Tanta University

Department: Elec. Power and Machines Engineering
Total Marks: 85 Marks

Faculty of Engineering

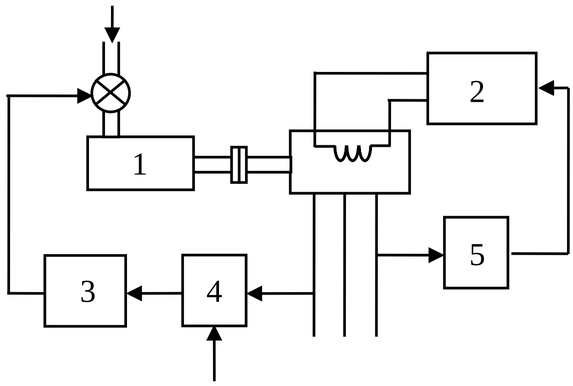
Title: Control of Electrical Power Systems (2)	**Course Code: EPM4228**	**Year: fourth year**
Date: 14, June 2010	**Allowed time: 3 hr**	**No. of Pages: (2)**

Problem number (1) (30 Marks)

a) Mention at least three abnormal conditions that can take place in power systems. Discuss in detail the causes of each one, the effect of each one on the operation of power systems and the possible corrective control action required to restore the normal condition of the power system. (10)

b) Integrate between (explain the link and relation between) the main components of the SCADA system and the main functions of the system. (10)

c) For the shown schematic diagram of load frequency and excitation voltage regulation, write the definition of each block (from 1 to 5) and explain its task in the control system. (10)



Problem number (2) (30 Marks)

a) A load of 200 MW is supplied by two generating units in parallel at 50 Hz. If the ratings of the two units are 100 MW and 200MW and their droop characteristics is 4%, calculate the loading of each unit. (10)

b) Prove that the control of the system voltage can be accomplished only through the control of the reactive power. (10)

c) Draw the block diagram of the automatic generation control (AGC) for interconnected power systems and explain its operation principles. Compare between the functions of this control system and that used with isolated power systems (10)

P.T.O.

Problem number (3) (25 Marks)

a) Draw both the schematic diagram and the control block diagram of the alternator voltage regulator scheme. What is the effect of the stabilization process on the performance of the controller? (10)

b) Explain the operating principles of the on-load tap changing transformer. Compare between this type of voltage control and the synchronous condenser. (10)

c) Define the following terms: thyristor-controlled reactor, thyristor-switched capacitors, fixed capacitors-thyristor-controlled reactor (5)

Good Luck

Course Examination Committee
Dr. Ahmed Refaat Azmy
Dr Ibrahem Beder
Prof. Mazen Abd-Elsalam
Prof. Mohamed Tantawy
Course Coordinator: Dr. Ahmed Refaat Azmy

(قوى جديد)

Tanta University
Faculty of Engineering
Department of Mechanical Power Engineering
Year: Fourth Subject: Hydraulic Machines B
Name: Z.M. Omara (2004)

Date: -6-2010
Time allowed: 3 Hours
Full Marks : 75
Final Exam: pages 2
Academic Number: MEP4220

Question 1 **(marks 19)**

1-a) Explain t he function of the air vessel in a reciprocating pump?
2-

1-b) In a reciprocating pump prove that the work done against pipe friction , if air vessel is fitted , compared with that done with no air vessel is $(3/2\ \pi^2)$.

1-c) Suggest some methods to smoothen or even-out the pulsating discharge from a reciprocating pump.

1-d) A single acting reciprocating pump has a plunger of 7.5 cm diameter and stroke length of 15 cm. It takes its supply of water from a sump 3 m below the pump, through a pipe of 5 m long and 4 cm in diameter. It delivers water to a tank 12 m above the pump through a pipe 15 m long and 3 cm in diameter. If the separation occurs at 0.75 kg/cm^2 below the atmospheric pressure, find the maximum speed at which pump may be operated without separation. Assume the plunger has a simple harmonic motion.

Question 2 **(marks 19)**

1-a) Define cavitations in a reciprocating pump. And explain how it can be avoided.

2- b) Show that the maximum acceleration head in a reciprocating pumps. without air vessel is given by $Hi= (L/g)(A/a)\ w^2 r$.

2-c) How does the basic operation of a lift pump differ from that of a force pump. Explain with net sketches.

2-d) A double acting reciprocating pump of 175 mm diameter by 350 mm stroke draws from a source of 3 m below, and delivers to a height 46 m above, its own level. Both suction and delivery pipes are 100 mm diameter and their respective lengths are 6 m and 75 m. The pump piston has simple harmonic motion and makes 40 double strokes per minute. Large air vessel is fitted on both sides of the pump. The air vessel on the suction side is 1.5 m away from the cylinder, while that on the delivery side is 45 m away. The friction for the pipes is 0.032. Determine the pressure difference between the two sides of the piston at the beginning of strokes

Question 3 **(marks 19)**

3- a) Draw sectional view of Pelton, Francis and Kaplan turbines. And explain the working mechanism of each turbine?

3-b) By means of a neat sketch, explain how the reaction turbines are governed for constant speed.

3- c) A 1500 KW , generator is driven by a pelton wheel the total available head being 350 m , and the overall efficiency of the turbine , nozzle and generator is 0.8 , the transmission losses are 4 % and the nozzle coefficient is 0.98.
Determine the wheel and nozzle diameters, the speed in rpm, turbine BHP, given that: speed ratio ($\frac{U}{V} = 0.45$) , diameter of wheel = 12 times the jet diameter and efficiency of generator = 0.9 .

3-d) A Kaplan turbine, operates under a net head of 20m, develops 50,000hp with an overall efficiency of 86%. The speed ratio is 20 and flow ratio is 0.6. The hub diameter of wheel is 0.35 times the outside diameter of wheel. Find the diameter and speed of the turbine.

