Tanta University

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

Faculty of Engineering

Course Title: Control in Electrical Power Systems (2)	Course Code: EPM4228	Year: 4th
Date: 15 Jun 2023	Allowed time: 3 hour	No. of Pages: 1

Answer the following questions:

Question (1) (45 Marks)

a) **Mention** the **function** of the following:

1- SCADA
2- ACE
3- PMU
4- AGC in isolated area

b) Explain the principles of operation of synchronous condenser.

c) **Draw** block diagram of AVR of synchronous generator, then **draw** the voltage response for step increase in load reactive power, Clarifying the problems that could be associated in the voltage response. Mention two methods to improve voltage response, sketch response after improvement for each method.

d) Draw block diagram of governor with speed-droop characteristic, explain how generated power cold be controlled.

e) Explain with only equations how tie line power between two interconnected areas is changed if load in one area is increased without control.

Question (2) (40 Marks)

a) A generating area has two generating units whose droop characteristics are 0.04 and 0.02, respectively. Meanwhile, the load damping of this area is 0.6. The area has a nominal frequency of 50 Hz, and the rating of each generating unit is 180 MW. The base values are taken to be the generating unit nominal values.

1- If the static load power connected to that area (ΔP_{L1}) increased by 60 MW. Calculate the steady-state power supplied by each generating unit if each generating unit was delivering 100 MW before the disturbance occurred. Hint: Assume the coherent response of all the generators.

2- If another identical area is connected to area (1) via a transmission line. Calculate the steady-state system frequency and the power interchange between the two areas if the static load connected to area (1) is increased by 60 MW. Notice that each generating unit was delivering 100 MW before the disturbance occurred. Also, there was no power flow between the areas ($\Delta P_{12o} = 0$).

b) Explain using phasor diagram the concept of shunt reactive power compensation.

c) Describe the principle of operation of the STATCOM .

Best wishes
Ass.Prof. Doaa Mokhtar

Department: **Electrical Power and Machines Engineering**

Tanta University | Total Marks: **85 Marks** | Faculty of Engineering

Course Title: Power System Protection	Course Code: EPM4118	Year: 4th
Date: Jan. 2023 (First term)	Allowed time: 3 hrs	

Answer the following questions

Problem number (1) **(25 Marks)**

a) Define the Power System Protection? Explain the protection system elements? State the fault detection methods?

b) Give an example to show the locations of the CTs with respect to the dead and life tank circuit breakers for two overlapping unit protection.

c) Describe the construction and principle of operation of an induction type non-directional over-current relay

d) Specify the protective zones for.the system shown in Fig. 2. Determine the following:
- Which zones should trip for a fault F1?
- Which zones should trip for a fault F2?
- What is the action if the primary protection for fault F2 failed to operate?

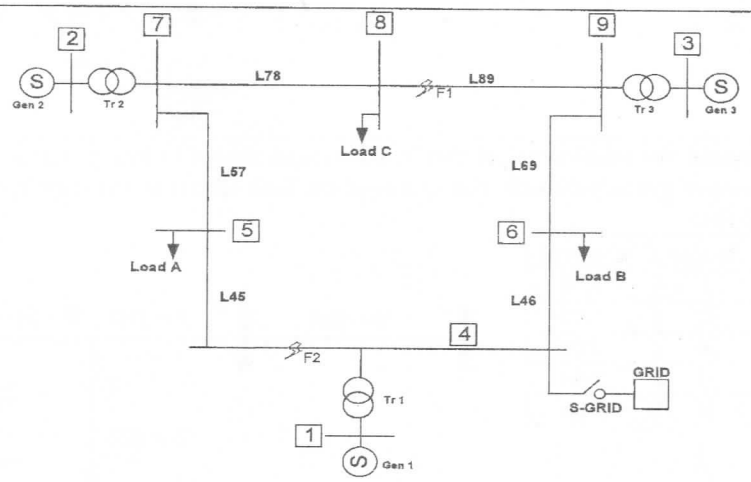


Fig. 2

e) Consider the fault F on the transmission line shown in Fig. 3. Discuss the relaying system dependability and security for this network.

