resistor was measured. At $R_L = 25 \ \Omega$, maximum power dissipation of 16 W was found in that resistor. What was the value of R? **(18)**

4. (a) Find v_0 using superposition theorem for the circuit shown in Fig. for Q. No. 4(a). **(15)**

   (b) Determine the value of current, I_s required to establish a flux of 5×10^{-5} wb in the cast iron core shown in Fig. for Q. No. 4(b). **(20)**

   (Use magnetic circuit into equivalent electrical one).

SECTION – B

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

5. (a) Assume that a current $i = I_m \sin \omega t$ flows through a series RC circuit. Derive the expressions for applied voltage (V), total impedance (Z), instantaneous power (p), real power (P), reactive power (Q) and apparent power (S). Also draw the wave shape for power. **(20)**

EEE 163 (CSE)

Contd ... Q. No. 5

(b) Find out the power factor of the circuit shown in Fig. for Q. 5(b). To what value must
be 10 μF capacitor be changed to result in the overall power factor 0.95 lagging? **(15)**
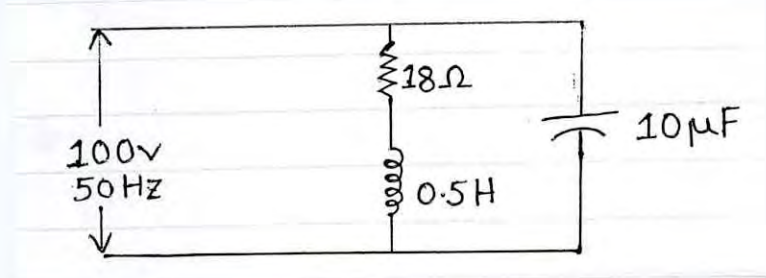

Fig. for Q.5(b)

6. (a) What is Phasor? Draw the complete phasor diagram of the circuit shown in Fig. for
Q. 6(a) showing the current and the voltage drop across each resistance or reactance with
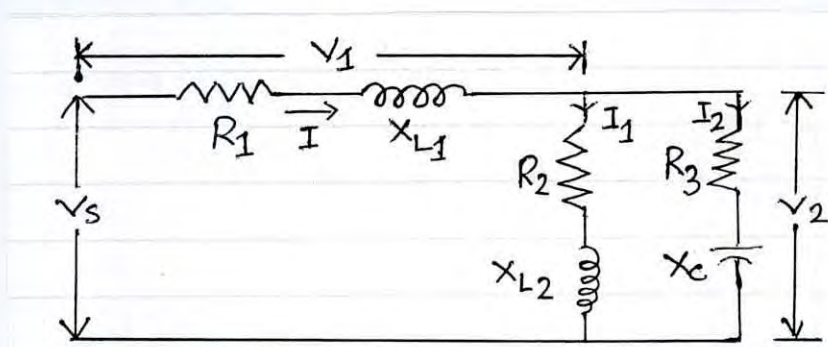V_2 as reference. **(15)**

Fig. for Q 6 (a)

(b) Find the r.m.s. value of the voltage having the wave shape as shown in Fig. for Q. 6(b). **(20)**
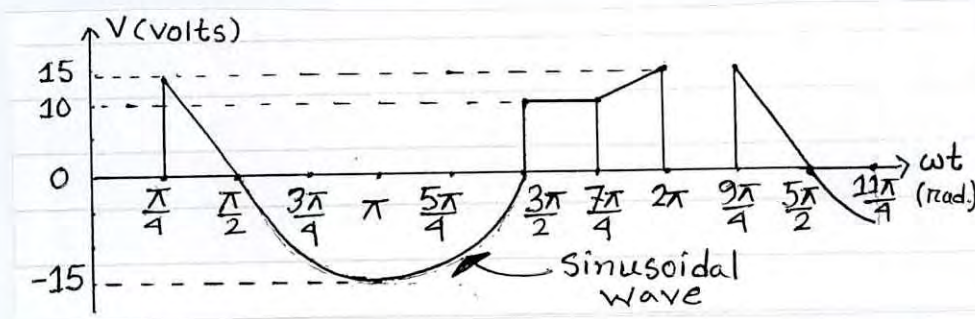

Fig. for Q 6 (b)

7. (a) In an AC circuit, show that the maximum average power is transferred to the load
when the load impedance Z_L equals to the complex conjugate of the Thevenin impedance
Z_{Th}. Also find the maximum average power P_{max} at this condition. **(15)**

EEE 163 (CSE)

Contd ... Q. No. 7

(b) Find the Norton equivalent circuit with respect to the terminals a, b for the circuit shown in Fig. for Q. 7(b). Now, for maximum average power transferred if a load (purely resistive) is connected across the terminals a and b, then what will be its value?   **(20)**
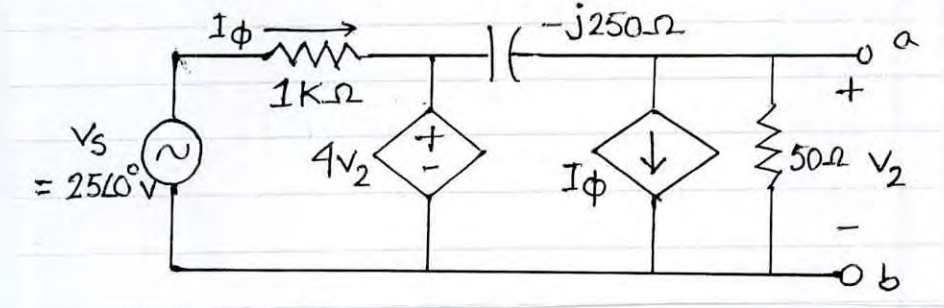

Fig. for Q 7 (b)