Question 4 **(marks 18)**

4- a) Write short notes on the flowing item :
- Cavitations in hydraulic turbines.
- Draft tubes

4- b) Discuss and compare with net sketches The load and efficiency characteristics curves for Pelton, Francis and Kaplan turbines. What conditions govern the high efficiency of reaction turbines.

4- c) A Francis turbine of Di/Do = 0.5 gave the following data when using at full load: Net head = 80 m, hyd. Eff. = 0.84, Speed ratio = 1.2, Flow ratio = 0.3.
If the load is reduced and before the governing system operates the turbine speed rises by 50%. Draw carefully the inlet and outlet velocity triangles for the two cases of loading. Calculate approximately the hydraulic efficiency in the second case (take $g = 10\ m/s^2$)

قوى كهربية (حديث)

Tanta University
Faculty of Engineering
Electrical Power and Machines Engineering
Computer Application in Electrical Machines

Forth Year/ Second Term

Final Exam 2009/2010
Time: **3:00** hr   Max Marks: 85

Question 1: Marks: [20]

Select the correct choice(s) for the following statements:

a- The main difference between computers and calculators is [4]
1- The ability to execute program
2- The ability to store programs
3- The ability to handle large numbers
4- The ability to deal with text

b- The computer system includes [4]
1- Operating system
2- Hardware and software
3- Human ware
4- Non of the above

c- Programming paradigm is [4]
1- fundamental style of programming
2- style of solving software engineering problems
3- formulation methodology
4- a concept that does not affect directly programming style

d- The C programming language supports the following programming paradigms [4]
1- Object oriented programming
2- procedure oriented programming
3- Matrix oriented programming
4- Non of the above

e- A doubly linked list will use larger memory than array but [4]
1- It can use fragmented memory
2- use less variable names
3- store larger amount of data
4- none of the above

Question 2: Marks: [20]

a- Write a C++ program to perform the matrix Multiplication. Your program should have the following features: [7]

- Check the validity of matrix dimensions for the operation required
- Values of matrix's elements are initialized inside the program.
- Output should be transferred into a file.
- Comments, variable names and file format should be as explained in the table below.

Variables					
First Matrix	A	Type double	Second Matrix	B	Type double
Rows of **A**	RowA	Type integer	Rows of **B**	RowB	Type integer
Columns of **A**	ColA	Type integer	Columns of **B**	ColB	Type integer

Result Matrix	C	Type double
Rows of **C**	RowB	Type integer
Columns of C	ColB	Type integer

b- Use your own statements to explain the rule of the different gains of PID controller. [6]

c- Write down the equations of dynamics required to model DC series excited motor supplied from ac supply with full wave rectifier. Support your answers with suitable illustrators whenever necessary. [7]

Question 3: (Vissim) Marks: [15]

a- Use your own statements to compare between analogue computers and digital computers. Support your answer with illustrations whenever necessary. [5]

b- The voltage source inverter, with the circuit shown in Fig. 3-a, is used to obtain three phase voltage V_{aINV} , V_{bINV}, V_{cINV} from a DC voltage supply V_{dc}. A comparison between a triangle V_c and the demand three-phase signals V_{pa}, V_{pb} and V_{pc}. The logic used to control the switches is given by: [10]

$$B_p = \begin{cases} 1 & v_p^* > v_c \\ 0 & v_p^* \le v_c \end{cases}$$

The resulting inverted voltage is given by:

$$v_{aINV} = (2B_a - B_b - B_c).V_{dc}/3$$

$$v_{bINV} = (2B_b - B_c - B_a).V_{dc}/3$$

$$v_{cINV} = (2B_c - B_a - B_b).V_{dc}/3$$

Fig. 3-b shows the resulting waveform of the resulting inverted voltage of phase *a*. **In the scope of the above statements, redraw the given analogue computer model in your paper and complete the missing blocks and arithmetical signs.**