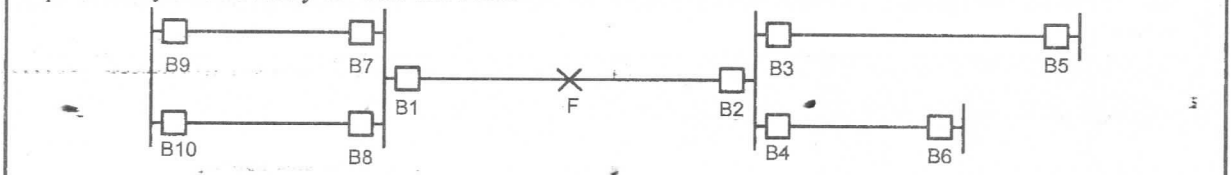


Fig. 3

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

a) What are the functions of current and voltage transformers? Explain the alternative connections of current and voltage transformers for protection system?

b) A current transformer (CT) has a rating of 100/5 A. its magnetizing and loss components of the exciting current are 6 A and 4 A respectively and its burden is purely resistive. Calculate the transformation ratio at rated current.

c) Explain instants of fault for no offset, positive offset and negative offset in the fault current. What is the overreach percentage of a practical instantaneous overcurrent relay in terms of relay operating time and power system constants?

d) An 11 kV, 3-phase radial feeder is equipped with two CTs along with associated normal inverse overcurrent relays at two different locations. The full-load currents at relay location are 570 A and 190 A respectively and the relays associated with CT secondaries have A = 0.14 and B = 0.02. Determine the plug setting and time-dial setting of these relays, if the fault current through the feeder is 3000 Amp. Also calculate the time of operation of the relay located at the upstream.

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

a) Explain why first zone of distance relay cover only 80% of the protected line section. How can the remainder part of line be protected?

b) Determine the three zone settings for the relay R_{ab} in the system shown in Figure 4. The system nominal voltage is 138 kV, and the positive sequence impedances for the various elements are given in the Figure. The transformer impedance is given in ohms as viewed from the 138 kV side. Assume that the maximum load at the relay site is 120 MVA, and select a CT ratio accordingly. The available distance relay has zone 1 and zone 2 settings from 0.2 to 10 Ω, and zone 3 settings from 0.5 to 40 Ω, in increments of 0.1 Ω. The angle of maximum torque can be adjusted to 75◦ or 80◦.

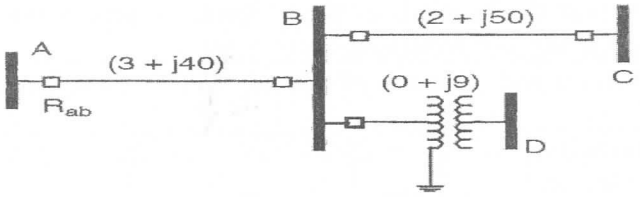


Fig. 4.

c) Consider the multi-terminal line in the system shown in Fig. 5. Each of the buses C, D, G, H and J has a source of power behind it. For a three-phase fault on bus B, the contributions from each of the sources are as follows:

Source	Current
J	600
C	200
D	300
G	800
H	400

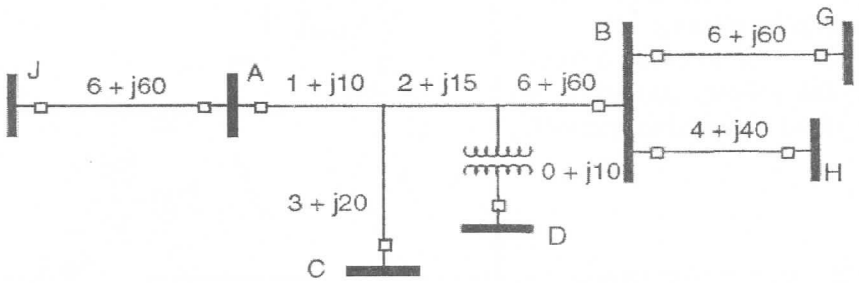


Fig. 5 ➔

You may assume that the fault current contributions from each of these sources remain unchanged as the fault is moved throughout the system shown. Determine the zones 1, 2 and 3 settings for the distance relays at bus A.

