BITS, Pilani – Dubai
International Academic City – Dubai
IV year EEE, Ist Semester 2010-11
Course Title - Advanced Power Systems (EEE C 462)
Comprehensive Examination
Full Marks – 80 (Weightage 40 %) Duration—3 hours
Date: 28-12-2010
Notes: Highlight all your answers by enclosing in boxes

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(1) A 50 Hz. Transmission line has a total series impedance of 40+j125 ohms per phase and a total shunt admittance of j0.001 mho per phase. The receiving end load is 50 MW at 220 kV(line voltage) with 0.8 power factor(lagging).Calculate the sending end voltage and sending end current using: (i) Nominal T-representation and(ii) Using approximate equations: A=D =1+(YZ/2) , B=Z[1+(YZ/6)] , C=Y[1+(YZ/6)] [5+5 Marks].

2(a) Explain the operation of a Nuclear Power station with relevant diagrams/equations/chemical reactions.
(b) The power available from a Hydro-plant is 60 MW for an effective HEAD of 24 metre.. This plant uses a Kaplan turbine having a water flow of circular cross section of diameter =5 metre. Calculate the velocity of the water jet. . [7+5Marks]

3.) A three phase star connected Synchronous Generator has positive and negative sequence impedances as j0.09 p.u and j0.075 p.u respectively. The neutral is solidly grounded. A line-to-line fault occurs on terminals of the generator phase "b" and phase "c" windings, with Z^f =0. Assume E_a =1.0+j0.0 p.u and I_a= 0
Starting from fundamentals (and drawing necessary diagrams) derive the expression for I_{a1} and hence calculate V_b and I_b (in p.u) . .[6+5 Marks]

4.) With reference to a long transmission line, develop the differential equations of voltage and current and solve them using Laplace Transform technique ,starting from fundamentals. Draw the necessary diagram also with necessary explanation/labeling. [4+6+2 Marks]

5) Draw the labeled circuit diagram of a modified Impedance Relay and derive the relay equation in R-X plane , starting from fundamentals and draw the concerned R-X diagram (locus) also. [2+8+2 marks]

6) (a) Derive the expression for Transient Recovery Voltage [$e_{TRV}(t)$] of a circuit breaker, starting from fundamentals with completely labeled necessary circuit diagrams. Apply the method of Laplace Transform ,with all initial conditions relaxed.

(b) In context to part (a) question: L= 9.0 Henry , C= 0.02 μF and maximum value of RRRV is 800000 KV/sec
Calculate the maximum value of current through the capacitor. [6+5 Marks]

[P.T.O]

Continued

7) Applying "Equal Area Criterion" , calculate the critical clearing angle for the system shown in the following figure(Fig.1) for a three –phase fault at the point "P". The generator is delivering 0.8 p.u power under pre- fault condition. Total reactance for (l_1 + l_2) length of the second line is j0.27 . At the post-fault condition, the faulty line is switched off and power is supplied through the healthy line(line no. 1). All reactances are given in p.u. Also it is given that: $l_1 = (1/2)\, l_2$ [12 Marks]

