University of Rajshahi
Department of Computer Science and Engineering
B.Sc. Engg. Part-1, Even Semester, Examination 2020
Course Code: PHY 1211 Course Title: Basic Electricity and Electrical Circuits.
Time: 3 Hours Full Marks: 52.5
[N.B. Answer SIX questions taking at least THREE from each Section.]

Section A

1(a) Define electric field, electric dipole and dipole moment. 3

(b) Show that $\tau = \vec{P} \times \vec{E}$ for an electric dipole is placed in a uniform electric field $\vec{E}$. 2.75

(c) An electric dipole of moment 3×10^{-9}cm is placed in a uniform field intensity $1.5 \times 10^{5} NC^{-1}$. What does the maximum torque the field exert on the dipole? 3

2(a) State and prove Gauss's law in electrostatics. 4.75

(b) A long cylinder of radius α is uniformly charged with charge density λ per unit length. Find the field E at points inside and outside the cylinder. 3

(c) When do we apply Gauss's law? 1

3(a) State and prove Ampere's law for arbitrary path enclosing electric currents. 5.75

(b) A solenoid has length 1.65 m and inner diameter 2.55 cm it carries a current 4.35 A. It consists of five closed packed layers, each with 150 turns along. What is the magnetic field B at it's enter? 3

4(a) Explain current density and drift velocity of a carrier. 2

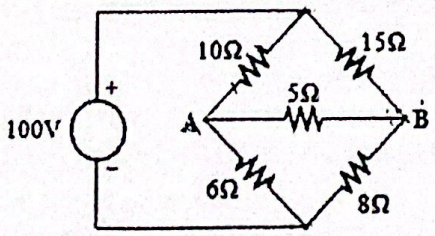
(b) Establish the relation between drift velocity and current density. 3

(c) Calculate the drift velocity of free electron in copper from the following data: Current density = $5 \times 10^{6} Am^{-2}$, density of copper = $9000 kg/m^{3}$, At wt. of copper 64gm/mole, Avogadro number = 6×10^{23} atoms/mole, electron charge = $1.6 \times 10^{-19} C$. 3.75

Section B

5(a) State and prove maximum power transfer theorem. 4

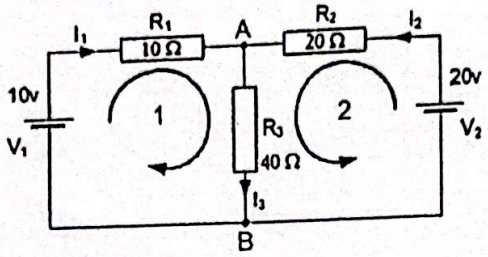
(b) Apply Thevenin's theorem to calculate the current through the 5Ω resistor of the circuit below: 4.75



6(a) What is alternating emf? 2

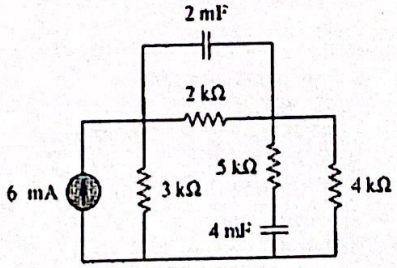
(b) State and explain Kirchhoff's voltage law. 3

(c) Consider the following circuit. Find the current flowing in the R_3 resistor. Also calculate the voltage across it. 3.75

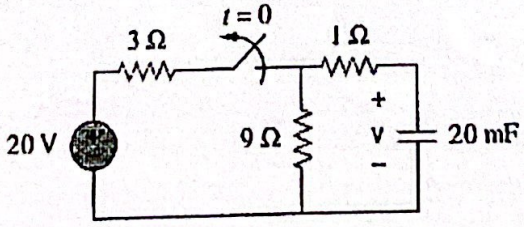


7(a) Show the current-voltage, voltage-current relationship and the energy stored in the capacitor. 3

(b) Obtain the energy stored in each capacitor in figure below under dc conditions. 2.75