8. (a) A balanced abc-sequence Y-connected source with $V_{an} = 100\angle10°$ V is connected to a Δ-connected balanced load having $(8 + j4)$ Ω impedance per phase. Calculate the phase and line voltages, phase and line currents, total three phase apparent power, real power and reactive power. The circuit diagram is shown in the Fig. for Q. 8(a).   **(15)**
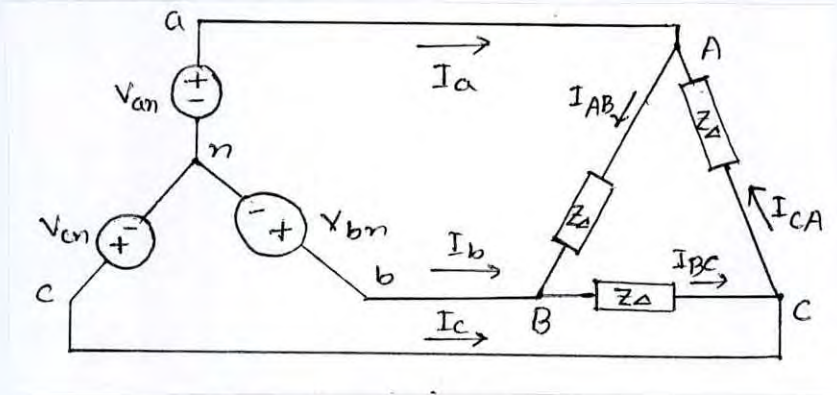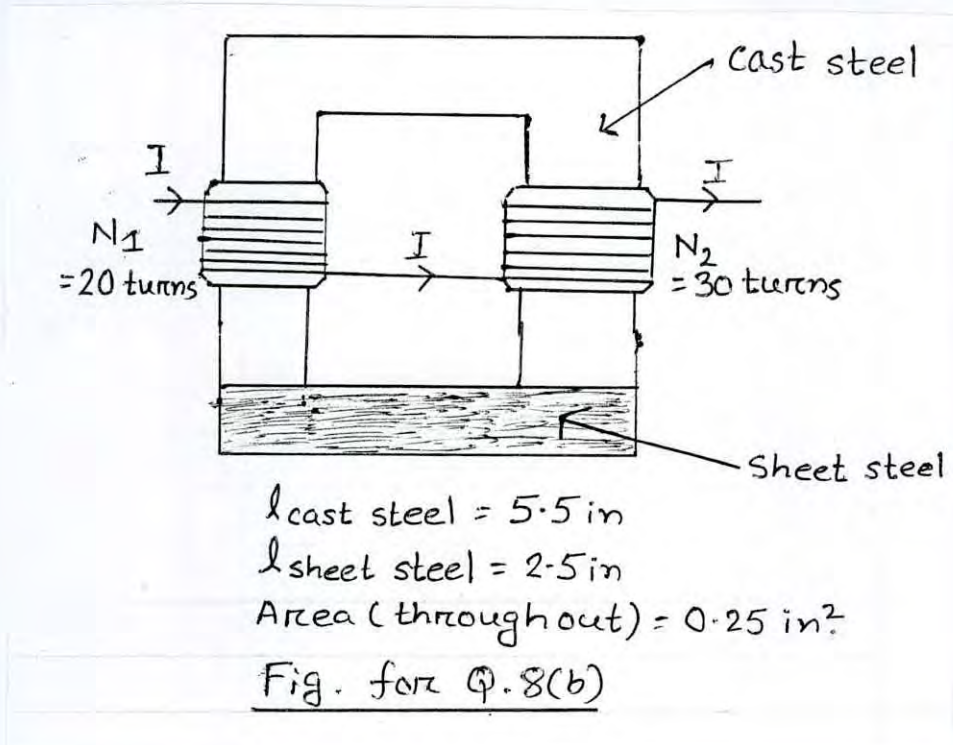

Fig. for Q. 8 (a)

(b) Find the current I necessary to establish a flux of $\phi = 0.8 \times 10^{-4}$ wb in the series magnetic circuit shown in Fig. for Q. 8(b). Also find the permeability of each material.   **(20)**
(Use B-H curve attached)

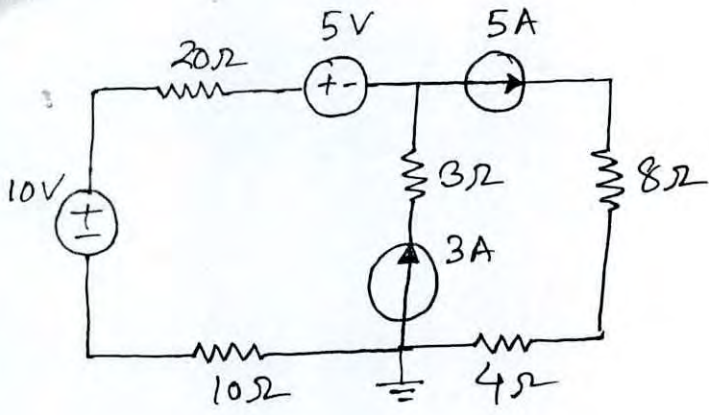

ℓ cast steel = 5·5 in
ℓ sheet steel = 2·5 in
Area (throughout) = 0·25 in²

Fig. for Q. 8(b)

P. T. O

Fig. for Q. No. 1(a)