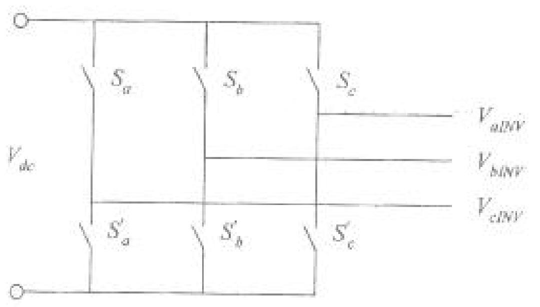


Fig. 3-a: Equivalent circuit of voltage source inverter

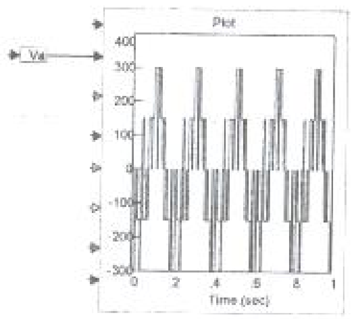
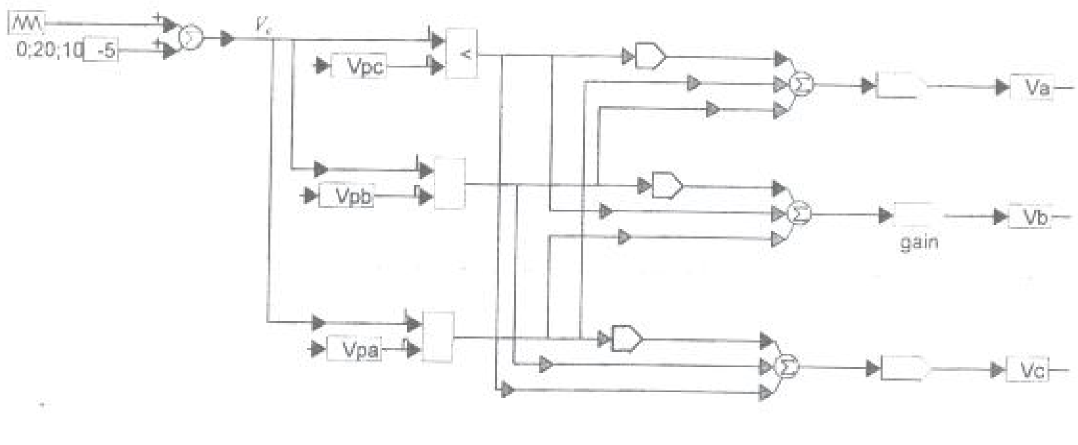
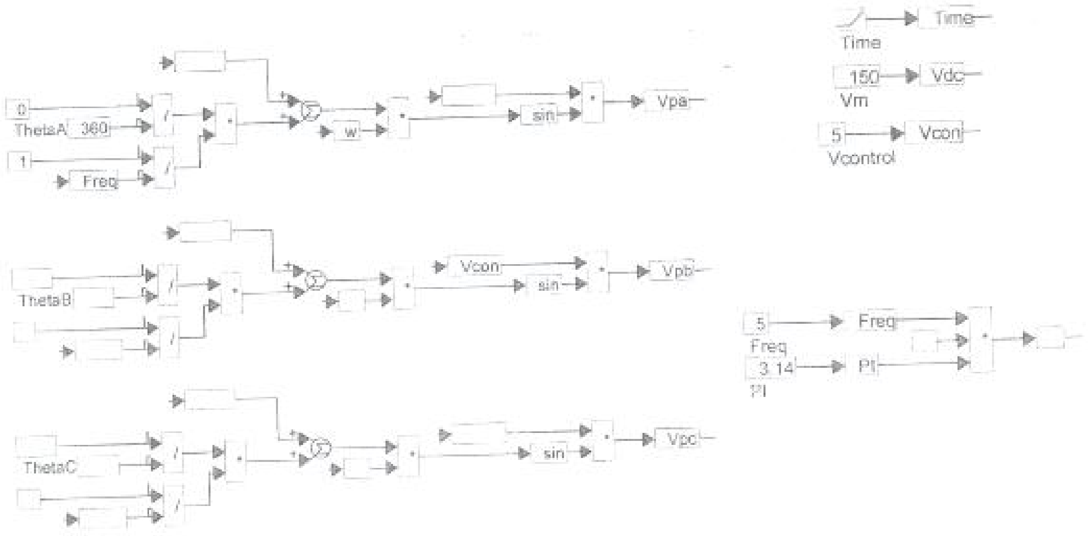


Fig. 3-b: Resulting waveform for inverted voltage of phase *a*.





Marks: [15]

Question 4

a- The equivalent circuit of ideal transformer is shown in Fig. 4-a. Three ideal single-phase transformers are used to construct three-phase transformer. The three-phase transformer is shown in Fig. 4-b. Write down ***netlist*** file with following requirements:

  a- Redraw the circuits shown in Fig. 4-a and Fig. 4-2, suggest a suitable reference node.

  b- Define a sub-circuit to define the ideal single-phase transformer.

  c- Simulate the three-phase transformer shown in Fig. 4-2 using the values listed below.

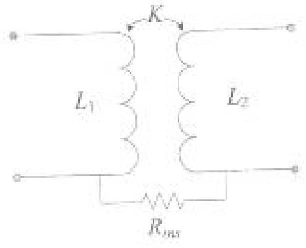


Fig. 4-a: Equivalent circuit of ideal transformer

Symbol	Value	Unit
L_1	0.60	H
$L2$	0.15	H
K	0.999	
R_{ins}	10^6	Ω
V_m	50	V
R_{Load}	20	Ω
C_{Load}	2.0	μF
f	50	Hz

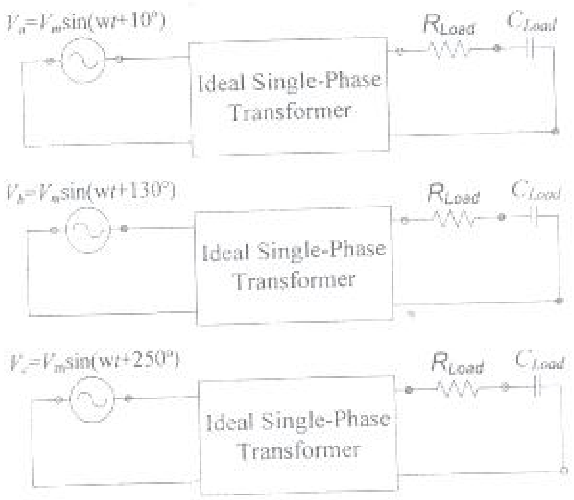


Fig. 4-b: Three ideal single-phase transformers

Marks: [15]

Question 5:

a- Starting form Maxwell's equations derive an expression to retain the magnetostatic problem in a single equation in terms of vector magnetic potential A and current density **J**. The equation [7] should be suitable for finite element solution.

b- Describe a finite elements model including geometry to solve the problem shown in Fig. 5-a. Use solid lines and axis as boundaries for your problem. Your answer should contain the following: [8]

- Points names and coordinates
- Lines names and their end points
- Area names and material properties
- Definition of boundary conditions and the geometrical shapes they are applied to.

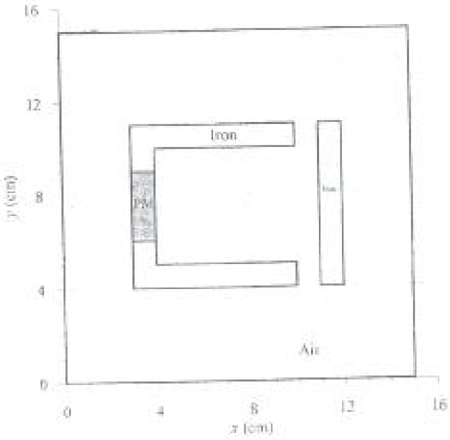


Fig. 5-a: Geometry of problem 5-1

With Best Wishes

قود قديم

Tanta University	Date: -6-2010
Faculty of Engineering	Time allowed: 3 Hours
Department of Mechanical Power Engineering	Full Marks : 100
Year: Fourth Subject: Hydraulic Machines B	Final Exam: pages 2
Name: Z.M. Omara (1997)	Academic Number: MEP4220

Question 1 **(marks 25)**

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1-b) In a reciprocating pump prove that the work done against pipe friction , if air vessel is fitted , compared with that done with no air vessel is $(3/2\ \pi^2)$.