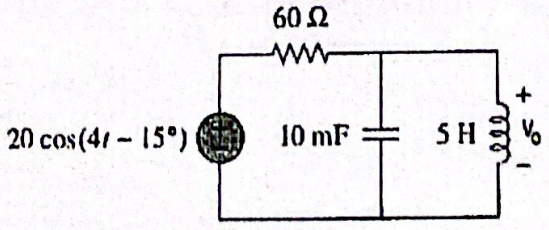
(c) The switch in the circuit in figure below has been closed for a long time, and it is opened at $t = 0$. Find $v(t)$ for $t \geq 0$. Calculate the initial energy stored in the capacitor. 3



8(a) Explain reactance and impedance of an AC circuit. 3

(b) Show the voltage-current relation for an inductor and a capacitor in the time domain and in the frequency domain with phasor diagram. 3.75

(c) Determine $v_o(t)$ in the circuit in figure below: 2



University of Rajshahi

Department of Computer Science and Engineering

B.Sc. in Engineering 1st Year Even Semester Examination-2019

Course: **PHY-1221 [Applied Electricity and Magnetism]**

Marks: 52½ [Answer any six (06) questions taking three (03) from each section] Time: 03 Hours

Section-A

1.a) What is electric dipole? 1

b) How do you calculate the electric field intensity due to an electric dipole? 4¼

c) An electric dipole consists of charges +2e and -2e separated by 0.87 nm. It is in an electric field of strength 4.4×10^6 N/C. Calculate the magnitude of the torque on the dipole when the dipole moment is (i) parallel to (ii) perpendicular to and (iii) antiparallel to the electric field. 3

2.a) Write-down the few applications of Gauss law. 1¼

b) Applying Gauss's law to calculate the electric field intensity due to a uniformly charged sphere (non-conducting) at points (i) outside the sphere, (ii) at the surface of the sphere, (iii) inside the sphere 5

c) Draw the curve for the variation of the electric field intensity as function of radial distance due to a uniformly charged sphere (non-conducting) and discuss the results. 2½

3.a) Define capacitance and a capacitor. On what factor does the capacitance depend? 1¼+1½

b) Find an expression for the capacitance of a parallel plate capacitor. 3

c) A parallel plate capacitor consists of two square metal plates with 5.0 cm of side separated by 1.0 cm. A Sulphur slab of 6.0 mm thick and with $k = 4$ is placed on the lower plate, calculate the capacitance. 2¼

4.a) Explain the following terms (i) insulator, (ii) semiconductor and (iii) conductor using the band-gap. 1½

b) State and explain Kirchhoff's laws in an electric network. Apply these laws to find an expression for the current through the galvanometer in an unbalanced Wheatstone's bridge. 2+3¼

c) The current in a simple series circuit is 5A. When an additional resistance of 2Ω is inserted, the current drops to 4A. What was the resistance of the original circuit? 2

Section-B

5.a) State and explain Faraday's law of electromagnetic induction. 2

b) What are the coefficients of self-inductance and mutual inductance? Find an expression for the self inductance of a solenoid. 2+3

c) A 10 cm long solenoid having an air core has 100 turns and area of cross section 5 cm². Find the coefficient of self-inductance of the solenoid. 1¼

6.a) Explain the Seebeck effect. Write down the names of thermos electrically negative and positive metals in thermos couple. 1¼

b) How does Peltier effect differ from Joule heating effect? 2

c) What are the natural temperature and inversion temperature? 2

d) The emf (microvolts) in a lead-iron thermocouple, one junction of which is at 0°C is given by $E = 1874t - 3.4t^2$, where t is the temperature in degrees centigrade. Calculate the natural temperature, Peltier coefficient and Thomson coefficients. 3

7.a) Derive an equation for the growth of charge in a dc circuit with inductance, capacitance and resistance in series. 6

b) Using the above theory, explain the damped oscillatory case with figure. 2¼

8.a) What is alternating emf? 1

b) An alternating emf $E = E_0 \cos \omega t$ is applied to a circuit containing a resistance R and an inductance L in series. Find the current at any instant. 4¼

c) Define the reactance and impedance of ac circuit. 1½

d) In a series LR circuit, $E = 100\ volts, L = 25\ mh$ and $R = 50\Omega$. Calculate (i) the amplitude of the current, and (ii) the phase difference between the applied emf and current. 2

