TECHNICAL UNIVERSITY OF MOMBASA

Engineering

Electrical Department

UNIVERSITY EXAMINATION FOR:

EEE2312: ELECTRICAL MACHINES III

END OF SEMESTER EXAMINATION

SERIES: MAY 2016

TIME: 2HOURS

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 operation of an alternator and state two advantages of placing field winding on the rotor and armature winding on the stator of the machine **(5mks)**

(ii)Explain the difference between salient and non salient pole construction of a synchronous motor rotor and state giving two reasons why non salient type is commonly used for high speed alternators **(4mks)**

(iii) Two 50MVA, 3phase, alternators operate in parallel. The setting of the governors are such that rise in speed from full load to is 2% in one machine and 3% in the other machine, the characteristics being a straight line in both cases. If each machine is fully loaded, when the total load is 100W, what would be the load on each machine when the total load is 60W? **(6mks)**

(b)(i) With aid of an equivalent circuit diagram describe the difference between no loads E.M.F, terminal voltage and load induced E.M.F of an alternator **(7mks)**

(ii) A 1500KVA,6.6KV,3phase star connected alternator has effective armature resistance of $0.5\Omega/phase$ and a synchronous reactance of $5\Omega/phase$, with aid of phasor diagrams find the percentage change in terminal voltage when a rated output of 1500KVA at Unity power factor, 0.8 lagging power factor and 0.8 leading power factor is switched off. The speed of excitation current remains unchanged. **(8mks)**

Question TWO

Qn2 (a) (i) Define voltage regulation of an alternator and with aid of a sketch describe the effect of power factor on voltage regulation **(2mks)**

(ii) With aid of sketches describe how to determine the short circuit characteristics and open circuit characteristics of an alternator **(4mks)**

(iii) Describe the synchronous impedance method of finding voltage regulation of an alternator with aid of sketches. **(4mks)**

(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. With aid of phasor diagrams, find the voltage regulation on full load at 0.8 power factor lagging and 0.8 power factor leading at full load. **(7mks)**

Question THREE

Qn3 (a) (i) Define infinite buses bars and describe TWO factors which influence the characteristics of alternators connected to infinite bus bars **(3mks)**

(ii) With aid of sketches describe the effect of over excitation and under excitation on alternators connected on infinite bus bars when the prime mover power is maintained 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 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. **(6mks)**

Question FOUR

Qn4 (a) (i) Explain any TWO advantages of operating alternators in parallel **(2mks)**

(ii) Explain the importance of synchronizing of alternators and FOUR conditions which must be met during this process **(2mks)**

(iii) With aid of a sketch describe synchroscope method of synchronization **(4mks)**

(b) (i) Describe the two axes theory of armature reaction on synchronous alternators **(2mks)**

(ii) Describe synchronizing power as used in two alternators operating in parallel and show that it can be given by $P_{Sy} = \frac{\alpha E^2}{2X_S}$ per phase**. (5mks)**

(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. **(5mks)**

Question FIVE

Qn5 (a) (i) Derive an equation for electrical power output per phase of a cylindrical rotor of an alternator and the maximum power output can be given by $P_{\max} / phase = \frac{E_0 V}{Z_0} - \frac{V^2}{Z_0}\cos\theta$ **(5mks)**

(ii) With aid a sketch describe the power/power angle characteristics of an alternator **(3mks)**

(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. **(5mks)**

(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. **(3mks)**