[b] **Explain**, with a complete schematic of an electric drive system of IM, **how** the speed is controlled by direct field-oriented vector control with rotor flux orientation. The answer should include the derivation of following issues with the neat equations: *[15 Marks]*

(i) VSI with voltage control mode using control voltage estimator.
(ii) Estimation of rotor flux and flux angle from the measured air gap flux.
(iii) Torque/current transfer.
(iv) Decoupling circuit if necessary.
(v) PWM modulator, and all necessary sensors.

Question 3 [30 Marks]

[a] In IM drives under direct torque control (DTC): *[15Marks]*

(i) **Explain** with the aid of equations, **how** can stator voltage vectors control the stator flux of IM?
(ii) **Explain**, with the aid of phasors, the effect of increasing and decreasing the angle between the stator and rotor fluxes γ_{sr} on developed torque.
(iii) **Explain**, with drawing and equations, a three-level hysteresis torque comparator.
(iv) **Plot** a complete block-diagram of the direct torque control of IM drive.

[b] In PMSM drives under vector control: *[15 Marks]*

(i) **Explain**, with the aid of equations and phasor diagrams, the concept of the field-oriented control of the PMSM.
(ii) **How** can different modes of operation be obtained?
(iii) **Draw** and **explain** a complete block diagram for speed-controlled PMSM with field-weakening control using hysteresis current controllers.
(iv) **How** the reference torque and the reference flux could be modified?

Good Luck and Best Wishes ..... *Prof. Dr. Abdelsalam Ahmed*

Tanta University - Faculty of Engineering

Electrical Power and Machines Engineering Department

Final Exam 2022/2023		
4nd Year: Electrical Power and Machines Engineering	Time: 3 hours	Mark: 90
Date: Monday, June 5, 2023	Course: Electrical Drives	Code: EPM4227

Answer all questions: (Diagrams, phasors and equations are mandatory for answers)
The exam is in TWO pages.

Question 1 [30 Marks]

[a] An electric train weighting 500 tones climbs down-gradient with G = 20 and with following speed-time curve: ***[15 Marks]***

(i) Uniform acceleration of 3 kmphrpsec for 50 sec.
(ii) Constant speed operation for 10 min.
(iii) Uniform braking at 2.5 kmphps to rest.

The train resistance is 25 N/ton, rotational inertia effect 10% and combined efficiency of transmission and motor is 80%. **Calculate** the specific energy consumption. Assume efficiency of transmission system and motor during regeneration to be the same as during motoring.

[b] In DC motor operation with single phase full-controlled converter supply: ***[15 Marks]***

(i) **Draw** the armature voltage and armature current for continuous-current operation with a firing angle of 60°.
(ii) **Draw** the armature voltage and armature current for discontinuous-current operation with a firing angle of 60°.
(iii) **Explain** the difference between (i) and (ii) in terms of average voltage, speed, and torque-speed curves at 0° and 60°.

Question 2 [30 Marks]

[a] In IM drives under FOC, with all necessary equations and diagrams, **derive** the slip speed and torque equations with variable rotor flux. Then, **discuss** the response of the drive system and **suggest** a solution for the problem (if exist). ***[15 Marks]***

Tanta University

Department: **Electrical Power & Machines**
Programme: **Undergraduate**
Total Marks: **(85)** Marks

Faculty of Engineering

Course Title: **Elective Course (4): PLC** Course Code: **EPM4231** Year: **4th**
Date: **08 June 2023** Allowed time: **(3)** hrs. No. of Pages: (4)

Remarks:
- ✓ Answer the following questions, assume any missing data, and arrange your answer booklet
- ✓ Use graphs and examples whenever you have a chance during your answer
- ✓ Use only black or blue pens or pencil in your answer
- ✓ Answer only the required questions (Extra answers will not be considered)