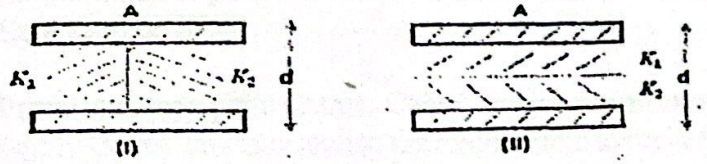
University of Rajshahi
Department of Computer Science and Engineering

B.Sc. (Engg.) Part-1, Even Semester, Examination-2018
Course: PHY-1221 (Applied Electricity and Magnetism)
Full Marks-52.5 Time: 3 hours

[N.B. Answer any six questions taking THREE from each of the Section]

Section-A

1. a) Define electric flux. 2
   b) Derive an expression for the capacitance of a spherical capacitor. 3.5
   c) The area of each plate of a parallel plate capacitor is A, and their separation is d. It is filled with two dielectrics of dielectric constants K_1 and K_2. Calculate the capacitance when the dielectrics are filled as in following figures. 3.25



2. a) State and prove Gauss's law in electro statistics. 5
   b) A long cylinder of radius a is uniformly charged with charge density λ per unit length. Find the field E at points inside and outside the cylinder. 3
   c) When do we apply Gauss's law? 0.75

3. a) What is dipole moment? Obtain an expression for the potential due to an electric dipole. 3.75
   b) Show that $\tau = \vec{P} \times \vec{E}$ for an electric dipole is placed in a uniform electric field $\vec{E}$. 2.5
   c) An electric dipole consist of two opposite charges of magnitude $q = 2.0 \times 10^{-6} C$ separated by 2.0cm. The dipole is placed in an external field of $2.0 \times 10^5\ Nt/Coul$. Calculate the maximum torque on the dipole. 2.5

4. a) What is current density and drift velocity of a charge carrier? 2
   b) Establish the relation between drift velocity and current density. 3
   c) Calculate the drift velocity of free electron in copper from the following data: current density= $5 \times 10^6\ Am^{-2}$, density of copper= $9000 kg/m^3$, At. wt. of copper 64 gm/mole, Avogadro number = 6×10^{23} atoms/mole, electron charge = $1.6 \times 10^{-19} C$. 3.75

Section-B

5. a) State and prove Ampere's law. Apply it to calculate the magnetic field due to a solenoid. 6
   b) A solenoid is *1.0 m* long and *3.0cm* in mean diameter. It has 5 layers of windings of *850 turns* each and carries a current of *5A*. Calculate B at its center. 2.75

6. a) What are the Thomson effect and Peltier effect? 3
   b) Explain the thermoelectric diagrams. 1.75
   c) The *emf* of a thermocouple, one junction is kept at $0^o C$, is given by $E = at + bt^2$. Determine the neutral temperature, temperature of inversion, and the Peltier and Thomson coefficients. 4

7. a) Obtain an expression for the growth and decay of current in a *dc* circuit containing a resistance and inductance. 6.5
   b) An *emf 10 volts* is applied to a circuit having a resistance of *10 ohms* and an inductance of *0.5 Henry*. Find the time required by the current to attain 63.2% of its final value. 2.25

8. a) Obtain the expression for the mean value and the root mean square value of an alternating current. 3
   b) What is resonance frequency? Obtain an expression for it in case of *LCR* series circuit. Explain it for various R values. 3.75
   c) Find the resonance frequency of an *LCR* series circuit for $L = 10\,mH, C = 0.02\,\mu F$ and $R = 20\Omega$. 2

University of Rajshahi
Department of Computer Science and Engineering
B.Sc. (Engg.) Part-1, Even Semester Examination-2017
Course: PHY 1221 (Applied Electricity and Magnetism)
Time: 3 Hrs. Marks: 52.5
[Answer SIX (06) questions taking THREE (03) from each Section.]