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Course Title: Application of Power System Protection	Course Code: EPM4229	Year: 4th
Date: June 2010 (Second term)	Allowed time: 3 hrs	

Answer the following questions

Problem number (1) **(20 Marks)**

a) What are the abnormal conditions in a large alternator against which protection is necessary? Discuss them briefly? (4 Marks)

b) Explain the current differential protection system as applied to Δ- connected alternator. Will his protection provide any protection for turn-to-turn fault? (4 Marks)

c) What are the rotor faults in an alternator? For such faults give their causes and suggest protective measures. (4 Marks)

d) The unit generator shown in Fig. 1 has a capacitance-to-ground of value 0.2885 microfarads per phase and the ground resistor R has a 64.14 kW rating at 138 V.

i. Determine the fault current magnitude for a single-line-to-ground fault between the generator and the power transformer.

ii. Determine the three-phase fault current magnitude for a fault between the generator and the power transformer.

iii. Choose a CT ratio for the generator differential protection. Compare the fault currents of parts a and b with the generator relay pick-up value of 0.15 A.

iv. How much voltage is available to operate an overvoltage relay 59G when connected across the grounding resistor? What is the multiple of pickup if 59G minimum operating value is 5.4 V. How much current flows through the resistor? Select a CT and suggested overcurrent pickup values for the 50/51 relay.

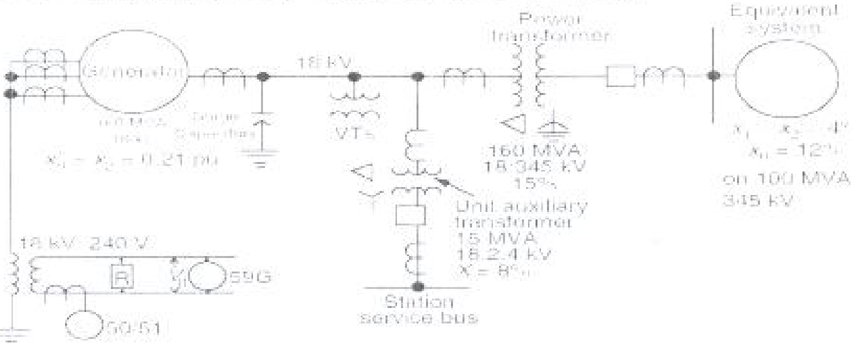

Fig. 1

Problem number (2) **(20 Marks)**

a) Current differential protection system is not sufficient to protect alternators against earth fault. Discuss this fact aided with neat-sketch and numerical values if needed (4 Marks)

b) Earth fault protection system used for alternator does not cover 100% of the alternator winding. Justify the previous statement and explain one method used to protect 100% of winding?

c) Specify the time elapsed between fault detection and fault clearing for large alternator. Explain your answer (4 Marks)

d) Figure 2 shows a percentage differential relay applied for the protection of a generator winding. The relay has a 0.1 A minimum pickup and a 10% slope. A high-resistance ground fault has occurred as shown near the grounded-neutral end of the generator winding while it is carrying load with the currents flowing at each end of the generator as shown. Assume that the CT ratios are as shown in the figure and they have no error. Will the relay operate to trip the generator under this condition? Would the relay operate if the generator were carrying no load with its breaker open? Draw the relay operating characteristic and the points that represent the operating and restraining currents in the relay for the two conditions. (12 Marks)

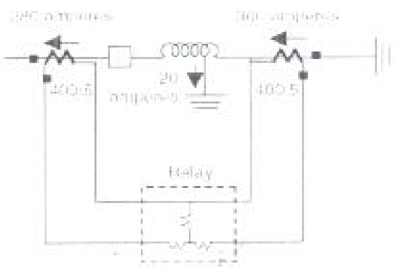

Fig. 2

Problem number (3) **(20 Marks)**

1) Draw the connection diagram of a differential relay for the protection a Y-Δ transformer. How does the bias winding of differential relay restricts a malfunctioning of the relay against: (i) CT mismatch, (ii) on-load tap changer and (iii) magnetizing current? What is magnetizing inrush current? What is the principle used to make a differential relay insensitive to magnetizing inrush current? (5 Marks)

2) What are the various protections usually recommended for 132/33 kV, 50 MVA power transformer? Discuss one of them with neat sketch. (5 Marks)

3) For the transformer bank of Fig. 3, assume that phases A, B, C on the 13.8 kV side have 3000/5 CTs with taps at 1500, 2000, 2200, and 2500 A, and that the 69 kV circuits a, b, c have 600/5 multi-ratio CTs with taps at 400, 450, 500, and 550. (10 Marks)

i. Show the three-phase connections for transformer differential relays to protect this bank.
ii. Select suitable 69 kV and 13.8 kV CT ratios for this transformer differential application.
iii. If the differential relay has taps of 4, 5, 6, and 8, select two taps to be used with the CT ratios selected in part b so that the percent mismatch is less than 10%.
iv. With this application and setting, how much current can flow to operate the differential relay(s) if the phase-a-to-ground fault is within the differential zone? How many of the three relays operate for this ground fault?