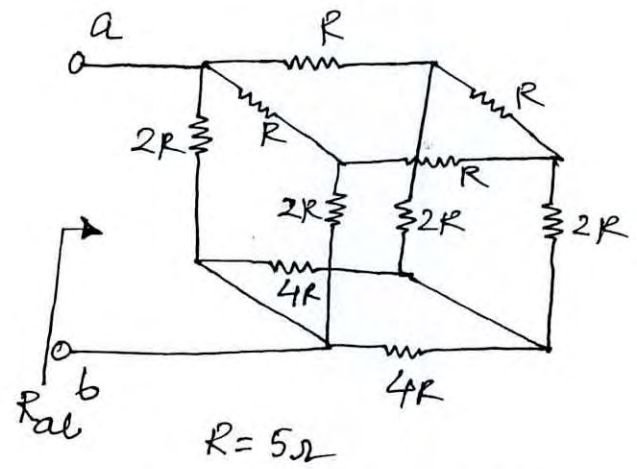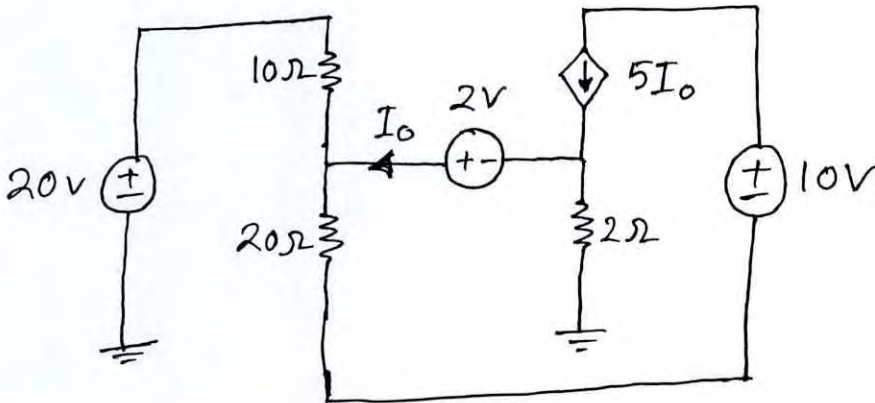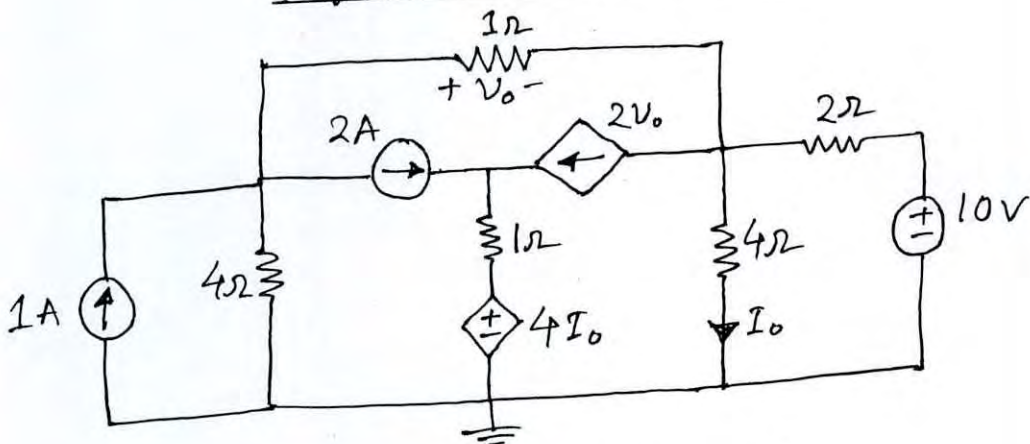$R = 5\Omega$

Fig. for Q. No. 1(b)

Fig. for Q. No. 2(a)

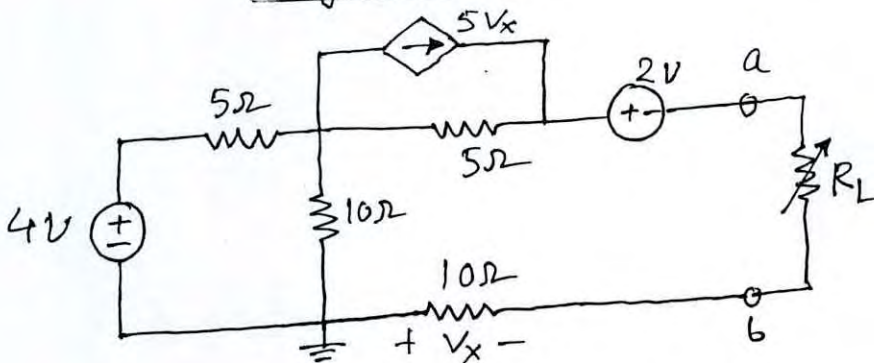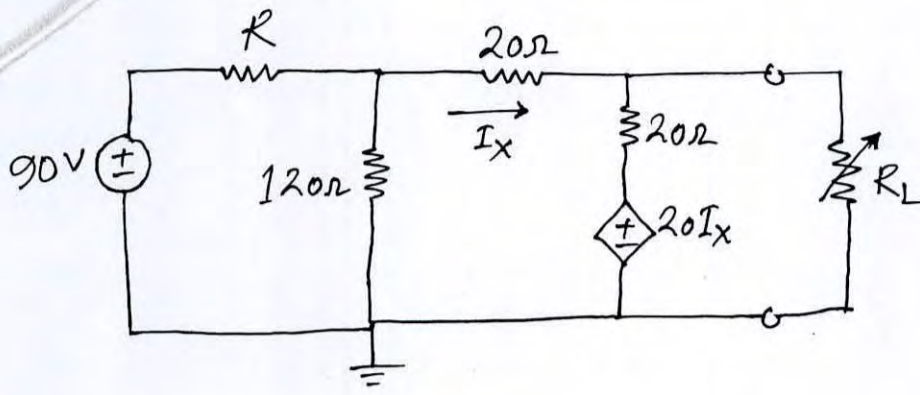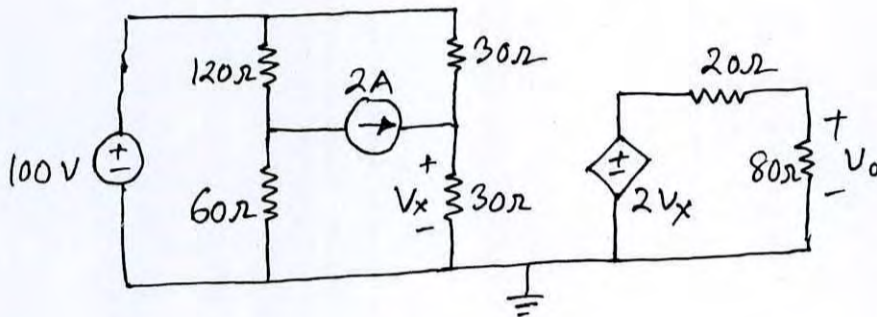Fig. for. Q. No. 2(b)