Section A

1. (a) Define electric field, electric dipole, and dipole moment. 2
   (b) Find the potential energy of an electric dipole placed in a uniform external electric field. 3.75
   (c) A neutral water molecule in its vapor state has an electric dipole moment of magnitude 6.2×10^{-30} c.m. (i) How far apart are the molecules center's of positive and negative charge? (ii) If the molecule is placed in an electric field of 1.5×10^4 N/C, what maximum torque can the field exert on it? 3

2. (a) Prove that, for a point charge, Gauss' law is equivalent to Coulomb's law. 3.25
   (b) Apply Gauss' law to calculate the electric field for cylindrical symmetry. 3.5
   (c) Write down the few applications of Gauss' law. 2

3. (a) Define capacitor and capacitance. 3
   (b) Deduce the relation $C = \frac{\varepsilon_0 A}{d}$ for a parallel plate capacitor, where the symbols have their usual significance. 4
   (c) A storage capacitor on a Random Access Memory (RAM) chip has a capacitance of 55 μF. If the capacitor is charged to 5.3 V, how many excess electrons are on its negative plate? 1.75

4. (a) State Kirchhoff's laws of distribution in an electric network. 4
   (b) A metal rod of length 25 cm has resistance 7.5×10^{-6} Ω. The diameter of the rod is 0.40 cm. Calculate the resistivity of the metal. 2.75
   (c) Write short note about semiconductor. 2

Section B

5. (a) State and explain Faraday's law of electromagnetic induction. 3
   (b) Calculate the magnetic field inside a long straight wire with current. 3.5
   (c) A solenoid has length 1.23 m and inner diameter 3.55 cm and it carries a current 5.57 A. It consists of five closed packed layers, each with 850 turns along length. What is the B at its center? 2.25

6. (a) Write down the conditions for a moving coil galvanometer to be dead beat. 2
   (b) What is mutual inductance? Calculate the mutual inductance between two coaxial solenoids. 4.75
   (c) A solenoid of length 30 cm and area of cross-section 10 cm^2 has 1000 turns wound over a core of constant permeability 600. Another coil of 500 turns is wound over the same coil at its middle. Calculate the mutual inductance between them. 2

7. (a) What are thermocouple and thermal emf? 3
   (b) Define neutral temperature and temperature of inversion for thermocouple. 3
   (c) Calculate the maximum emf in a Fe-Pb thermocouple, the cold junction of which is kept at 0°C. Given a = 13.8 μ V/°C and b = -0.015 μV/(°C)^2. 2.75

8. (a) Define reactance and impedance of an AC circuit. 2
   (b) Analyze a series LCR circuit and explain the phenomenon of resonance. 4
   (c) Find the resonance frequency of an LCR series circuit for L = 10 mH, C = 0.02 μF and R = 20 Ω. 2.75

University of Rajshahi
Department of Computer Science and Engineering
B.Sc. Engg.(CSE) 1st Year EVEN Semester 2016
Course: PHY 1221 (Applied Electricity and Magnetism)
Time: 3 Hrs. Full Marks: 52.5
[N.B. Answer SIX questions taking at least THREE from each part]

Part A

1.a) State superposition principle for electric charges. 1
b) Derive an expressions for the electric field at a point on the axial line due to an electric dipole. 4.75
c) An electric dipole of moment 2×10^{-8} cm is placed in a uniform field intensity $1.5\times10^{5}NC^{-1}$ (i) What maximum torque does the field exert on the dipole? (ii) How much work is done on turning the dipole end to end? 3

2.a) State and prove Gauss's law in electrostatics. 5
b) Charge is distributed uniformly over the surface of a sphere. Use Gauss's law to find the electric field at the points (i) Outside of the sphere (ii) On the surface of the sphere 3.75

3.a) Define capacitor. Classify the capacitors. Write down the major uses of capacitor. 1+1+1
b) Derive an expression for the energy stored by a charged capacitor. 3
c) The parallel plates of an air-filled capacitor are 1 cm apart. What will be the area A of each plate if capacitance is to be 0.25 μF? 2.75

