MENOUFIYA UNIVERSITY SUBJECT: POWER SYSTEM PROTECTION.
FACULTY OF M.Sc. POSTGRADUATE EXAM. TIME: 3 HOURS.
ENGINEERING ELECTRICAL ENGINEERING DEPT. DATE: 22 /01/2015.

ANSWER THE FOLLOWING QUESTIONS

1) What are the abnormal and fault conditions the synchronous generator is subjected to? Show how the CTS are connected for stator differential protection for small and large generators to provide phase-fault primary protection. Show the current distribution in the protection circuit under normal operating and fault conditions.

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2) Show how the multi-ct differential protections are connected for star and delta connected generators, and split winding generators, to provide phase-fault primary protection. Show the current distribution in the protection circuit under normal operating and fault conditions.

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3) A generator rated 160MVA, 18 KV of $x_d = x_2 = 0.21$p.u., tied to a high voltage power system through a delta/earthed-star transformer rated 160 MVA, 18/345 KV, of 0.15 p.u. The high voltage system is 345 KV and of $x_1 = x_2 = 0.03$ p.u. , $x_o = 0.06$ p.u. on 100 MVA . Find the operating and restraining currents of the differential relay for a three phase fault on the terminals of the generator if the fault is inside and out side the generator differential protection zone. Find these quantities also if the generator-transformer unit is not connected to the 345 KV system (C.B. open). Suggest appropriate values for any missing data.

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4) Describe two sensitive protection schemes to protect a low impedance grounded generator against earth fault, showing the current distribution in the protection circuits for internal and external faults.

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5) Describe the methods used to provide 100% protection of the generator stator windings against earth fault for high impedance grounded generator.

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6) Derive an expression which shows that the impedance seen by an impedance relay located at the generator terminals will be equal to the negative of the generator reactance ($-jX_G$) when a complete loss of field occurs. Show also that this impedance locus forms different circles at different levels of excitation.

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7) Describe the methods used to protect the generator against loss of field and loss of synchronization and show the stable and unstable power swing locus on the complex impedance plain.

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8) Describe protection schemes which provide protection for the generator against under/over frequency, over excitation and over voltage.