Khulna University of Engineering & Technology

B. Sc. Engineering 3rd year 1st Term (Regular) Examination, 2018

Department of Electrical and Electronic Engineering

EE 3107

Electrical Machines - II

Time: 3 hours — Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Draw the torque speed characteristic of a polyphase induction motor and indicate stable and unstable regions of operation. Explain the effect of rotor resistance on torque characteristic. Show how is the torque characteristic modified by double cage and deep bar rotor. (15)

(b) Explain time and space harmonics and their orders. What are cogging and crawling phenomena of induction motors? Suggest techniques to reduce these. (10)

(c) Draw and explain the power flow diagram of a polyphase induction motor. Produce an account of losses of polyphase induction motor. (10)

Q2. (a) Draw and explain the operation of an autotransformer based starter for polyphase induction motor. Discuss on the types of starter for polyphase induction motor. (10)

(b) Explain the fundamentals of v/f control. Draw the block diagram of the control system of the v/f control method. (09)

(c) Show that a polyphase induction motor is a constant speed motor under normal operating condition. Describe the consequent pole method of speed control. (08)

(d) A three-phase induction motor has the following parameters: $R_1 = 0.90\ \Omega$, $X_1 = 0.12\ \Omega$, $R_2 = 0.03\ \Omega$, ${}_{ss}X_2 = 0.12\ \Omega$, $X_m = 17\ \Omega$, find the slip at maximum torque. (08)

Q3. (a) What is the role of capacitor in a capacitor-start motor? Justify your answer. (10)

(b) Discuss the working principle of shaded pole motors. (08)

(c) Define universal motor. How can the performance of the motor be improved for ac operation? (09)

(d) Show that the hysteresis motor is a constant-torque motor. (08)

Q4. (a) Show that the double revolving field theory can be used to explain the operation of a single phase induction motor. (11)

(b) Describe the voltage components of a single phase induction motor using cross-field theory. Also find out relations among them. (12)

(c) What are the voltage components in general of an electrical machine? Write down the voltage equation of a primitive machine. Explain the sign of speed voltage terms of the machine. (12)

Section B

Q5. (a) Explain the differences between asynchronous and synchronous generators. Discuss on the (i) field arrangement and (ii) cooling of alternators. (10)

(b) What are pitch and distribution factors? Show that fractional pitch and distribution of windings reduce harmonic contents at the cost of output voltage. What are the advantages of Y connection of armature windings on the motor output? (13)

(c) A 12-pole, 3-phase synchronous generator has Y-connected winding with 144 slots and 10 conductors per slot with 10 slots pitches. The flux per pole is 0.05 weber distributed sinusoidally and the speed is 500 rpm. Calculate (i) the distribution factor, (ii) coil span factor, and (iii) the voltage generated. (12)

Q6. (a) Discuss Blondel's two-reaction analysis. (10)

(b) What are the causes of transient in alternators? How to find subtransient and transient reactances in alternators? (08)

(c) A 5 MVA, 6.6 kV, 3-φ, Y-connected alternator has a resistance of 0.075 Ω per phase. Estimate the regulation for a load of 500 A at p.f. 0.71 lagging from the following open circuit and full-load zero p.f. curve. (17)

Field current	:	32	50	75	100	140
Open circuit terminal voltage	:	3100	4900	6600	7500	8300
Saturation curve Zero p.f.	:	0	1850	4250	5800	7000

Q7 (a) What do you mean by synchronizing of alternators? Describe the self synchronizing action of alternators. (11)

(b) Two similar 6600 V, 3-φ, generators are running in parallel on infinite bus-bars. Each has an equivalent resistance and reactance of 0.05 Ω and 0.5 Ω respectively and supplies on half of a total load of 10,000 kW at a lagging p.f. of 0.8, the two machines being similarly excited. If the excitation of one machine be adjusted until the armature current is 438 A and the steam supply to the turbine remains unchanged, find the armature current, the p.f., and the e.m.f. of the other alternator. (14)

(c) Discuss the principle of operation of synchronous motor. Write down the characteristics of the motor. (10)

Q8 (a) Illustrate the effect of loading and changing excitation on the characteristics of synchronous motor. (10)

(b) What do you mean by hunting of synchronous motor? How is the hunting prevented? (06)

(c) What are the principles of an electro-mechanical energy conversion system? Write down the energy balance equation of the system. (10)