4.a) Establish the relation between current density and electron drift velocity. 3.5
b) Deduce the condition for the balance of a Wheatstone's bridge. 3.5
c) Write short note about Superconductor. 1.75

Part B

5.a) State and prove Ampere's law. Apply it to calculate the magnetic field due to a solenoid. 3+3
b) Define self-inductance and mutual inductance. 2.75

6.a) Describe a moving coil galvanometer. Explain how current can be measured with it. 4
b) What are the differences between ballistic and deadbeat galvanometer? 2
c) Prove that the charge sensitivity of a B.G. is $2\pi/T$ times the current sensitivity. 2.75

7.a) Briefly describe about Seebeck and Peltier effects. 4
b) Write down the laws of addition of thermal electromotive forces. 4.75

8.a) A series circuit containing an inductor L and a resistor R is connected to a battery. Obtain the expression for the rate of decay of current. 4.75
b) An e.m.f. 10V is applied to a circuit having a resistance of 10Ω and in inductance of 0.5H. Find the time required by the current to attain 63.2% of its final value. What is the time constant of the circuit? 4

University of Rajshahi
Department of Computer Science and Engineering
B.Sc. Engg. Part-I Even Semester Exam - 2015
Course: PHY1221 (Applied Electricity and Magnetism)
Full Marks: 52.5 Time: 3 Hours

(Answer any 6 questions not taking more than 3 from each Part)

Part A

1.(a)	Define an electric dipole and its moment.	1
(b)	Find the electric field $\overline{E}$ at a point P due to a dipole at a distance r from the midpoint of the dipole.	5
(c)	A water molecule in its vapour state has an electric dipole moment $6.2\times10^{-30}\ cm$. What is the electric field $\overline{E}$ at a distance r of 1.1 nm from the molecule on the dipole axis?	2.75
2.(a)	What is electric flux?	2
(b)	Obtain Coulomb's law from Gauss's law.	3.50
(c)	A point charge of 1.8 μC is at the centre of a spherical Gaussian surface of radius 55 cm. What is the net flux through the surface?	3.25
3.(a)	Calculate the total enclosed charge q for a parallel plate capacitor with dielectric using Gauss's law.	5
(b)	A parallel plate capacitor of plate area 11.5 cm^2 and plate separation 1.24 cm. A potential difference 85.5 V is applied between the plates. The battery is then disconnected, and a dielectric slab of thickness 0.78 cm and dielectric constant 2.61 is placed between the plates. What is the capacitance with the slab in place?	3.75
4.(a)	What is the current density and drift velocity of the charge carrier?	2
(b)	Establish the relationship between the current density and drift velocity.	4
(c)	What is the drift velocity of the conduction electrons in a copper wire of diameter 0.5 mm and length 20 m, when it is connected across the battery of 1.5V and the internal resistance 1.25Ω. (Here $\rho=8.96\times10^3\ kg/m^3$, $n=8.49\times10^{28}\ m^{-3}$)	2.75

Part B

5.(a)	State and explain Faraday's law of induction. Deduce its differential form.	3.75
(b)	Find the mutual inductance of two co-axial coils.	5
6.(a)	What do you mean by thermal emf?	2
(b)	What is Thomson effect?	3
(c)	Find an expression of the thermo-electric power.	3.75
7.(a)	Find expression for the growth and decay of charges of a capacitor through resistor with constant emf.	3.75
(b)	What is the time constant in an RC circuit? Show that the time constant has the unit of time.	2
(c)	In an RC circuit $R=0.4\times10^6\ ohm$ and $C=2.5\times10^6\ F$, in what time will the charge in the capacitor decay one fourth of its initial value?	3
8.(a)	An alternating emf is applied to a circuit consisting an inductor, capacitor and resistor in series. Obtain the expression for the current and impedance.	5.75
(b)	A circuit consists of a non-inductive resistance of 50Ω, an inductance of 0.3H and a resistance of 2Ω and a capacitor of 40μF in series and is supplied with 200 volts at 50 Hz. Find the impedance and the current in the circuit.	3