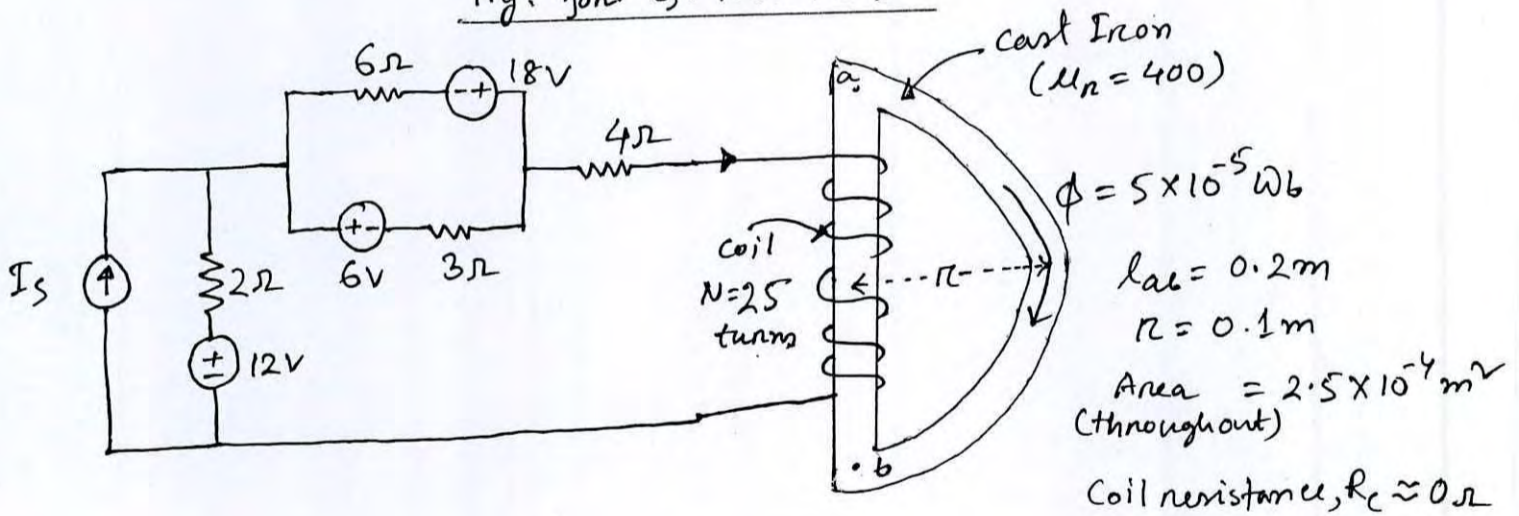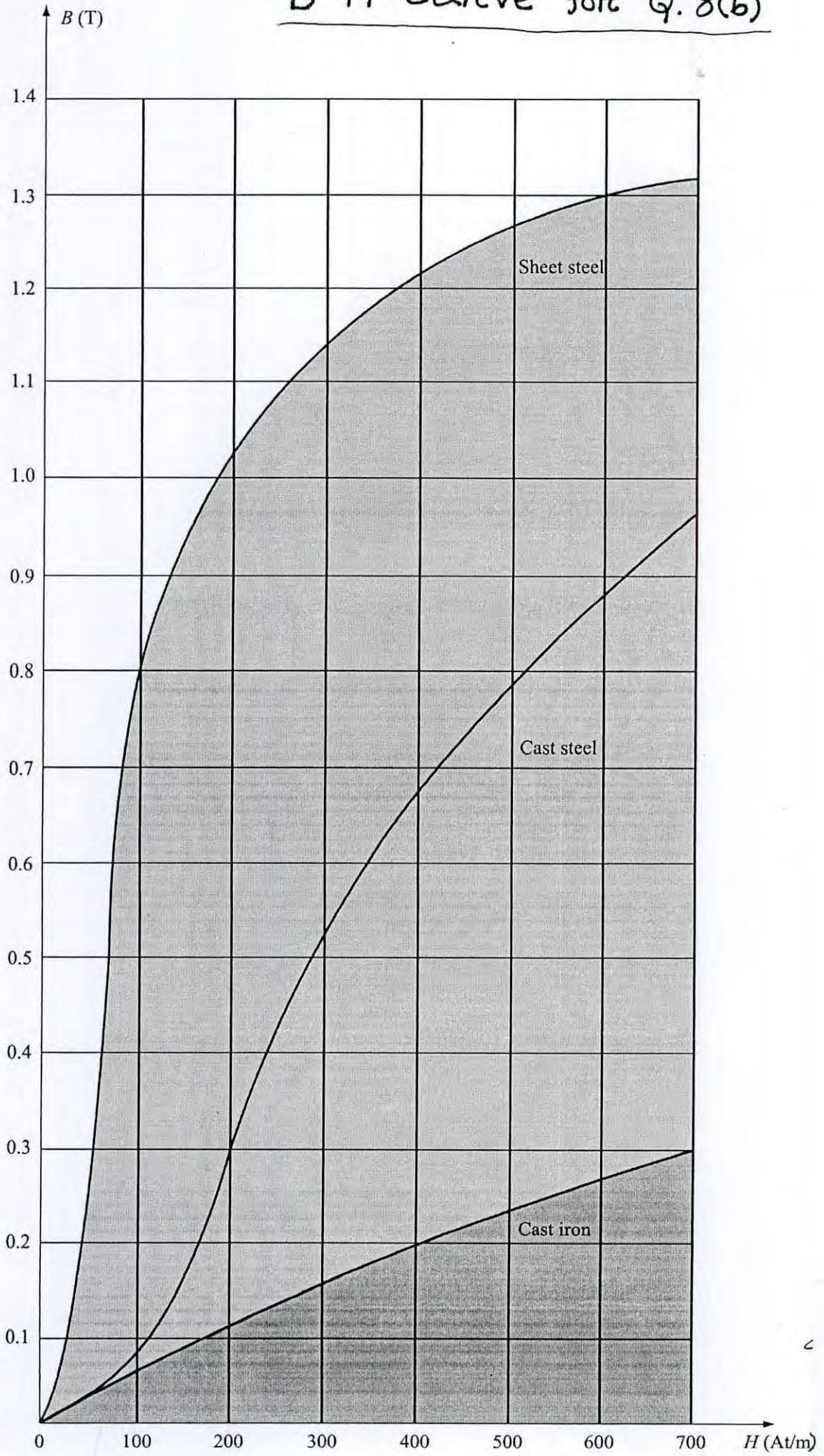Fig. for. Q. No. 3(a)

Fig. for. Q. No. 3(b)

Fig. for Q. No. 4(a)

Fig. for. Q. No. 4(b)

cast Iron
$(\mu_n = 400)$

$\phi = 5 \times 10^{-5} \, Wb$

$l_{ab} = 0.2 \, m$

$r = 0.1 \, m$

Area $= 2.5 \times 10^{-4} \, m^2$
(throughout)

Coil resistance, $R_c \approx 0 \, \Omega$

P.T.O

B-H Curve for Q.8(b)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2014-2015

Sub : **MATH 141** (Differential Calculus and Co-ordinate Geometry)

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) A function f(x) defined as follows: **(12)**

$$f(x) = \begin{cases} 1 & ; \quad -\infty < x < 0 \\ 1 + \sin x & ; \quad 0 \le x < \pi/2 \\ 2 + (x - \pi/2)^2 & ; \quad \pi/2 \le x < \infty \end{cases}$$

Discuss the continuity and differentiability of f(x) at x = 0 and x = $\frac{\pi}{2}$.