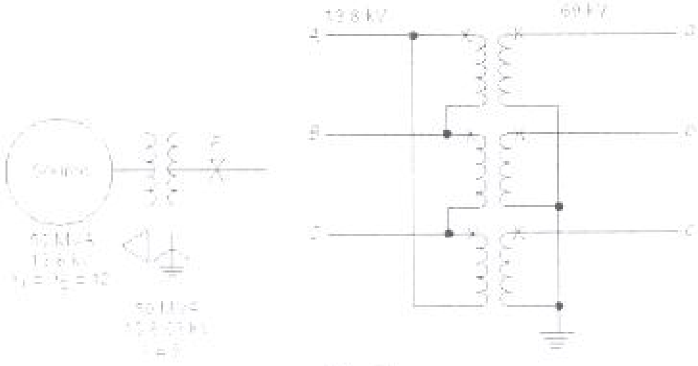

Fig. 3

Problem number (4) **(15 Marks)**

1) What are the different bus-bar arrangements possible in a substation? Discuss them briefly with the type of protective relays required for bus-bar in high voltage substation? (5 Marks)

2) Explain the protection system for bus-bar used in double bus single breaker system. (5 Marks)

3) For the three-phase system shown in Fig. 4. (5 Marks)

i. Draw a complete connection diagram for differential protection.
ii. Suggest a method to minimize the mismatch in current transformers.

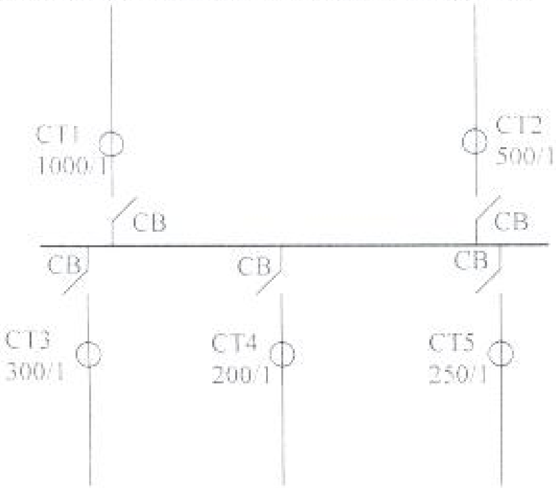

Fig. 4

Good Luck

Course Examination Committee

Dr. Mohamed Abo Elazm

قوى كهربية جديد

TANTA UNIVERSITY

Faculty of Engineering

Electrical Engineering Dept.

Fourth Year

Course: Electrical Drive

Marks: 85

Time: 3 hour

Date: 3 /6/2010

Answer all the following questions:

1-1) Explain how to measure the moment of inertia for an electrical drive?

1-2) A three-phase, 120 kw, 4-pole, 1460 rpm wound rotor induction motor drives a load whose torque varies such that a torque of 2000 N.m of 10 sec. duration is followed by a torque of 500 N.m of duration long enough for the motor to attain steady-state. Calculate the moment of inertia of the flywheel, if the motor torque should not exceed twice the rated value. Moment of inertia of the motor is 10 kg-m^2. Motor has a linear speed-torque curve in the region of interest.

2-1) What are the important features of traction drives?

2-2) A goods train is employed to transport Ore from the top of hill to ground. Weight of the empty train is 1000 tonnes and when fully loaded is 5000 tonnes. The track has a gradient of 15 in 1000 and maximum train speed is limited to 30 km/hr. Acceleration when climbing should not be less than 0.3 km/hr/s. Train resistance is 40 N/tonne, rotational inertia 10% and the coefficient of adhesion 0.25. How many locomotives, each weighting 100 tonnes will be required?

3-1) The temperature rise of a motor when operating for 30 min. on full load is 25°C and becomes 40°C when the motor operates for another 30 min. on the same load. Determine the heating time constant and the steady state temperature rise.

3-2) The speed of a 20 hp, 440 V, 900 rpm, separately excited dc motor is controlled by a three-phase full converter. The field circuit is also controlled by a three-phase full converter. The ac input to armature and field converters is three-phase, Y-connected, 220 V, 50 Hz. The armature resistance, R_a=0.15Ω, the field circuit resistance, R_f=145Ω and the motor voltage constant, K_v=1.15 V/A-rad/s. The viscous friction and no-load losses are negligible. The armature and field currents are continuous and ripple-free, (a) If the field converter is operated at the maximum field current and the developed torque is T_d=106 N-m at 750 rpm, determine the delay angle of the armature converter, α_a, (b) If the field circuit converter is set to the maximum field current, the developed torque is T_d=108 N.m, and the delay angle of the armature converter is α_a=0, determine the speed, (c) For the same load demand as in part (b), determine the delay angle of the field circuit converter if the speed has to be increased to 1800 rpm.

P.T.O.

4-1) 3-phase, 400 V, 50 Hz, 10 kW, 960 rpm, 6-pole star-connected slip-ring induction motor has the following constants referred to the stator $R_s = 0.4\Omega$, $R'_r = 0.6\ \Omega$, $X_s = X'_r = 1.4\ \Omega$.

The motor drives a fan load at 960 rpm. The stator to rotor turns ratio is 2.

(a) What resistance must be connected in each phase of the rotor circuit to reduce the speed to 800 rpm?

(b) When the motor is controlled by static rotor resistance control, calculate the value of external resistance, so that motor runs at 800 rpm for the duty ratio of 0.5.

4-2) A 3-phase, 440V, 6 pole, 970 rpm, 50 Hz, Y-connected induction motor has the following parameters referred to the stator. $R_s=0.2\ \Omega$, $R'_r=0.15\Omega$, $X_s = X'_r = 0.4\Omega$. The stator to rotor turns ratio is 3.5. The motor speed is controlled by the static Scherbius drive. The drive is designed for a speed range of 30% below the synchronous speed. The maximum value of firing angle is 165°. Calculate:

(i) turns ratio of the transformer.

(ii) torque for a speed of 850 rpm and $\alpha = 140^\circ$.

(iii) firing angle for half the rated motor torque and a speed of 850 rpm.

5-1) Draw and explain the self-controlled synchronous motor drive scheme.

5-2) A synchronous motor is controlled by a load commutated inverter, which in turn is fed from a line commutated converter. Source voltage is 6.6 kV, 50 Hz. Load commutated inverter operates at a constant firing angle α_ℓ of 140° and when rectifying $\alpha_\ell = 0^\circ$, dc link inductor resistance $R_d = 0.1\Omega$. Drive operates in self-control mode with a constant (V/f) ratio. Motor has the details: 8 MW, 3-phase, 6600 V, 6-pole, 50 Hz, unity power factor, star connected, $X_s=2.8\ \Omega$. $R_s = 0$. Determine source side converter firing angles for the following:

(i) Motor operation at the rated current and 500 rpm. What will be the power developed by motor?

