Engineering

Electrical Deparment

UNIVERSITY EXAMINATION FOR:

EEE2312 MACHINES 3 PAPER 2

END OF SEMESTER EXAMINATION

SERIES: MAY 2016

TIME: 2 HOURS

DATE: MAY 2016

Instructions to Candidates
You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO
Questions.
Do not write on the question paper.

Question ONE (Compulsory 30 marks)

Qn1 (a)(i) With aid of a sketch describe the construction of salient pole rotor and explain why non
salient pole rotor is preferred for high speed operation **(5mks)**

(ii)With aid of a sketch describe the principle of operation of a synchronous generator and state
THREE factors which determine the magnitude of the induced voltage **(5mks)**

(iii) A 60KVA, 220V, 50Hz single phase alternator has effective resistance of 0.016Ω and armature
leakage reactance of 0.07Ω. With aid of phasor diagrams find the voltage induced in the armature
when the alternator is delivering rated current at, unity power factor, 0.7lagging power factor and o.7
leading power factor. **(5mks)**

(b)(i) Describe the equivalent circuit diagram of a loaded alternator and draw its phasor diagram for
an inductive load **(5mks)**

(ii) With aid of phasor diagrams describe the characteristics of an overexcited and under excited
alternator. **(5mks)**

(iii) A lighting load of 2000KW and a motor load of 4000KW at a power factor 0.8 lagging are supplied by two alternators running in parallel. One machine is loaded to 2400KW at 0.95 power factor lagging. What is the KW output and power factor of the second machine **(5mks)**

Question TWO

Qn2 (a) (i) With aid a sketch describe the effect of load power factor on change on terminal voltage and its effect on voltage regulation of an alternator **(3mks)**

(ii) Describe how to obtain the THREE types of data required in order determining voltage regulation of an alternator using any method **(7mks)**

(b)(i) State THREE factors which determine the voltage regulation of an alternator **(3mks)**

(ii) A 1200KVA, 3300V, 50Hz three phase star connected alternator has armature resistance of 0.25Ω per phase. A field current of 40A produces a short circuit current of 200A, and an open circuit E.M.F of 1100V line to line. Find the voltage regulation on full load at 0.8 power factor lagging and 0.8 leading at full load. **(7mks)**

Question THREE

Qn3 (a) (i) Define the National grid and explain how its busbar voltage and frequency can be increased or decreased **(3mks)**

(ii) Explain the effect of change in excitation while power input to the prime mover of an alternator is kept constant.**(3mks)**

(iii) Explain with aid of sketches the effect of increasing power input to the prime mover of an alternator connected to infinite bus bars when its excitation is maintained constant **(4mks)**

(b)(i) With aid of a sketch illustrate a typical national grid and state TWO of its characteristics **(4mks)**

(ii) A 2MVA, 3phase, 8pole alternator connected to 6000V, 50Hz busbars and a synchronous reactance of $4\Omega / phase$. Calculate the synchronizing power and synchronizing torque per mechanical degree of rotor displacement at no load. Assume normal excitation **(6mks)**

Question FOUR

Qn4 (a) (a) (i) Describe synchronizing power as used in two alternators operating in parallel and show that it can be given by $P_{Sy} = \dfrac{\alpha E^2}{2X_S}$ per phase **(4mks)**

(ii) A 3000KVA, 6 pole alternator runs at 1000rpm in parallel with other machines on 3300V bus-bars. The synchronous reactance is 25%. Calculate the synchronous power for one cylindrical degree of displacement and the corresponding synchronizing torque. **(6mks)**

(b) (i) Explain any THREE advantages of operating alternators in parallel **(3mks)**

(ii) Explain the importance of synchronizing of alternators and FOUR conditions which must be met during this process **(4mks)**

(iii) With aid of a sketch describe synchroscope method of synchronization **(3mks)**

Question FIVE

Qn5 (a) (b)(i) With aid of a sketch describe the synchronizing action of alternators connected in parallel **(4mks)**

(ii)Describe effect of speed change during synchronization action. **(2mks)**

(b)(i) Derive an equation for electrical power output per phase of a cylindrical rotor of an alternator and show that the maximum power output can be given by $P_{max}/phase = \dfrac{E_0 V}{Z_0} - \dfrac{V^2}{Z_0}\cos\theta$ **(5mks)**

(ii) With aid a sketch describe the power/power angle characteristics of an alternator **(4mks)**

(iii) A 20,000KVA, 11000V, 3phase, star connected alternator running on constant voltage and constant frequency bus-bars has a resistance of $0.06\Omega/phase$ and synchronous reactance of $1.8\Omega/phase.$ If excited to give a terminal voltage of 13000V on open circuit find its maximum possible output power. **(6mks)**