



## Final Exam 2024/2025

Renewable Energy Program

Time: 3 hours

Mark: 40

Date: Tuesday, 1 July 2025

Course: Electrical Drives

Level: Fifth level

Answer all questions: (Diagrams, phasors and equations are mandatory for answers)

Exam in Two pages

### Question 1: [9 Marks]

- [a] Write a brief note on the sources employed in electrical drives. **State and explain** the functions of various power converters. [3 Marks]
- [b] A drive has the following parameters:  $J = 10 \text{ kg-m}^2$ ,  $T = 100 - 0.1N$ , N-m, passive load torque,  $T_l = 0.05N$ , N-m, where  $N$  is the speed in rpm. Initially the drive is operating in steady-state. Now it is to be reversed. For this motor characteristic is changed to be  $T = -100 - 0.1N$ , N-m. **Calculate** the time of reversal. [6 Marks]

### Question 2: [11 Marks]

- [a] **Explain** the duty cycle of electric trains with the help of speed-torque and power-time diagrams for both the idealized traction drive and the urban subway train. [3 Marks]
- [b] A locomotive of 110 tons can just accelerate a train weighting 500 tons with an acceleration of 1 kmphps on up-gradient with  $G = 10$ . Train resistance is 35 N/ton and increase of mass due to rotational inertia is 10%. 80% of locomotive weight is carried by driving wheels. This locomotive is assisted by another weighting 70 ton and with its full weight coming on driving wheels. **Calculate** weight of the additional bogies that could be attached to this train maintaining the same schedule of operation on the same track. [8 Points]

### Question 3: [10 Marks]

- [a] In IM drives under FOC, with all necessary equations and diagrams, **derive** the equations of slip speed and developed torque with a fixed rotor flux. Then, **analogize** between the IM under FOC and the DC machines. [5 Marks]
- [b] **Explain**, in details with all necessary equations and diagrams, the estimation process of the rotor flux linkage of IM by voltage-based model. Then, **draw** a complete block diagram that describes this method. [5 Marks]



**Question 4: [10 Marks]**

[a] **Explain**, with a complete electric drive system for an induction motor, **how** the speed is controlled by direct field-oriented vector control with rotor flux orientation. The answer should **include** the following issues: torque/current transfer, decoupling circuit, if necessary, VSI with voltage control mode using PI controllers, PWM modulator, and all necessary sensors. **[5 Marks]**

[b] In an IM drives under direct torque control: **[5 Marks]**

- (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  $\gamma_{sr}$  on developed torque.

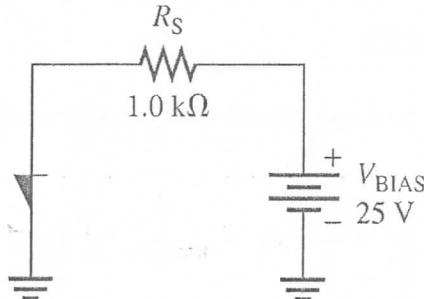
*Good Luck and Best Wishes*

*Prof. Abdelsalam Ahmed Abdelsalam  
Dr. Mohamed Gamal Hussien*

**Question Number (3)**

**(10 Points)**

- (a) Determine the value of **anode current** in the Figure shown when the device is on.  $V_{BR(F)}=20V$ . Assume the Diode forward voltage drop is **0.9 V**
- (b) Repeat part (a) for  $V_{BR(F)}=30V$ .

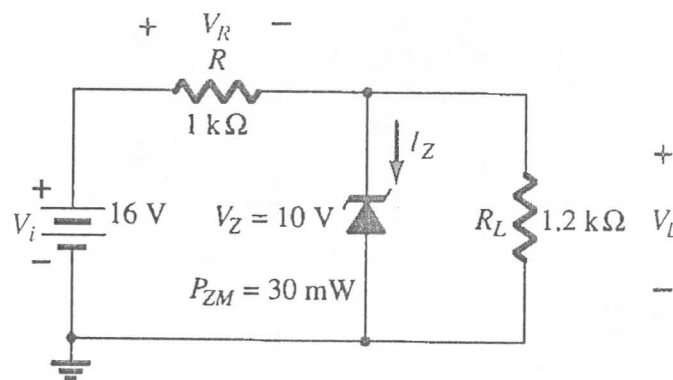


- (c) Sketch only the **symbol** and the **transistor equivalent model** of the SCR.
- (d) Explain with a diagram how an SCS can be **turned on**