(ii) Regenerative braking operation at 500 rpm and rated motor current. Also calculate power supplied to the source.

------------------------------ GOOD LUCK ------------------------------

فوق متقدم

TANTA UNIVERSITY

Faculty of Engineering

Electrical Engineering Dept.
Fourth Year
Course: Electrical Drive

Marks: 90
Time: 3 hour
Date: 3/6/2010

Answer all the following questions:

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1-2) A three-phase, 120 kw, 4-pole, 1460 rpm wound rotor induction motor drives a load whose torque varies such that a torque of 2000 N.m of 10 sec. duration is followed by a torque of 500 N.m of duration long enough for the motor to attain steady-state. Calculate the moment of inertia of the flywheel, if the motor torque should not exceed twice the rated value. Moment of inertia of the motor is 10 kg-m^2. Motor has a linear speed-torque curve in the region of interest.

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2-2) A goods train is employed to transport Ore from the top of hill to ground. Weight of the empty train is 1000 tonnes and when fully loaded is 5000 tonnes. The track has a gradient of 15 in 1000 and maximum train speed is limited to 30 km/hr. Acceleration when climbing should not be less than 0.3 km/hr/s. Train resistance is 40 N/tonne, rotational inertia 10% and the coefficient of adhesion 0.25. How many locomotives, each weighting 100 tonnes will be required?

3-1) The temperature rise of a motor when operating for 30 min. on full load is 25°C and becomes 40°C when the motor operates for another 30 min. on the same load. Determine the heating time constant and the steady state temperature rise.

3-2) The speed of a 20 hp, 440 V, 900 rpm, separately excited dc motor is controlled by a three-phase full converter. The field circuit is also controlled by a three-phase full converter. The ac input to armature and field converters is three-phase, Y-connected, 220 V, 50 Hz. The armature resistance, R_a=0.15Ω, the field circuit resistance, R_f=145Ω and the motor voltage constant, K_v=1.15 V/A-rad/s. The viscous friction and no-load losses are negligible. The armature and field currents are continuous and ripple-free, (a) If the field converter is operated at the maximum field current and the developed torque is T_d=106 N-m at 750 rpm, determine the delay angle of the armature converter, α_a, (b) If the field circuit converter is set to the maximum field current, the developed torque is T_d=108 N.m, and the delay angle of the armature converter is α_a=0, determine the speed, (c) For the same load demand as in part (b), determine the delay angle of the field circuit converter if the speed has to be increased to 1800 rpm.

P.T.O.

4-1) 3-phase, 400 V, 50 Hz, 10 kW, 960 rpm, 6-pole star-connected slip-ring induction motor has the following constants referred to the stator $Rs = 0.4\Omega$, $R'r = 0.6\ \Omega$, $Xs = X'r = 1.4\ \Omega$.
The motor drives a fan load at 960 rpm. The stator to rotor turns ratio is 2.

(a) What resistance must be connected in each phase of the rotor circuit to reduce the speed to 800 rpm?

(b) When the motor is controlled by static rotor resistance control, calculate the value of external resistance, so that motor runs at 800 rpm for the duty ratio of 0.5.

4-2) A 3-phase, 440V, 6 pole, 970 rpm, 50 Hz, Y-connected induction motor has the following parameters referred to the stator. $Rs=0.2\ \Omega$, $R'r=0.15\Omega$, $Xs = X'r = 0.4\Omega$. The stator to rotor turns ratio is 3.5. The motor speed is controlled by the static Scherbius drive. The drive is designed for a speed range of 30% below the synchronous speed. The maximum value of firing angle is 165°. Calculate:

(i) turns ratio of the transformer.

(ii) torque for a speed of 850 rpm and $\alpha = 140^\circ$.

(iii) firing angle for half the rated motor torque and a speed of 850 rpm.

5-1) Draw and explain the self-controlled synchronous motor drive scheme.

5-2) A synchronous motor is controlled by a load commutated inverter, which in turn is fed from a line commutated converter. Source voltage is 6.6 kV, 50 Hz. Load commutated inverter operates at a constant firing angle α_ℓ of 140° and when rectifying $\alpha_\ell = 0^\circ$, dc link inductor resistance $R_d = 0.1\Omega$. Drive operates in self-control mode with a constant (V/f) ratio. Motor has the details: 8 MW, 3-phase, 6600 V, 6-pole, 50 Hz, unity power factor, star connected, $X_s=2.8\ \Omega$. $R_s = 0$. Determine source side converter firing angles for the following:

(i) Motor operation at the rated current and 500 rpm. What will be the power developed by motor?

(ii) Regenerative braking operation at 500 rpm and rated motor current. Also calculate power supplied to the source.

------------------------------ GOOD LUCK ------------------------------

(قوى كهربية ١ قديم)

Tanta University	Department: Elec. Power and Machines Engineering Total Marks: 85 Marks	Faculty of Engineering

Course Title: Power system analysis Date: July 7th 2010 (Second term)	Course Code: EP4202 Allowed time: 3 hrs	Year: 4th No. of Pages: (2)

Remarks: (answer the following questions... assume any missing data... answers should be supported by sketches...etc)

Problem number (1) **(30 Marks)**

a) Discuss briefly the different methods used for transient stability improvement of electrical power system. (5 Marks)

b) The power transfer from infinite bus to synchronous motor is 0.4 of its maximum power capacity. Find the maximum additional mechanical power without causing instability. (10 Marks)

c) An Y-grounded alternator having an induced e.m.f. of 1.6 p.u. is connected to infinite bus of 1.0 p.u. If two lines connected in parallel between the alternator and the infinite bus with 0.6 p.u. reactance each and alternator reactances are 0.2 p.u., 0.21 p.u. and 0.05 p.u. for positive, negative and zero sequence reactances respectively. Determine the critical clearing angle for the following solidly faults at mid point of second line if the initial power transfer is 1.6 p.u.: (i) symmetrical three-phase fault; (ii) line-to-ground fault. (15 Marks)

Problem number (2) **(25 Marks)**

a) For the system shown in Figure (1):

(i) Determine the bus voltages at buses 2 and 3 if $V_1 = 1.02\angle 0\ p.u.$, slack bus, using fast-decoupled method. (Only one-iteration required).