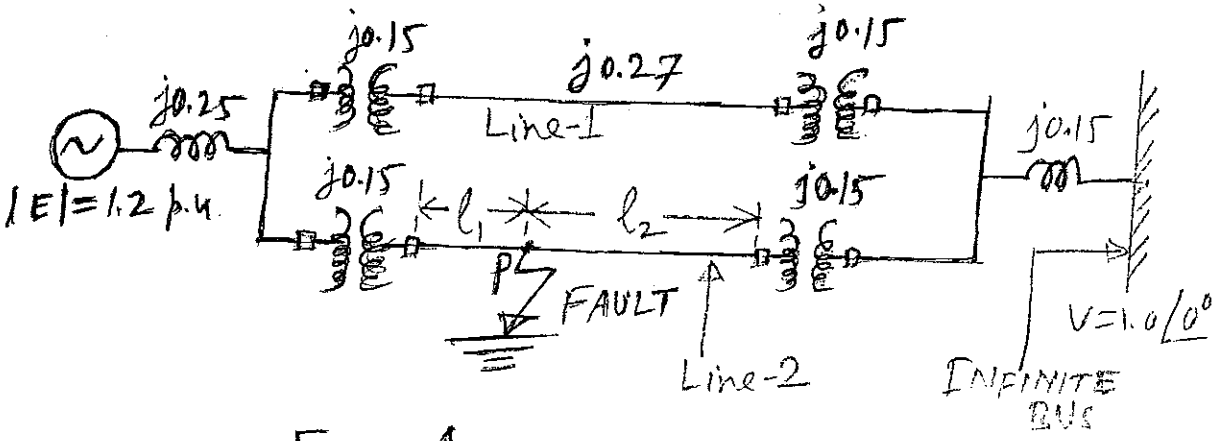

Fig. 1

BITS, Pilani – Dubai
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IV year EEE, 1st Semester 2010-11
Course Title - Advanced Power Systems (EEE C 462)
Test-II (Open Book)
Full Marks – 20 (Weightage 20 %) Duration—50 min.
Date: 11-12-2010
Instruction: Text Book and handwritten class notes are only allowed.

1.) Two 25 MVA, 11.0 KV (line-to-line), three phase star connected Synchronous Generators are connected in parallel . The star point of one of the generators is grounded through a resistance of 3.0 ohm/phase and that of the other is isolated. A "single line –to-ground" fault occurs on phase "a" and $I_b = I_c = 0$. Each generator has positive, and zero sequence impedances as j0.18 p.u, and j0.10 p.u , respectively. The values of subtransient direct axis and quadrature axis armature synchronous reactances of each machine are : $X_d^{"} = j\ 0.18$ p.u and $X_q^{"} = j\ 0.12$ p.u . Fault impedance is neglected.
Calculate: (a) Negative sequence reactance of each machine(in p.u).
(b)the fault current (in p.u), in complex polar form.
(c) the current(magnitude) in the grounding resistor (in amps or kilo amps.) [1+ 3+2 Marks]

2.) A three phase synchronous generator of reactance 1.2 p.u is connected to an infinite bus-bar(magnitude of voltage,V = 1.0 p.u) through transformers and a line of total reactance of 0.6 p.u. The generator excitation e.m.f is 1.1 p.u and its inertia constant is H= 3.5 MW-s/MVA. The damping power coefficient of the machine is 0.2 p.u/electrical radian/sec. The operating load angle (δ_o) = 20 degree(electrical). The prime mover (mechanical) power input to the generator remains unchanged. In connection with the Steady State Stability Criterion: (Operating frequency = 50 Hz.)
(i) Develop the Differential Equation in $\Delta\delta$ (Small Perturbation Model).
(ii) Applying Laplace Transform(initial conditions being relaxed) to the D.E in (i), develop the Characteristic Equation and find out the roots.
(iii) Hence, comment on the steady state stability aspect of the machine. [1+3+1 Marks]

3.) A synchronous generator delivers 1.0 p.u power to an infinite bus through a transmission circuit in which resistance is neglected. The values of the maximum power transferable are given as follows:
Before fault----1.8 p.u. During fault---0.5 p.u, After clearance of the fault---K p.u. , where "K" is unknown and K>1.0.
Critical clearing angle is 70.06 degree. δ_{max} indicates the load angle at the point of intersection of the "post-fault P-δ curve" with the line "P_m =1.0 p.u" and also $\delta_{max} > \pi/2$ radian
Applying " Equal Area Crieterion" , prove that

$$0.341\ \mathrm{Cosec}(\delta_{max}) - \mathrm{Cot}(\delta_{max}) = \delta_{max} - 0.834$$ [9 Marks]

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IV year EEE, I Semester 2010-11
Course Title - Advanced Power Systems (EEE C 462)
Test 1
Full Marks – 25 (Weightage 25 %) Duration—50 min
Date: 24---10--2010

(1) A three phase transmission line has: $Z= 300e^{j75}$ ohm per phase and Y=j 0.0025 mho per phase , where the phase angle is given in "degree" unit.The power at the generating station is 40MVA at a power factor of 0.85(lag)at a voltage of 120 KV (line-to-line). There is a load of 10 MW at unity power factor at the mid -point of the line. Calculate the load (in Megawatts) at the distant end of the line. Use nominal-T circuit of the line. [7 Marks]

(2) A short transmission line with a reactance of 18.0 ohm per phase(resistance of the line being considered as zero) supplies a load at0.85 power factor(lag) For a transmission line current of 1000 Amps. per phase, the receiving- and sending-end voltages are to be maintained at 230KV(line-to-line) . Calculate: (a) The load current, (b) The load MVA, (c) MVAR rating of synchronous capacitor required.
The necessary expression (formula) for zero voltage regulation may be directly used and the necessary circuit diagram must be drawn.