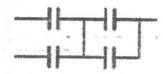
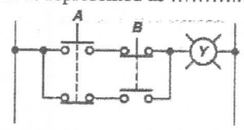
Question No. 1 : Indicate whether the statement is true or false (ورقة التصحيح الإلكتروني) and correct the wrong statement in your answer sheet. (36 Marks)

1.	The relay logic is basically a digital computer designed for use in machine control.
2.	A PLC is an example of a real-time system since the output of the system controlled by the PLC does not depend on the input conditions.
3.	The programmable logic controller is designed for multiple input and single output arrangements, and resistance to vibration and impact.
4.	The relay logic is capable not only of performing relay switching tasks but also of performing other applications such as timing, counting, calculating, and the processing of analog signals.
5.	Since all the logic is contained in the PLC's memory, there is a chance of making a logic wiring error.
6.	PLCs are designed for low-speed and real-time applications.
7.	For some small micro PLC systems, power to field devices is provided by external alternating current (AC) or direct current (DC) supplies.
8.	The CPU cannot control all PLC activity and is designed so that the user can enter the desired program in relay ladder logic.
9.	Removing the programming unit will not affect the operation of the user program.
10.	A battery backup (such as a lithium battery) is required with ROM to avoid losing data in the event of a power loss.
11.	In the modular PLC type, the user cannot decide the mix of required modules, but it is easy to expand the number of input/output (I/O) connections.
12.	Capacitive proximity switches are insensitive to humidity, dust, and dirt.
13.	Magnetic Reed Switch is affected by dust, humidity, and fumes; thus, their life expectancy is quite low.
14.	In the through-beam scan, the transmitter and receiver are housed in the same enclosure.
15.	The frame and plunger of an AC-operated solenoid are constructed with solid piece of iron.

Question No. 2 : (15 Marks)

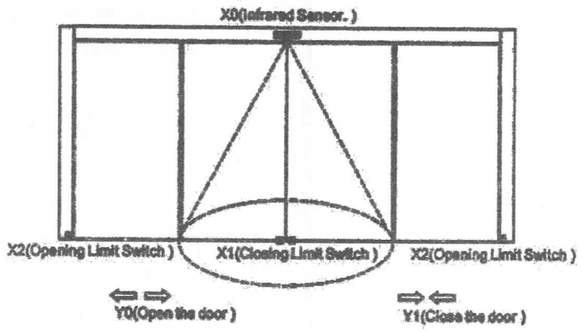
Identify the choice that best completes the statement (ورقة التصحيح الإلكتروني).

1.	The ..... is the "brain" of the PLC. a. processor (CPU) b. EPROM c. input/output (I/O) section d. programming device

12.	The BCD number 0001 0010 0111 represents a decimal number that equals ..... a. 512 b. -27 c. 7F d. 127
13.	PLCs contain number conversion functions such as BCD-to-binary is required for the ..... a. output b. monitor c. input d. alarm
14.	The given graphical symbol represents the logic function ..... using the statement list. a. And Load (AND LD) b. Or Store (OR STR) c. Or (OR) d. And (AND) 
15.	The equivalent Boolean equation of the given relay schematic can be represented as ..... a. $\overline{AB} + AB = Y$ b. $\bar{A}B + A\bar{B} = Y$ c. $(\bar{A}B)(A\bar{B}) = Y$ d. $(\bar{A} + B)(A + \bar{B}) = Y$ 

Question No. 3 : (16 Marks)

In the given PLC application, the control purpose is to automatically control the door. When someone enters the infrared sensing field, opening motor starts working to open the door automatically till the door touches the opening limit switch. If the door touches the opening limit switch for 7 seconds (To timer) and nobody enters the sensing field, the closing motor starts working to close the door automatically till the closing limit switch touched together. Stop the closing action immediately if someone enters the sensing field during the door closing process.



Draw a table to define the Inputs and Outputs descriptions and create a PLC ladder program in your answer sheet. Then, choose the closest answer (ورقة التصحيح الإلكتروني).