(ii) If after some iterations the bus voltages are $V_1 = 1.02\angle 0\ p.u.$, $V_2 = 0.951\angle -0.0162\ p.u.$ and $V_3 = 0.9426\angle -1.8586\ p.u.$ find the active and reactive power generation at slack bus and power losses through line between buses 1 and 2. (20 Marks)

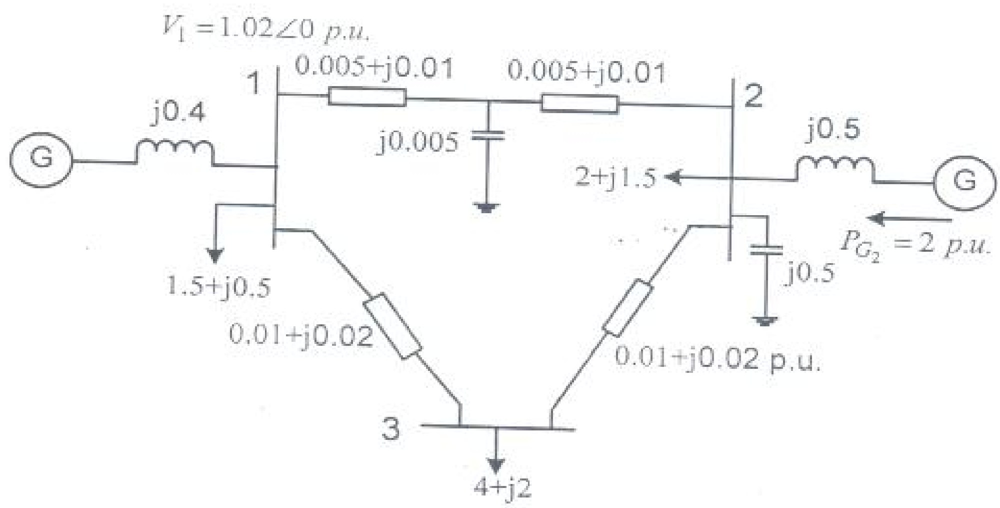


Figure (1)

b) Discuss briefly the importance of power flow calculations for electrical power system analysis. (5 Marks)

Problem number (3) **(30 Marks)**

a) Unsymmetrical fault occurred at terminals of grounded Y-connected three-phase synchronous generator. If the symmetrical components of phase voltages at fault are $V_{a1} = 0.5\ p.u.$, $V_{a2} = -0.4\ p.u.$ and $V_{a0} = -0.1\ p.u.$ while the zero sequence current at fault position is $-j1.6\ p.u.$ Find: (i) fault type; (ii) the positive, negative and zero sequence impedances of the alternator if $E = 0.9\angle 0^0\ p.u.$; (iii) the line currents at fault position; (iv) the phase and line voltages at generator terminals.

(7 Marks)

b) For four-bus power system shown in Figure (2), find the fault current, bus voltages and line currents if symmetrical three-phase fault occurred at bus 3. assume no load conditions. The system data is given in Table (1)

(16 Marks)

Table (1) Data of power system shown in Figure (2)

Item	MVA Base	Rating Voltage	x_1	x_2	x_0
G_1	75	23 kV	0.15	0.16	0.05
G_2	75	23 kV	0.15	0.16	0.05
T_1	75	23/220 kV	0.1	0.1	0.1
T_2	75	23/220 kV	0.1	0.1	0.1
TL_1	75	220 kV	0.15	0.15	0.3
TL_2	75	220 kV	0.125	0.125	0.25
TL_3	75	220 kV	0.15	0.15	0.3
TL_4	75	220 kV	0.125	0.125	0.25

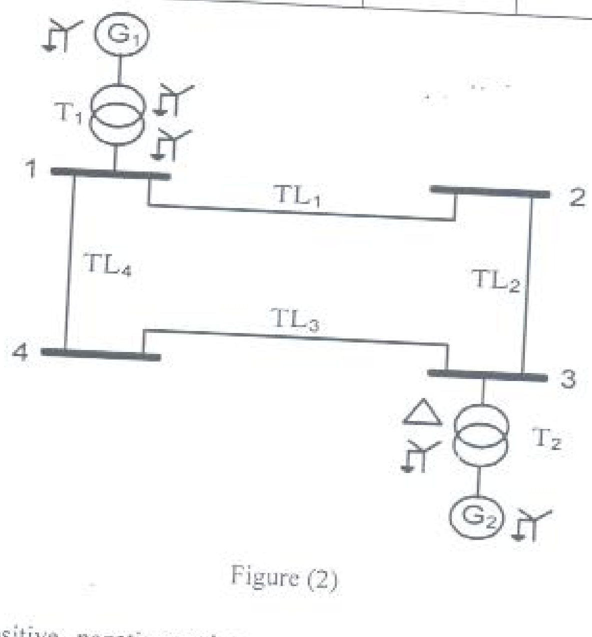


Figure (2)

c) Three-phase generator with positive, negative and zero sequence reactances of x_1, x_2 and x_0 respectively. If the generator is star connected with solidly grounded reactance of x_n, find: (i) the fault current for solidly three-phase fault at generator terminals; (ii) the fault current for solidly line-to-ground fault at generator terminals; (iii) the condition for equal fault current for parts (i) and (ii).