**Question Number (4)**

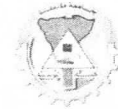
**(10 Points)**

- (a) For **BJT transistor** if  $I_B=30\mu A$ ,  $\beta =100$  find  $I_C$ ,  $I_E$  and  $V_{CE}$
- (b) Calculate the ripple factor ( $r$ ) for a certain power-supply filter which produces an output with a ripple of 200 mV peak-to-peak and a dc value of 20 V.
- (c) For the Zener diode network, determine  $V_L$ ,  $V_R$ ,  $I_Z$ , and  $P_Z$ .
- (d) Repeat part (c) with  $R_L = 3 k\Omega$



*With my best wishes*

*Dr / Nessim Mahmoud*



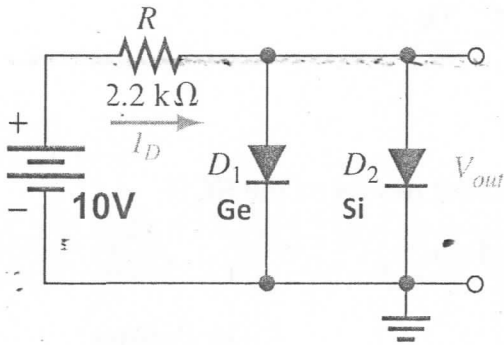
Tanta University		Faculty of Engineering			
Course	Electronic circuits	New	2024/2025	Total Marks	40
Date	28/6/2025		No. of Pages (2)	Time	2 hrs

Assume diode practical model

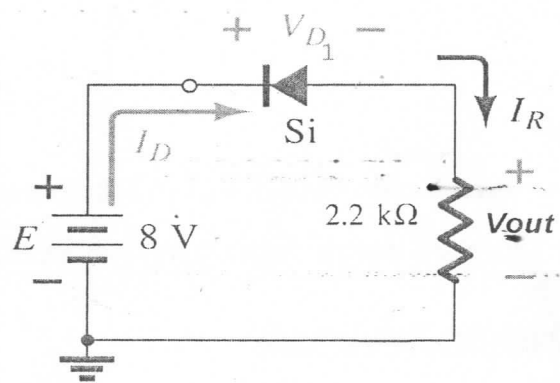
**Question Number (1)**

(10 Points)

a) For the diode configuration shown below, determine  $V_{D1}$ ,  $V_R$ ,  $I_D$  and  $V_{out}$ .



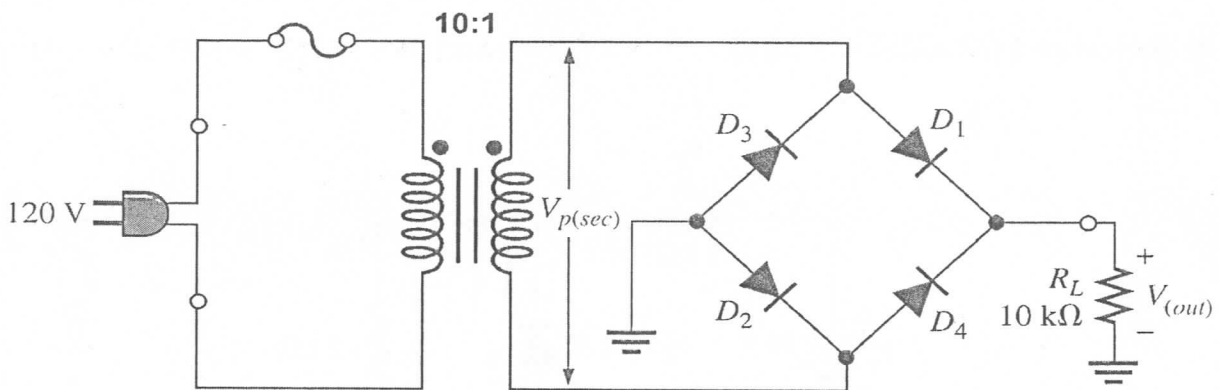
(i)