(b) Evaluate: (i) $\displaystyle\lim_{x \to \pi} \left(\frac{2\pi}{x} - 1 \right)^{\tan(x/2)}$ (ii) $\displaystyle\lim_{x \to 0} \cot x \log \frac{1-x}{1+x}$.   **(6+6=12)**

(c) Use Leibinitz's theorem to find y_n (x) at x = 0 both for even and odd n, where   **(11)**

$$y = \left(x + \sqrt{1 + x^2} \right)^m$$

2. (a) State Euler's theorem for homogeneous functions of two variables of degree n.   **(11)**

If $u = \sin^{-1} \dfrac{x + y}{\sqrt{x} + \sqrt{y}}$, show that $x \dfrac{\partial u}{\partial x} + y \dfrac{\partial u}{\partial y} = \dfrac{1}{2} \tan u$.

(b) Expand y = log secx in a series of ascending powers of x up to the sixth power of x inclusive.   **(12)**

(c) State Mean value theorem. If $f(x + h) = f(x) + hf'(x) + \dfrac{h^2}{2!} f''(x + \theta h); \quad 0 < \theta < 1$.

Find the value of θ for x = a, when $f(x) = (x - a)^{5/2}$.   **(12)**

3. (a) If $u = f(x^2 + 2yz, y^2 + 2zx)$, find the value of   **(12)**

$$\left(y^2 - zx \right) \frac{\partial u}{\partial x} + \left(x^2 - yz \right) \frac{\partial u}{\partial y} + \left(z^2 - xy \right) \frac{\partial u}{\partial z}$$

(b) In the curve, $x = \dfrac{y^2 - a^2}{4a} - \dfrac{a}{2} \log \dfrac{y}{a}$, show that the difference between the lengths of

the tangent and the sub-tangent is constant.   **(12)**

(c) Find the volume of the greatest cylinder that can be inscribed in a right circular cone

of height h and semi-vertical angle α.   **(11)**

MATH 141 (CSE)

4. (a) If (α, β) be the co-ordinates of the centre of curvature of the curve $\sqrt{x} + \sqrt{y} = \sqrt{a}$
at (x, y), show that $\alpha + \beta = 3(x + y)$. **(11)**

(b) Show that the pedal equation of the curve $r^m = a^m \sin m\theta + b^m \cos m\theta$ is **(12)**

$$r^{m+1} = p\sqrt{a^{2m} + b^{2m}}$$

(c) Find all the asymptotes of the following curve **(12)**

$$x^3 - x^2y - xy^2 + y^3 + 2x^2 - 4y^2 + 2xy + x + y + 1 = 0$$

SECTION – B

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

5. (a) Transform the equation $9x^2 + 15xy + y^2 + 12x - 11y - 15 = 0$ in rectangular
coordinates using suitable translation and rotation of axes so as to remove the terms in
x, y and xy. Then identify the conic. **(17)**

(b) Show that the equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ represents a pair parallel

straight lines if $\dfrac{a}{h} = \dfrac{h}{b} = \dfrac{g}{f}$ and also that the distance between the parallel lines is

$$2\sqrt{\dfrac{g^2 - ac}{a(a + b)}}.$$ **(18)**

6. (a) Prove that the equation $(ax + by)(\alpha x + \beta y) + kxy - (a + \alpha)x - (b + \beta)y + 1 = 0$
represents a pair of straight lines, if $k = (a - \alpha)(b - \beta)$. Find their point of intersection. **(18)**

(b) Find the equation of the circle whose diameter is the chord cut off on the line $3x + 2y = 6$
by the circle $x^2 + y^2 = 16$. **(17)**

7. (a) Find the equation of the pair of lines joining the origin to the points of intersection of

the line $\dfrac{x}{a} + \dfrac{y}{b} = 1$ and the circle $x^2 + y^2 = c^2$ and deduce that if the line is tangent to the

circle then $\dfrac{1}{a^2} + \dfrac{1}{b^2} = \dfrac{1}{c^2}$. **(17)**

(b) Find the coordinates of the limiting points of the system of circles co-axial with the
circles $x^2 + y^2 - 2x + 8y + 11 = 0$ and $x^2 + y^2 + 4x + 2y + 5 = 0$. **(18)**

8. (a) A tangent to the parabola $y^2 = 4a(x + a)$ is at right angle to a tangent to the parabola
$y^2 = 4a'(x + a')$. Prove that these tangents meet on the line $x + a + a' = 0$, which is the
common chord of the parabola. **(17)**

(b) Tangents are drawn to the hyperbola $4x^2 - y^2 = 4a^2$. Prove that the poles of these
tangents with respect to the parabola $y^2 = 4bx$ lie on the circle $x^2 + y^2 = a^2$. **(18)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2014-2015

Sub : **PHY 109** (Heat and Thermodynamics, Structure of Matter,

Waves and Oscillations and Physical Optics)

Full Marks : 280   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) Distinguish between crystalline and amorphous solids. Among them which one is more stable and why? Explain allotropy with some examples. What is graphene? **(13)**

   (b) What are the lattice parameters of a 3D unit cell? Mention lattice parameters of hexagonal crystal system. Give some examples of hexagonal crystal. Draw a typical 3D unit cell for hexagonal crystal and calculate number of atoms per unit cell and coordination number. Show that for an ideal hexagonal crystal c/a ratio is 1.63, where the symbols have their usual meanings. **(20)**

   (c) Derive the relationship between unit cell edge length and atomic radius for face-centered cubic and body-centered cubic crystal structures. **($13\frac{2}{3}$)**

2. (a) Why the interatomic or intermolecular bonds exist in solids? Briefly describe various types of bonds in solids. **(12)**

   (b) Draw a schematic diagram of an X-ray diffractometer. Deduce Bragg's law. Draw a typical X-ray diffraction pattern for body centered cubic polycrystalline iron with their Miller indices. **(20)**