(d) A nonmagnetic rotor containing a single-turn coil is placed in a uniform magnetic field of magnitude B_o, as shown in Fig. Q8(d). The coil sides are at radius R and the wire carries current I as indicated. Find the θ-directed torque as a function of rotor position α when I = 10 A, B_o = 0.02 T and R = 0.05 m. Assume that the rotor is of length l = 0.3 m. (09)

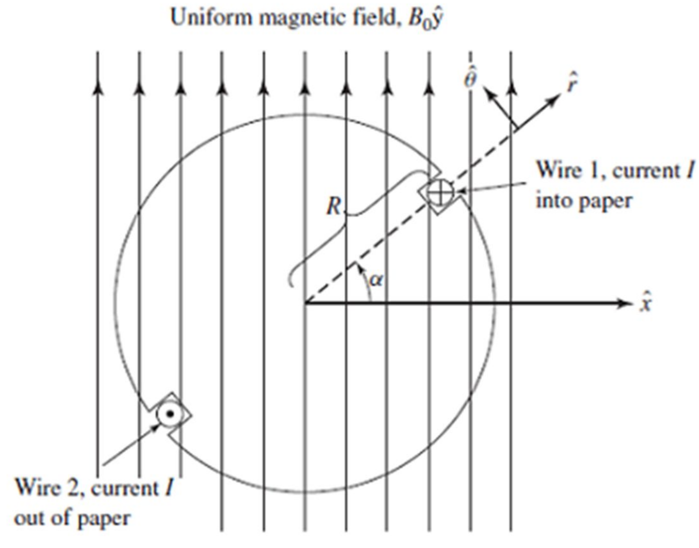

Figure for Q8(d)

Khulna University of Engineering & Technology
B. Sc. Engineering 3rd year 1st Term (Regular) Examination, 2018
Department of Electrical and Electronic Engineering

EE 3115
Electrical Measurement and Instrumentation

Time: 3 hours | Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Classify resistances. What are the available methods for measuring low-resistance? Derive the relationship between galvanometer current sensitivity and bridge sensitivity of the Wheatstone bridge. (15)

(b) Describe Kelvin Double bridge method to measure low resistances? Why it is superior than Ammeter-Voltmeter method? (10)

(c) Why guard circuit is necessary for high resistance measurement? A Wheatstone bridge is connected for a Varley Loop test as shown in Fig. Q1(c). When the switch is in position 1, the bridge is balanced with R_1 = 1 kΩ, R_2 = 2 kΩ, R_3 = 100 Ω. When switch is in position 2, the bridge is balanced with R_1 = 1 kΩ, R_2 = 2 kΩ, R_3 = 99 Ω. If the resistance of the earthed wire is 0.15 Ω/km, how many meters from the bridge has the ground fault occurred? (10)

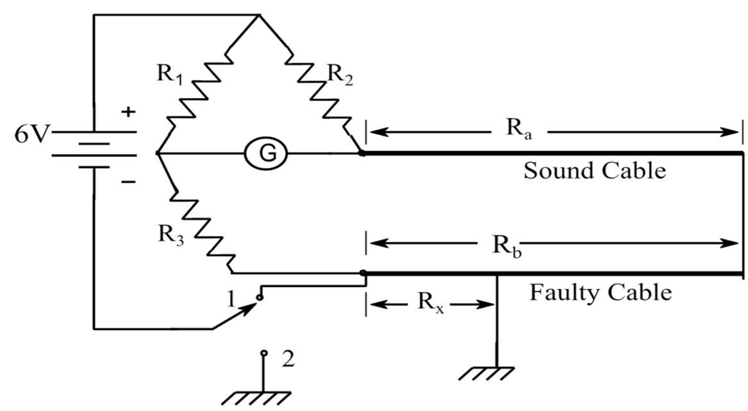

Figure for Q1(c)

Q2. (a) What are the differences between ac bridge and Wheatstone bridge? How self-inductance and quality factor can be measured by Hay's bridge? Mention advantages and disadvantages of Hay's bridge. (15)

(b) Describe step-by-step method for determining B-H curve and hysteresis loop of a magnetic specimen. (10)