(ii)

b) For the circuit shown below Assume diode practical model

- Determine with diagram the o/p voltage
- The average value
- The Peak current through  $R_L$



**Question Number (2)**

(10 Points)

- Draw the symbol and the internal structure of the N channel MOSFET transistor.
- Determine the drain current ( $I_D$ ) for an N- MOSFET , assume :  
 $V_{GS} = 0.9V$  ,  $V_D = 1.4 V$  ,  $\mu_n C_{ox} = 100 \mu A/V^2$  ,  $W/L = 50$  , and  $V_{TH} = 0.6 V$ .
- Repeat (b) for  $V_{GS} = 0.3V$  and comment.

**Final Exam: لائحة قديمة 2024-2025**

Renewable Energy Program (Level 4)

Time: 3 hours

Mark: 40

Saturday, 28 June 2025

Course: Power Electronics (2)

Code: EPE352

Answer all questions with the required graphs and equations

**Question 1 [8 Marks]**

[A] For single-phase full-wave AC voltage controller: [4 Marks]

- Explains** the operation of single-phase full-wave AC voltage controller with resistive load.
- Plot** the single-phase full-wave controller: circuit, input supply voltage, output voltage, gate pulse for the controlled switches.
- Derive** the RMS output voltage.

[B] For three-phase full-wave AC voltage controller: [4 Marks]

- Plot** the three-phase bidirectional controller circuit.
- Plot** waveforms of input line voltages, input phase voltage, thyristor gate pulses, output phase voltage at delay angle of  $60^\circ$ .
- Explain** the operation, in detail, to show how the output phase voltage has been got at delay angle of  $60^\circ$  with suitable switching sequence.

**Question 2 [18 Marks]**

[A] A single-phase full-bridge inverter has a resistive load of  $R = 2.4 \Omega$  and the dc input voltage is  $V_s = 48 \text{ V}$ . Determine (a) the rms output voltage at the fundamental frequency  $V_{o1}$ , (b) the output power  $P_o$ , (c) the average and peak currents of each transistor, (d) the peak reverse blocking voltage  $V_{BR}$  of each transistor, (e) the average supply current  $I_s$ , (f) the THD, (g) the DF, and (h) the HF and LOH. [5 Marks]

[B] For a three-phase bridge inverter: [8 Marks]

- Plot** the circuit configuration of the three-phase bridge inverter.
- Explain** the operation of three-phase VSI with plotting the waveforms of gate pulses and line-to-line output voltages for  $180^\circ$  conduction.
- For Y-connected load, with the aid of equivalent circuits, **derive** the values of the phase voltages during the whole cycle and then **plot** its waveforms.

- [C] In current source inverters: [5 Marks]
- Explain the operation of full-bridge single-phase current source inverters
  - Plot the circuit of transistor current source inverter, gate signals, and load current and its fundamental.
  - Right down the state switches in table.

**Question 3 : [14 Marks]**

- [A] For three-phase/single-phase cycloconverter: [7 Marks]
- Explain with draw circuit, line voltages of 60 Hz supply, 12 Hz output voltage, and conduction periods for P and N converters.
  - Explain with configurations, how much thyristors could be required for building a full-wave three-phase/three-phase cycloconverter?

