UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

Department of Electrical and Electronic engineering

MAIN EXAMINATION 2016

Title of the paper:

Fundamentals of Power Engineering

Course Code: **EE351**

Time allowed: **Three Hours**

Instructions:

1. To answer, pick any to sum a total of 100% from 8 questions in the following pages.
2. The answer must be written in the space provided in the question book; those in elsewhere considered invalid. Use the answer book as a scratch pad. Both question and answer book must be handed-in and marked with name and ID.
3. This paper has 8 pages, including this page and a blank page for question Q3.

DO NOT OPEN THIS PAPER UNTIL
PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

Q1: (10 pts) Draw a one-line diagram to show the typical structure of a distribution system, which down to the loads. Mark all necessary components. The system in Uniswa is the best example. (2.5 pts for each component or group of components of the same level)

Q2: (10 pts) Draw a per-unit reactance diagram for the 3-Φ system shown in Fig. Q2-1. Choose a 80 MVA, 66 KV base at the transmission line. (6 pts for structure; -1 pts for each component mistake until a total 4)

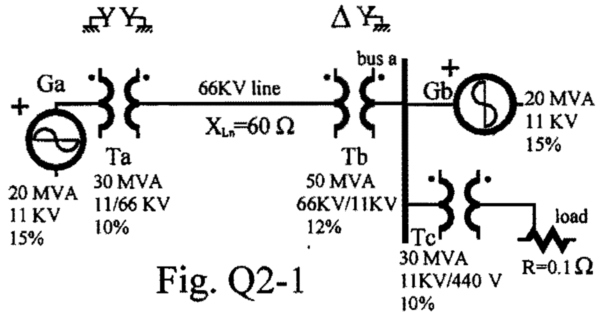

Fig. Q2-1

Q3: (20 pts) 3 impedances, $\mathbf{Z_a}=3<0^\circ$, $\mathbf{Z_b}= 4<60^\circ$, and $\mathbf{Z_c}=5<90^\circ\ \Omega$, are connected in Y. This Y-connected load is supplied by a 60 Hz, balanced positive sequence Δ-connected 3-phase source, $\mathbf{E_{ab}}= 240\angle 0$ V,. Determine (i)(6 pts). the line currents; (ii)(6 pts). the power drawn by each impedance; (iii)(4 pts). the reactive power in each phase; and (iv)(4 pts). the over-all power factor of the load.

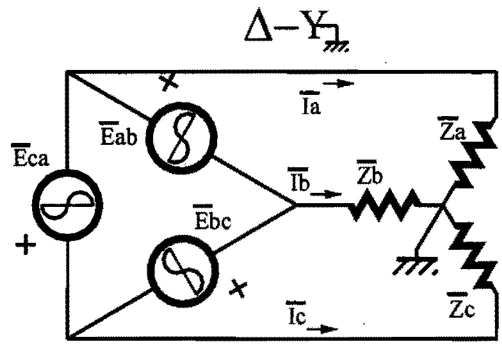

Fig. Q3-1

Q4: (10 pts) Given a 300 rpm, 60 Hz, and 3-Φ synchronous machine, find (i). how many pairs of poles per phase? And how many total poles in the machine? (ii). Describe the differences between a synchronous generator and a synchronous motor. (5 pts each).

Q5: (20 pts) A rotating magnetic field, shown in Fig. Q5-1, has two coils Ch and Cv; each is energized respectively by the current:

$$i_h = I \cdot \sin .\omega t \qquad i_v = I.\cos .\omega t$$

such that i_h produces a field Mh and i_v a field Mv. (15 pts) Prove the resultant magnetic field will rotate at an angular speed ω; ie, $\theta_o = \omega t$. (5 pts) Find out the rotating is CCW or CW.

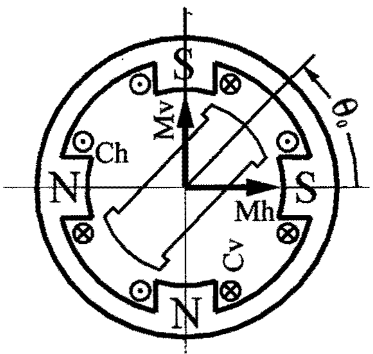

Fig. Q5-1

Q6: (20 pts) List power source quality factors, most concerned to the base users, (5 pts each) 4 items least. Following the list, a detailed definition or explanation is required.

Q7: (10 pts) Design a scheme or circuit to improve the over-all power factor in Q3 to over 95%.

Q8: (20 pts) The power system shown in Fig. Q8-1 is a continuation of Q2. (i) Convert the one-line diagram into a 2 source circuit diagram. (ii) Solve the no load voltage V_{NL}, and (iii) the full load voltage V_{FL}. (iv) Calculate the voltage regulation. (5 pts each)

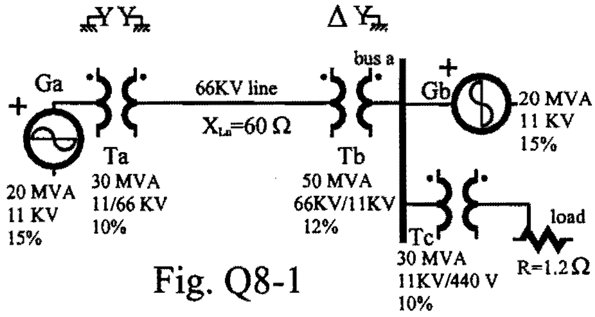

Fig. Q8-1