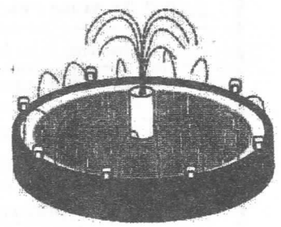
16.	The network of Yo in the ladder diagram will contain the NO contact Xo and the ..... a. NO contact X2 b. NO contact To c. NC contact X2 d. NO contact Y1
17.	The network of To in the ladder diagram will contain the NO contact X2 and the ..... a. NC contact X1 b. NC contact Xo c. NC contact Yo d. NO contact X0
18.	The network of Y1 in the ladder diagram will contain the NC contact X1 and the ..... a. NO contact X0 b. NO contact T0 c. NO contact Y0 d. NC contact X2

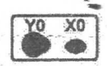
2.	..... is divided by compartments into which separate modules can be plugged. a. PLC communication module b. The PLC memory c. Modular I/O configuration d. The programming device
3.	The PLC program is executed as part of a repetitive process referred to as a ..... a. diagnostic task b. communication task c. scan task d. run mode
4.	The ..... forms the interface by which field devices are connected to the controller. a. central processing unit (CPU) b. I/O system c. programming device d. memory
5.	..... is a user-developed series of instructions that directs the PLC to execute actions. a. Human Machine Interface (HMI) b. processor c. program d. operator panel
6.	The PLCs come equipped with terminals for ..... a. permanently attached keyboard b. CD drive c. communication ports d. markers
7.	The optical isolator can directly separate the higher AC input voltage from the ..... a. output circuits b. bridge rectifier c. logic circuits d. programming devices
8.	The ..... refers to the method used by photoelectric sensors to detect an object. a. transmitter b. receiver c. photoresistive cell d. scan technique
9.	There are ..... operated solenoids. a. only DC b. only AC c. both AC and DC d. none of the above
10.	The ..... junction of temperature sensors is the joined end of a thermocouple that is exposed to the process where the temperature measurement is desired. a. cold b. hot c. reference d. constant
11.	The binary number 1011 represents a decimal number equals ..... using the 2's Complement. a. -3 b. +4 c. -5 d. -4

19.	If the timer has not been used, the network of Y1 in the ladder diagram will contain the NC contact X1 and the ..... a. NC contact T0 b. NO contact X0 c. NO contact X2 d. NO contact Y0
20.	If the timer has not been used, the network of Yo in the ladder diagram will contain the NO contact Xo and the ..... a. NC contact Y1 b. NC contact To c. NO contact X2 d. NO contact Y1

Question No. 4 : (18 Marks)

In the given PLC application, it is required to control the operation of the fountain. When the start button Xo is pressed, the running indicator Yo will be kept ON state. After Running indicator is ON for 2 seconds, the following devices will start to operate in the following order: the middle sprayer light is firstly operated for 2 seconds, then the middle sprayer valve will operate for 2 seconds, After that, the surrounding lights will start operation for 2 seconds. Finally, the surrounding sprayer valves will operate for 2 seconds. The application uses the following devices (To is the timer for running indicator; Y1 for middle sprayer light with T1 timer; Y2 for middle sprayer valve with T2 timer; Y3 for surrounding lights with T3 timer; Y4 for surrounding sprayer valves with T4 timer).





Draw a table to define the Inputs and Outputs descriptions and create a PLC ladder program in your answer sheet. Then, choose the closest answer (ورقة التصحيح الإلكتروني).