   (c) Calculate number of atoms per unit cell in various space lattice of cubic crystal system. Provide necessary diagrams. **(7)**

   (d) Describe briefly various types of defects that exist in solids. **($7\frac{2}{3}$)**

3. (a) Define mean free path. Find an expression of mean free path for gaseous molecules. **(16)**

   (b) Using Maxwell's distribution function find an expression of root mean square speed for gaseous molecules. **($18\frac{2}{3}$)**

   (c) Given that the effective diameter of oxygen molecule is $d = 3.15 \times 10^{-10}$ m. Calculate (i) the mean free path, (ii) the average speed, and (iii) the average collision rate for oxygen at room temperature (27°C) and a atmospheric pressure. **(12)**

PHY 109/CSE

4. (a) State second law of thermodynamics as many ways as you can. **(8)**

    (b) Define efficiency of a heat engine. Describe each step of Carnot cycle and hence show that efficiency of Carnot engine is $\eta = 1 - \dfrac{T_2}{T_1}$, where the symbols have their usual meanings. **(26)**

    (c) In a Carnot cycle, the isothermal expansion of an ideal gas takes place at 412K and isothermal compression at 297K. During the expansion, 2090J of heat energy are transferred to the gas. Determine (i) the work performed by the gas during the isothermal expansion, (ii) the heat rejected from the gas during the isothermal compression, and (iii) the work done on the gas during the isothermal compression. **(12⅔)**

SECTION – B

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

5. (a) Show with a neat diagram how coherent sources are produced in Newton's rings experiment. Prove that in reflected light (i) diameters of the dark rings are proportional to the square roots of the natural numbers, and (ii) diameters of the bright rings are proportional to the square roots of odd natural numbers. **(26⅔)**

    (b) Why the central spot in Newton's rings due to reflected light is dark? **(8)**

    (c) Interference fringes are produced by a Fresnel bi-prism in the focal plane of a reading microscope which is 100 cm from the slit. A lens introduced between the biprism and the microscope gives two images of the slit in two positions. If the distance between the images of the slits are 4.05 mm in one position, 2.90 mm in the other position and the wavelength of sodium light is 589.3 nm, find the distance between the consecutive interference bands. **(12)**

6. (a) Define optic axis, principal section and half-waveplate. **(12)**

    (b) What do you mean by diffraction grating? Describe in detail how would you use a transmission grating to determine the wavelength of light. **(26⅔)**

    (c) The polarizing angle of a piece of glass for green light is 59°14'14". What is the angle of minimum deviation for a 60° prism made of the same glass? **(8)**

7. (a) What is time period? Show that for a body vibrating simple harmonically the time period is given by, $T = 2\pi \sqrt{\text{displacement/acceleration}}$. **(12)**

    (b) What are Lissajous' figures? Derive the general expression for the resultant vibration of a particle simultaneously acted upon by two initially perpendicular simple harmonic vibrations having the same time period but different amplitudes and phase angles. What happens if the phase difference is (i) $\dfrac{\pi}{2}$ and (ii) π radians? **(24⅔)**

PHY 109/CSE

Contd ... Q. No. 7

(c) Two simple harmonic motions acting simultaneously on a particle are given by, $y_1 = \sin\left(\omega t + \pi/3\right)$ and $y_2 = 2\sin\omega t$. Find the equation of the resultant vibrations. **(10)**

8. (a) What is wave? Deduce the differential equation of wave motion. **(12)**

(b) In the case of longitudinal waves in solids, establish the relation $v = \sqrt{Y/\rho}$, where the symbols have their usual meaning. **(24⅔)**

(c) Consider the forced oscillation of a damped block-spring system. Show that at resonance (i) the amplitude of oscillation is $x_m = F_m/b_\omega$ and (ii) the maximum speed of the oscillating block is $v_m = F_m/b$. **(10)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2014-2015

Sub : **ME 165** (Basic Mechanical Engineering)

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) Determine the tension in the cables in order to support the 100-kg crate in the equilibrium position shown in the Figure for Q. 1(a).   **(15)**

   (b) Three control rods attached to a lever *ABC* exert on it the forces shown in the Figure for Q. 1(b). (a) Replace the three forces with an equilibrium force-couple system at *B*. (b) Determine the single force that is equivalent to the force-couple system obtained in part a, and specify its point of application on the lever.   **(20)**

2. (a) A T-shaped bracket supports a 300-N load as shown in the Figure for Q 2(a). Determine the reactions at *A* and *C* when $\alpha = 45°$.   **(15)**

   (b) Determine the forces in members *CF*, *CD* and *GF* of the truss shown in the Figure for Q. 2(b). Indicate whether the members are in tension or compression. Assume each member in pin connected.   **(20)**

3. (a) Determine the components of all forces acting on member *ABD* of the frame shown in Figure for Q. 3(a).   **(15)**

   (b) In the Figure for Q. 3(b) block *B* starts from rest and moves downward with a constant acceleration. Knowing that after slider block *A* has moved 9 in. its velocity is 6 ft/s, determine (a) the acceleration of *A* and *B*, (b) the velocity and the change in position of *B* after 2 s.   **(20)**

4. (a) The double gear shown in the Figure for Q. 4(a) rolls on the stationary left rack *R*. Knowing that the rack on the right has a constant velocity of 2 ft/s, determine (a) the angular velocity of the gear, (b) the velocities of points *A* and *D*. Use the method of the instantaneous center of rotation.   **(15)**

   (b) Rod *OA* in the Figure for Q. 4(b) rotates about *O* in a horizontal plane. The motion of the 0.5-lb collar *B* is defined by the relations $r = 10 + 6 \cos \pi t$ and $\theta = \pi(4t^2 - 8t)$, where *r* is expressed in inches, *t* in seconds, and θ in radians. Determine the radial and transverse components of the force exerted on the collar when $t = 0.5$ s.   **(20)**

ME 165/CSE

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SECTION – B

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

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5. (a) Write down the chemical formula of the following refrigerants: (any three) **(6)**

   (i) R717, (ii) R12, (iii) R112 and (iv) R290

   (b) Draw the schematic and T-s diagram of a vapor compression refrigeration cycle with multistage compression. **(14)**