(c) Why high voltage measurement is needed? A sheet of Bakelite 4.5 mm thick is tested at 50 Hz between electrodes 0.12 m in diameter. The Schering bridge employs a standard air capacitor C_2 of 106 pF capacitance, a non-reactive resistance R_4 of $\frac{1000}{\pi}$ Ω in parallel with a variable capacitor C_4, and a non-reactive variable resistance R_3. Balance is obtained with C_4 = 0.5 µF and R_3 = 260 Ω. Calculate the capacitance, power factor and relative permittivity of sheet. (10)

Q3. (a) What are the factors to be considered for selecting an earth electrode? Describe the fall of potential method for measuring earth resistance. (12)

(b) How relative permittivity of a specimen can be measured using Schering bridge? How dissipation factor of a capacitor can be measured using bridge? (13)

(c) A moving coil voltmeter with a resistance of 20 Ω gives a full-scale deflection of 120^0 when a potential difference of 100 mV is applied across it. The moving coil has dimensions of 30 mm × 25 mm and is wound with 100 turns. The control spring constant is 0.375×10^{-6} Nm/deg. Find the flux density in the air gap. Find also the diameter of copper wire of coil winding if 30% of instrument resistance is due to coil winding. The specific resistance of copper = 1.7×10^{-8} Ωm. (10)

Q4. (a) Write short notes on: (i) Creep, (ii) Law's of illumination, and (iii) Lag adjustment devices. (12)

(b) What is energy meter? Describe single phase induction type energy meter. (13)

(c) A test was conducted on a sample of sheet Laminations gave the following results at a maximum flux density of 1.0 Wb/m^2 with flux waveform purely sinusoidal. (10)

Frequency (Hz)	25	40	50	75
Iron loss (W/kg)	2.32	4.35	6.0	10.9

Determine (i) Hysteresis and eddy current loss in W/kg at 50 Hz and at 1.0 Wb/m^2 and also at (ii) maximum flux density of 1.2 Wb/m^2 when the frequency is 60 Hz and the form factor of flux wave is 1.2. Assume Steinmelt index is 1.6.

Section B

Q5. (a) Define measurement. What is the significance of measurement in all branches of engineering? Classify instrument according to their functions. (10)

(b) Define the terms: (i) Reproducibility, (ii) Repeatability, (iii) Standard deviation, and (iv) Variance. (10)

(c) Define Limiting errors. Derive the expression for relative Limiting error. (07)

(d) The resistance have the following ratings: (08)
$R_1 = 37\ \Omega \pm 5\%$, $R_2 = 75\ \Omega \pm 5\%$, and $R_3 = 50\ \Omega \pm 5\%$.
Determine the magnitude and Limiting error in ohm and in precent of the resistance of these resistances connected in series.

Q6. (a) Mention some applications of strain gauges. Deduce the expression $G_f = 1 + 2\vartheta$; where the symbols have their usual meanings. (13)

(b) Describe the construction and working principle of LVDT with proper sketching. (12)

(c) Draw a rotary and translational optical encoder. (10)

Q7 (a) Describe the reasons why the secondary of a current transformer should be closed while its primary is energized. (08)

(b) What are the purposes of using CTs and PTs? Derive the expression for ratio and phase angle errors for a PT. (17)

(c) A current transformer has a bar primary and 200 secondary winding turns. The secondary winding burden is an ammeter of resistance 1.2 Ω and reactance 0.5 Ω, the secondary winding has a resistance of 0.2 Ω and reactance 0.3 Ω. The core requires the equipment of an mmf of 10 A for magnetization and 50 A for core losses. (10)

(i) Find the primary winding current and ratio error when the ammeter in the secondary winding circuit indicates 5 A.

(ii) How many turns could be reduced in the secondary winding in order that the ratio error be zero for this condition?

Q8 (a) Define piezo-electric effect. Deduce the expression for output voltage of a piezo-electric transducer. (10)

(b) What is loading effect in measurement system? Discuss about loading effect for active and passive measuring quantities. (10)

(c) How RTD and thermistor can be used as a temperature detector? Which one is more sensitive? (08)

(d) A capacitive transducer uses two quartz diaphragms of area 750 mm^2 separated by a distance of 3.5 mm. A pressure of 900 kN/m^2 when applied to the top diaphragm produces a deflection of 0.6 mm. The capacitance is 370 pF when no pressure is applied to the diaphragms. Find the value of capacitance after the application of a pressure of 900 kN/m^2. (07)