21.	The network of To in the ladder diagram will contain the NC contact Y4 and the ..... a. NO contact Xo b. NO contact Y1 c. NO contact Yo d. NC contact Xo
22.	The network of Y1 in the ladder diagram will contain the NO contact To in parallel with the ..... a. NC contact Xo b. NO contact T2 c. NC contact Yo d. NO contact T4
23.	The network of T1 in the ladder diagram will contain the NC contact Y2 and the ..... a. NC contact Yo b. NO contact Y1 c. NO contact Xo d. NC contact To
24.	The network of T2 in the ladder diagram will contain the NC contact Y4 and the ..... a. NO contact Yo b. NO contact Y3 c. NO contact Y2 d. NC contact T1
25.	The network of T3 in the ladder diagram will contain the NO contact Y3 and the ..... a. NC contact T2 b. NC contact Y2 c. NC contact Y4 d. nothing else

Good Luck

Dr. Mohamed Gamal Hussien

TANTA UNIVERSITY

Electrical Power and Machines Department

Final EXAM 2022/2023- Second Term

Faculty of Engineering

Course	Special Electrical Machines(EPM4230)	Time Allowed	3 hours
Students	4thYear (Electrical Power and Machines)	Total Mark	75
Date	Mon. 12, June, 2023	Number of pages	THREE

قبل أن تبدأ إجابتك الرجاء قراءة التعليمات العامة الآتية والالتزام بها بكل دقة:

١. اكتب رقم السؤال بوضوح.	٢. استخدم الرسومات التوضيحية ذات البيانات الواضحة والكاملة كلما أمكن.
٣. أجب بوضوح سواء باللغة الإنجليزية أو العربية.	٤. لا يشترط الإجابة بترتيب الأسئلة في ورقة الامتحان.
٥. افترض قيمًا معقولة لأية بيانات ناقصة.	٦. عند استخدام القلم الرصاص تأكد تماما من وضوح الكتابة والرسم.
٧. ابدأ إجابة كل السؤال في بداية صفحة جديدة (إلا إذا تعذر ذلك)	٨. تجنب تمامًا في إجاباتك استخدام: • اللونين الأحمر والأخضر • سائل التصحيح corrector

Attempt ALL the following questions and problems:

The First Question 14 marks

1. **Show** that a DC series motor is capable of providing unidirectional toque when it supplied from an AC supply. Clarify your answer with suitable mathematical relations and illustrations. (3 Marks)
2. Explain what is meant by compensation in universal motors. Then how it can be achieved. (3 Marks)
3. Explain ***in details*** how operating permanent magnet motors at higher speeds is affected by rotor type. (3 Marks)
4. A 1500-kW, 50-Hz, three-phase, Y-connected 2300-V synchronous motor has direct and quadrature axis reactance of 1.95 and 1.4 ohm/phase respectively. Neglecting all losses, **calculate the power** that the motor delivers when it is connected to a supply of rated voltage and frequency while excitation is set so that power factor is unity at rated load. The shaft load is assumed to be increased gradually. (5 Marks)

The Second Question **12 marks**

1. For three-phase **synchronous reluctance motors** *considering armature resistance*:
   a) Sketch phasor diagram. (2 Marks)
   b) Give brief notes about employed rotor configurations (3 Marks)
   Use in your answer clear drawings with complete information.
2. A three-phase, 380-V, 4-pole, 50 Hz synchronous reluctance motor a magnetizing reactance of 180 Ω if the rotor were *cylindrical*. The ratio between d-axis and q-axis air gaps is 0.1. Rotor is of conventional type with pole arc to pole pitch ratio of 0.45 while the leakage reactance and winding resistance are 8 and 10 Ω /phase respectively. (7 Marks)
   a) **Determine** d-axis and q-axis reactances.
   b) **Plot** *as accurate as* you can torque-angle characteristics.

Please turn over

The Fifth question 17 marks

1. Choose the most suitable answer

a. Among the advantages of switched reluctance machine ……..
[ ] high starting torque [ ] low noise operation [ ] constant torque

b. SR motors operate in the single pulse mode at …… speeds. Because ……...
[ ] low speed, single pulse is sufficient
[ ] high speed, of the short current buildup time
[ ] low speed, low switch losses
[ ] high speed to reduce switching frequency

c. The linear motor cogging force is minimal in the ……. type.
[ ] slotless [ ] ironless [ ] double sided

d. If a hybrid stepper motor has a rotor pitch of 36 degrees and a step angle of 9degrees, the number of its phases must be…..
[ ]4 [ ]2 [ ]3 [ ]6

2. Write short notes about:

a. Energy conversion process for SRM in motor mode in terms of flux linkage against phase current.

b. Numerate the different types of linear motors. Compare the different types of linear motor from the viewpoints of construction and performance.