   (c) A refrigerator uses refrigerant-134a as the working fluid and operates on an ideal vapor compression refrigeration cycle. The mass flow rate of the refrigerant is 0.05 kg/s, If the COP of this cycle is 4.0 and compressor work input is 0.5 kW, then determine (i) the rate of heat removal from the refrigerated space (ii) The rate of heat rejection from condenser, and (iii) if this refrigerator was used as a heat pump then what would be the COP of that heat pump. **(9)**

   (d) Define the following terms: (i) 'tonne of refrigeration' (TR) (ii) COP. **(6)**

6. (a) Write down the name of engine sub-systems and draw a schematic diagram of a carburetor. **(3+5)**

   (b) Draw an actual valve timing diagram for a 4-stroke S.I. Engine. **(10)**

   (c) Among diesel and gasoline engines which one operates at lower compression ratio? Why? **(5)**

   (d) The bore and stroke length of a 4-stroke **FERRARI FF 6.3 V12** 12-cylinder engine working on the constant volume cycle, are 80 mm and 90 mm respectively with a clearance volume of 0.05 liter/cylinder. Determine the compression ratio and thermal efficiency of the engine. If this engine is converted to a constant pressure cycle at a cut-off ratio of 3.0, then determine the thermal efficiency of this engine. **(12)**

7. (a) Write down the name of potential sources of renewable energy and briefly describe the solar thermal energy. **(5+5)**

   (b) 2 kg air at 40°C dry bulb temperature and 50% relative humidity is mixed with 1 kg of air at 22°C dry bulb and 17°C wet bulb temperature. Calculate the (i) temperature, (ii) dew point temperature, (iii) specific humidity, and (iv) relative humidity of the mixture. **(25)**

8. (a) Derive the matrix that represents a pure rotation about the x-axis of the reference frame. **(15)**

   (b) A point $P(5, 4, 7)^T$ is attached to a frame $(\bar{n}, \bar{o}, \bar{a})$, is subjected to the transformation described as follows: **(20)**

   (i) A rotation of 90° about the z-axis

   (ii) Followed by a translation of [4, –3, 2]

   (iii) A rotation of 45° about the y-axis.