(7 Marks)

(With My Best Wishes)
Dr. Ibrahim Bedir

Electrical Power and Machines Engineering Department

Tanta University

Faculty of Engineering

Course Title: Special Electrical Machines		**Course Code:** EPM4230
Date: 09/06/ 2010		**Year:** 4^{th} Power
Maximum Marks: 75	**No. of Pages:** 3	**Allowed time:** 3 hrs.

Remarks: (answer the following questions... assume any missing data... answers 1should be supported by sketches...etc)

Question(1) *(a=5 Marks, b=10 Marks)*

a) Aided clear diagrams explain and analyze the operation of a single-phase induction motor using the double revolving field theory. Mention three methods used to make it self starting, showing the connection diagram and torque-slip characteristic for each method.

b) The following test data were obtained for a 1/2 hp, 100V, 1740 rpm, 60 Hz, 4 pole, single-phase induction motor has the following:

Stator winding resistance = 1.8 Ω

Blocked rotor test	:	V = 36.06 V,	I = 5 A,	P = 100 W
No load test	:	V = 100 V,	I = 4 A,	P = 90 W

i. Obtain an equivalent circuit for the motor for running conditions.

ii. Determine the no load rotational loss.

iii. Determine the motor efficiency and the developed torque at rated speed.

Question(2) *(a=5 Marks, b=10 Marks)*

a) Aided with clear diagrams explain the principle of operation of a self-excited induction generator. Sketch its equivalent circuit under no-load and loaded conditions. What are the parameters that affect the voltage build of the self excited induction generator when feeding isolated loads?

b) A 240 V, 50 Hz ac series motor is exerting a torque of 0.5 Nm at rms current of 1.2 A. The total resistance and self inductance of the field and armature windings are 60 Ω and 0.5 H respectively. When this motor is connected to 240 V dc supply and loaded to draw 1.2 A such that it exerts a torque of 0.5 Nm. Neglecting saturation, iron and friction losses, determine

i. The rotational emf, E_{ac} and E_{dc}.

ii. Output power, $(P_{o/p})_{ac}$ and $(P_{o/p})_{dc}$

iii. Speed, n_{ac} and n_{dc}

iv. Power factor when connected to ac source, cos Φ.

v. Efficiency, η_{ac} and η_{dc}

vi. Comment on the results obtained above.

Question(3) *(a=5 Marks, b=10 Marks)*

a) Aided with clear sketches, explain the principle of operation of linear induction motor. State how the direction of LIM may be reversed. Derive an expression for the slip of a LIM giving definition of each term used in the expression. State a possible application of a LIM.

b) Suggest a suitable design for a six-phase multi-stack stepper motor to obtain a step angle of 1.2°. In your design:

i. Determine number of stacks, number of stator poles in each stack, number of stator pole's teeth and number of rotor teeth.

ii. Draw a cross-sectional view of your designed motor

iii. What is the stepping rate of this motor.

Question(4) *(a=5 Marks, b=10 Marks)*

a) Define, aided with clear sketches whenever possible, the following terms:

i. AC brushless servo motor.

ii. Permanent magnet motors.

iii. Synchros (selsyn).

b) Derive the relation between stator number of poles, rotor number of poles and number of stator pole windings connected in series to form one phase.

For a 4 phase SRM calculate all possible fully open conduction angles for all possible switching modes.

Question(5) *(a=5 Marks, b=10 Marks)*

a) Draw sketches of an SRD showing the different components.

Draw stator and rotor laminations of three-SRD

Explain SRD principle of operation.

Draw two different switching circuits suitable for a 3-phase SRD.

Tanta University

Department: Elec. Power and Machines Engineering
Total Marks: 85 Marks

Faculty of Engineering

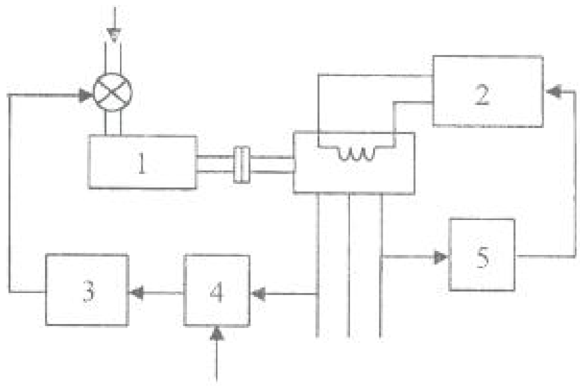
Title: Control of Electrical Power Systems (2)	Course Code: EPM4228	Year: fourth year
Date: 14, June 2010	Allowed time: 3 hr	No. of Pages: (2)

Problem number (1) **(30 Marks)**

a) Mention at least three abnormal conditions that can take place in power systems. Discuss in detail the causes of each one, the effect of each one on the operation of power systems and the possible corrective control action required to restore the normal condition of the power system. (10)

b) Integrate between (explain the link and relation between) the main components of the SCADA system and the main functions of the system. (10)

c) For the shown schematic diagram of load frequency and excitation voltage regulation, write the definition of each block (from 1 to 5) and explain its task in the control system. (10)



Problem number (2) **(30 Marks)**

a) A load of 200 MW is supplied by two generating units in parallel at 50 Hz. If the ratings of the two units are 100 MW and 200MW and their droop characteristics is 4%, calculate the loading of each unit. (10)

b) Prove that the control of the system voltage can be accomplished only through the control of the reactive power. (10)

c) Draw the block diagram of the automatic generation control (AGC) for interconnected power systems and explain its operation principles. Compare between the functions of this control system and that used with isolated power systems (10)

P.T.O.

Problem number (3) (25 Marks)

a) Draw both the schematic diagram and the control block diagram of the alternator voltage regulator scheme. What is the effect of the stabilization process on the performance of the controller? (10)

b) Explain the operating principles of the on-load tap changing transformer. Compare between this type of voltage control and the synchronous condenser. (10)

c) Define the following terms: thyristor-controlled reactor, thyristor-switched capacitors, fixed capacitors-thyristor-controlled reactor (5)

Good Luck

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