The active power drawn by synchronous capacitor may be neglected. [3+2+3 Marks]

(3)(a) Draw the block diagram and T-S diagram (with labeling) in context to a Thermal Power Station (diagram only). No explanation/discussion is needed.

(b) Derive the expression for "Sequence Impedances" of transmission lines with proper circuit diagram and matrix expressions/equations.[4+6 Marks]

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BITS, Pilani – Dubai **[Set-A]**
International Academic City – Dubai
IV year EEE, I Semester 2010-11
Course Title - Advanced Power Systems (EEE C 462)
Quiz II (Set-A)
Full Marks – 14 (Weightage 7 %) Duration—20 min
Date: 08---12—2010

Name--- **Id No.----------**

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(1) Salient features of power system protection (any three) are: (a)_____
(b)_____ (c)_____ [2 Marks]

(2) "Primary winding of a C.T usually consists of a single turn which is the power conductor itself (along with its return circuit)."---TRUE or FALSE?
[1 Mark]

(3)Write the general relay equation with meaning of the concerned symbols.
[2 Marks]

(4) Draw the RX-diagram of an Impedance Relay (Locus in R-X plane).
[2 Marks]

(5) Draw the circuit diagram of Modified Impedance Relay with labeling
[3 Marks]

P.T.O.

(6) Draw typical characteristics of IDMTL Relays with labeling

[2 Marks]

(7) Draw the circuit diagram of a Percentage Differential Relay protecting Generator phase winding [2 Marks]

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1st Sem, 2010-11 / IV yr (EEE) (Set-A)
Quiz-1 / Date 22/11/2010
Comm. Title — ADVANCED POWER SYSTEMS (EEE C462)

(5)

$$\begin{bmatrix} V_{a1} \\ V_{a2} \\ V_{a0} \end{bmatrix} = \begin{bmatrix} E_a \\ 0 \\ 0 \end{bmatrix} - \begin{bmatrix} Z_1 & Z_1/2 & Z_2/2 \\ Z_1/2 & Z_2 & Z_0/2 \\ Z_2/2 & Z_0/2 & Z_0 \end{bmatrix} \begin{bmatrix} I_{a1} \\ I_{a2} \\ I_{a0} \end{bmatrix}$$ — — — 1 Mark.

Statement — "TRUE" or "FALSE"?

The above Matrix Equation is correct

(6) Show the connection of sequence networks for a double line-to-ground fault as shown below :— 2 Marks (Fig. 3)

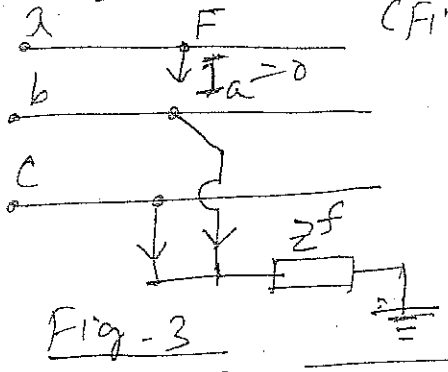

Fig-3

(7.)

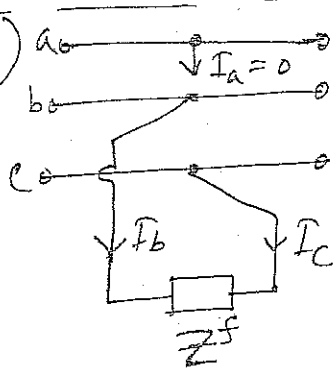

Fig-4.

For such type of Fault shown in Fig. 4, prove that $I_{a0} = 0$ 2 Marks

(8.) For a three phase salient-pole synchronous generator, Z_2 can be expressed as :

(a) $j\left(\frac{X_d'' + X_q''}{4}\right)$ (b) $j\left(\frac{X_d'' + X_q''}{2}\right)$ (c) $j\left(\frac{X_d'' + X_q''}{3}\right)$

(d) $j(X_d'' + X_q'')$ 1 Mark

Course Title – Advanced Power System (EEEE–C462) | BITS, Pilani – Dubai, (SET-A) | 1st Semester 2010-11 | F.M = 16 (8%) | Duration = 20 min (3)

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(9) $V_{a1} - V_{a2} = Z^f I_{a1}$ ⟶ By such expression, is which type of FAULT indicated? --- 1 Mark

(10) Prove that $A^T A^* = 3\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ --- 2 Marks