   Find the co-ordinates of the point relative to the reference frame at the conclusion of transformation.
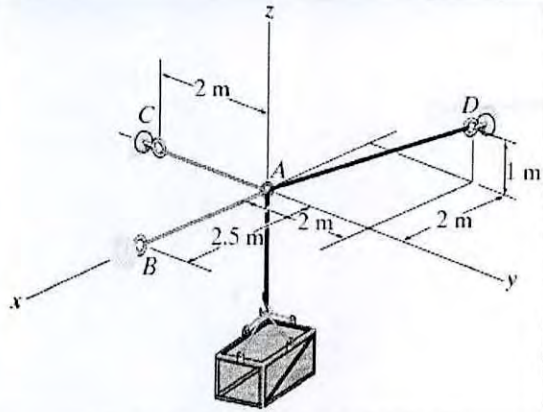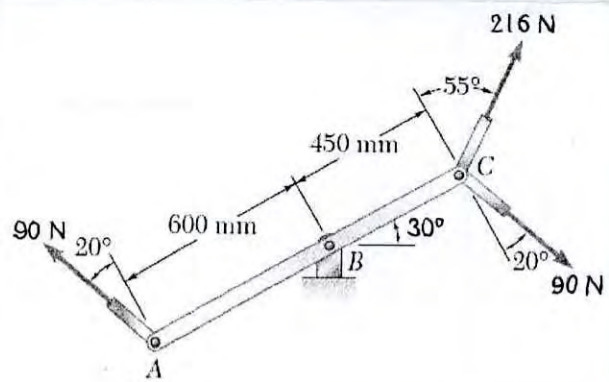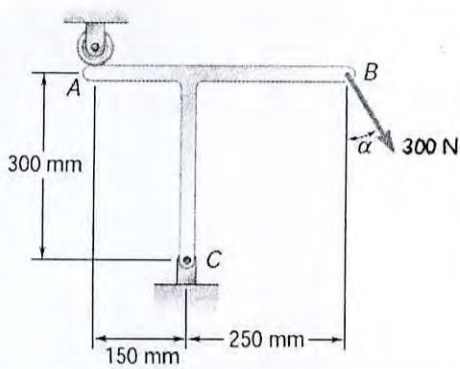
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Figure for Q1(a)	Figure for Q1(b)
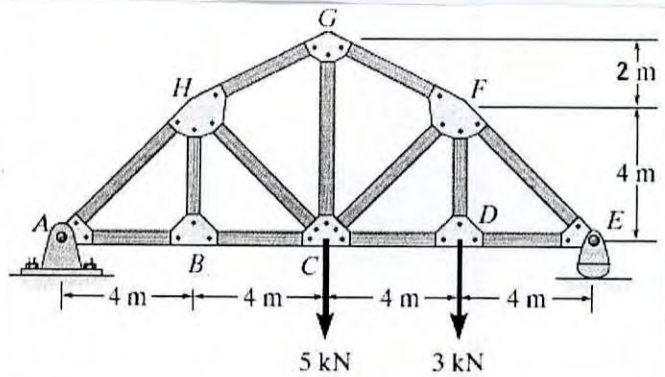
Figure for Q2(a)	Figure for Q2(b)
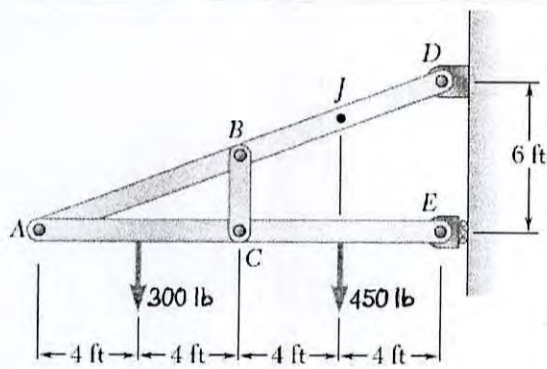
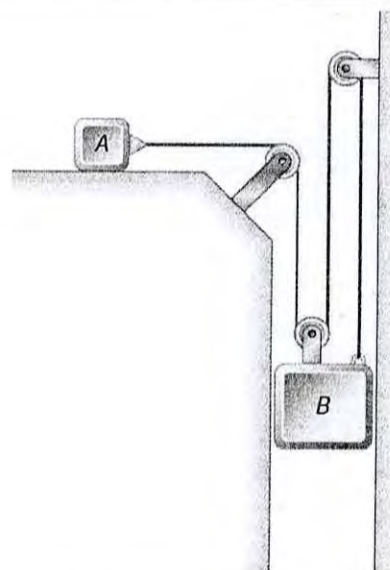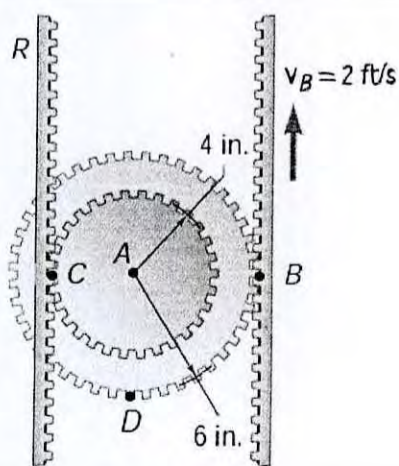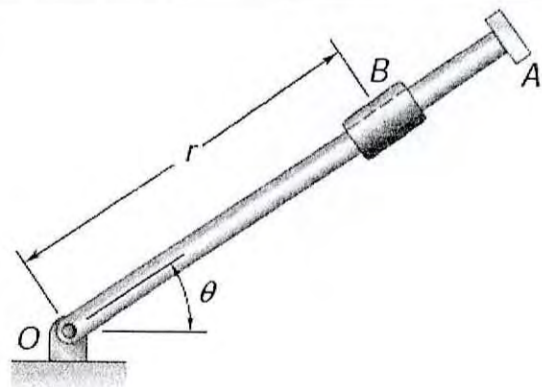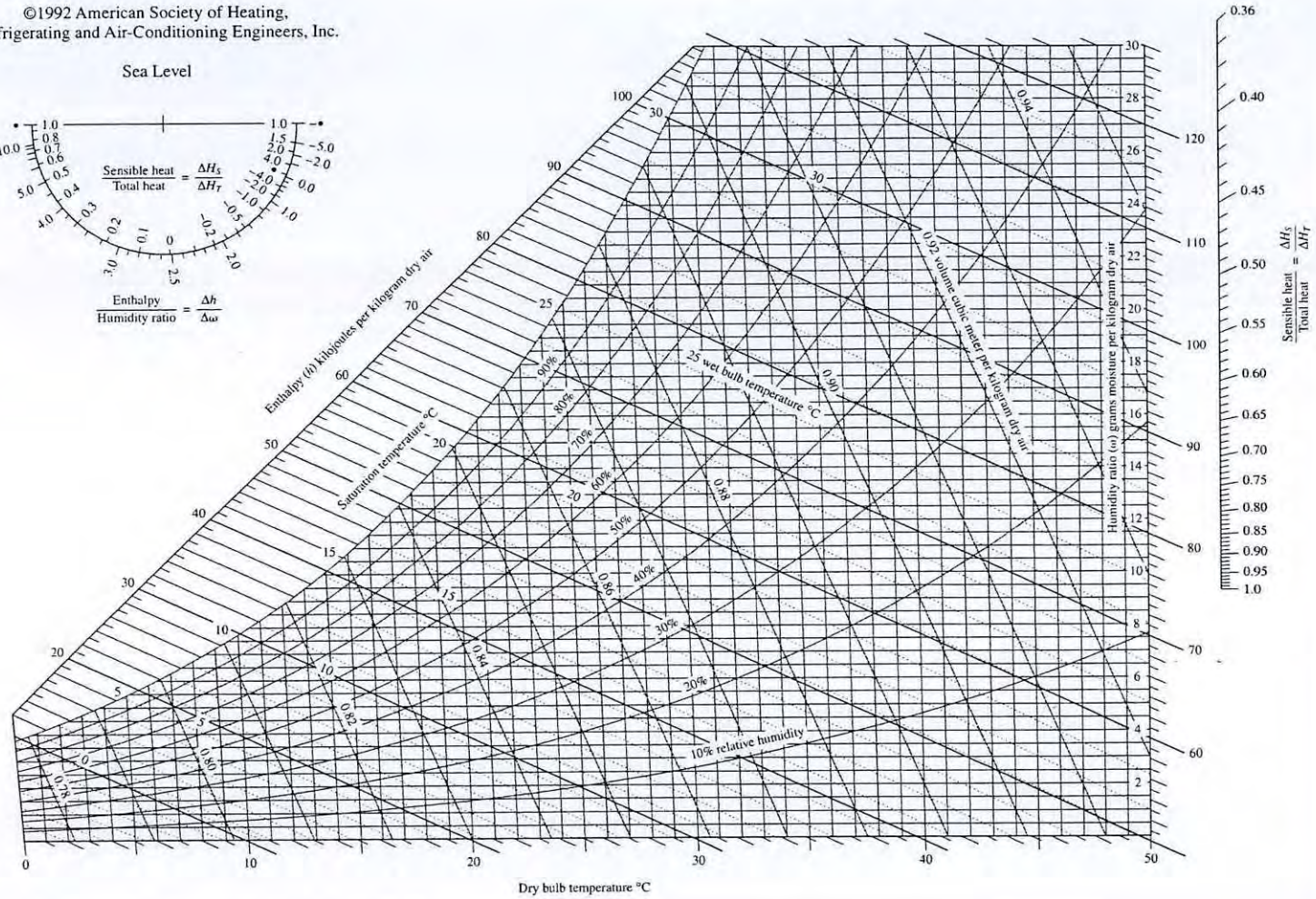|	
Figure for Q3(a)	Figure for Q3(b)

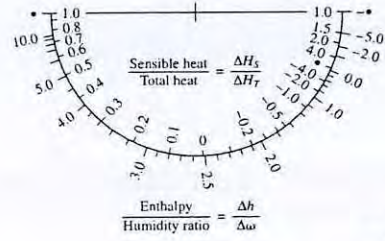|	
Figure for Q4(a)	Figure for Q4(b)

③

ASHRAE Psychrometric Chart No. 1
Normal Temperature
Barometric Pressure: 101.325 kPa

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Sea Level

Prepared by Center for Applied Thermodynamic Studies, University of Idaho.

FIGURE A–31

Psychrometric chart at 1 atm total pressure.

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