3. Find two possible Ns/Nr for a SRM with 12 stator poles, such that the resulting machines are self-starting with bidirectional operation. For each configuration, assume phase one is in aligned position, draw the machine lamination showing the winding of a phase (use dot and cross notation to show current direction). Then calculate the stator pole pitch and number of pulses required to complete one revolution of each configuration.

4. A single sided Maglev permanent magnet linear motor vehicle with combined propulsion and levitation of PM-LSM. When the vehicle is running on-land with airgap of 9mm, the trust force coefficient KF0 = 10.93N/A. The levitation force coefficients are:
   force between iron stator and current-carrying windings $K_{zS}(\delta e) = 3.1N/A2$
   force between the stator current and PM $K_{zMs}(\delta e) = 45.3N/A$
   force between PM and stator laminated-iron $K_{zM}(\delta e) = 12.4N$
   The total vehicle weight is 11Kg. The armature windings are supplied with balanced three phase of I1=4A Find the mechanical load angle as a ratio of pole pitch. Determine the attractive and repulsive components of levitation forces.
   If the hydrodynamic resistance force $F_{xR}(N)$ is expressed as a function of running speed v(m/s), it is found to be $F_{xR} = 60.76\ v^2$
   Find the running speed in the above conditions. Determine supply frequency at this condition.

Good Luck and best wishes

Prof. Essam Eddin M. Rashad, Prof. Mohamed K. El-Nemr and Exam Committee

The Third Question 20 marks

1. With aid of circuit diagrams and torque speed relations, **explain** the different methods employed to provide starting torque in single-phase induction motors. (4 Marks)

2. Give detailed notes about the requirements and specifications to be considered when designing auxiliary winding of a split-phase single-phase induction motor. (2 Marks)

3. Draw with complete details, the equivalent circuit of a capacitor run induction motor. (2 Marks)

4. A 1/3 hp, 220-V, 50-Hz, 6-pole, split-phase single-phase induction motor has the following circuit parameters (referred to the stator main winding): (6 Marks)

   R_1=1.52 Ω X_1 =2.1 Ω R'_2=3.13 Ω X'_2 =1.56 Ω and X_{mag} = 58.2 Ω,

   The core losses of the motor are 35 W. Friction, windage and stray loss is 16 W. The motor is running at the rated voltage and frequency while its starting winding is open and the motor slip is 5 percent. Calculate the following quantities:

   a) Stator current
   b) Motor power factor.
   c) Developed torque
   d) Motor efficiency

5. A 1/4 kW, 120-V, 50-Hz, 4-pole, single-phase induction motor has the following stand-still impedances at rated frequency: (6 Marks)

   Main winding: Z_m =4.5 +*j* 3.7 Ω Auxiliary winding: Z_a = 9.5 +*j* 3.5 Ω

   Find the values of **starting capacitances** to be inserted in series with auxiliary winding for ***each*** of the following conditions

   a) Achieving maximum staring torque
   b) Achieving maximum staring torque per ampere.
   c) Placing the main and auxiliary winding currents in quadrature at staring.

The Fourth Question 14 marks

1. For a three phase induction generator: (8 Marks)

   a) Explain the principle of operation when connected to a grid
   b) Sketch the variation of terminal voltage and frequency with load current (external characteristic) when operated as a self-excited generator driven at constant speed.
   c) Suggest a suitable arrangement to be applied to an isolated case in order to obtain a constant output voltage with a given allowed margin under varying loading conditions.

2. A 6 kV, four-pole, star-connected three-phase induction generator is driven by a diesel engine at 1500 r/min. The unsaturated value of magnetizing inductance is 0.253 H. (6 Marks)

   a) How much the minimum Y-connected capacitance to guarantee self-excitation?
   b) How much the generated frequency if the slip is -0.04?
   c) What to be done to obtain a frequency of 50 Hz at the same slip of -0.04?