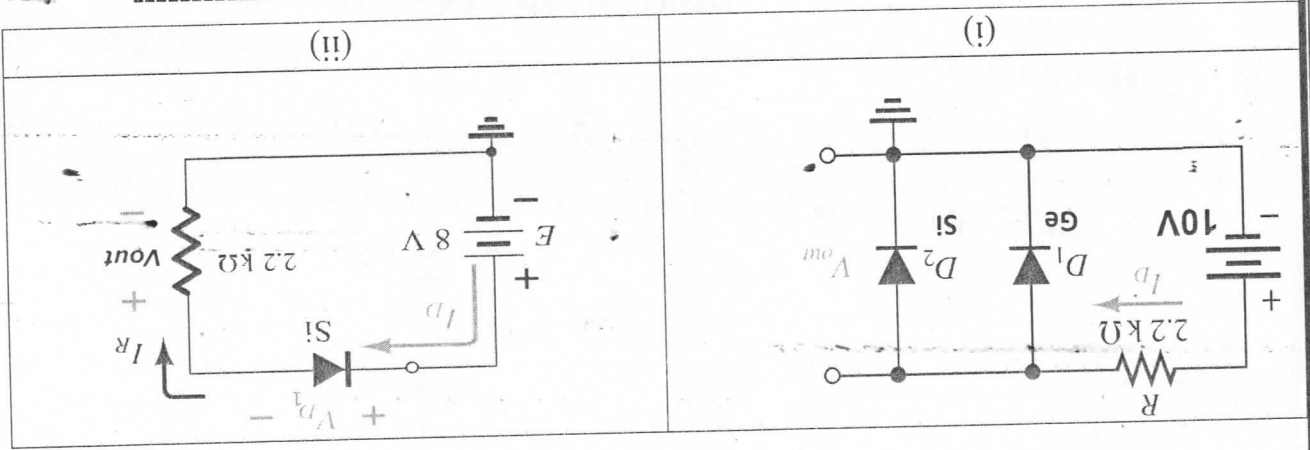
- [B] In sinusoidal pulse-width modulation: [7 Marks]
- Explain**, with figure, **how** the gating signals are generated for turning on and off transistors (explain two ways).
  - Draw** the gate signals for phase "a" of the VSI.
  - Plot** the output voltage expected to be applied to this phase.
  - Estimate** the RMS value of the output voltage.
  - Show** how the modulation index could be varied.
  - Plot** the harmonic profile, i.e., the normalized voltage and distortion factor against modulation index.

With Best Wishes *Prof. Abdelsalam Ahmed*

Assume diode practical model

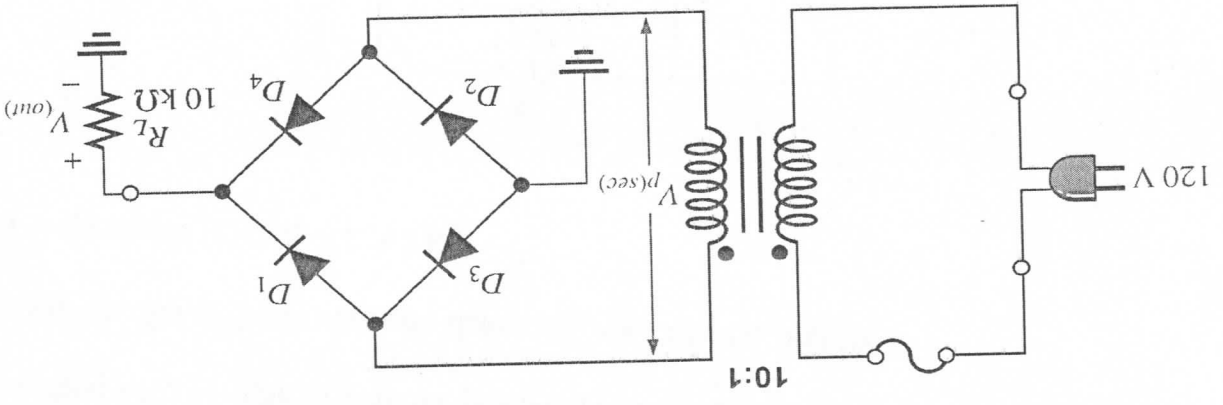
**Question Number (1)**

a) For the diode configuration shown below, determine  $V_{D1}$ ,  $V_R$ ,  $I_D$  and  $V_{out}$ . (10 Points)



b) For the circuit shown below Assume diode practical model

- i. Determine with diagram the o/p voltage
- ii. The average value
- iii. The current through  $R_L$



**Question Number (2)**

(10 Points)

- (a) Draw the symbol and the internal structure of the N channel MOSFET transistor.
- (b) Determine the drain current ( $I_D$ ) for an N-MOSFET, assume:  $V_{GS} = 0.9V$ ,  $V_D = 1.4V$ ,  $\mu_n C_{ox} = 100 \mu A/V^2$ ,  $W/L = 50$ , and  $V_{TH} = 0.6V$ .
- (c) Repeat (b) for  $V_{GS} = 0.3V$  and comment.

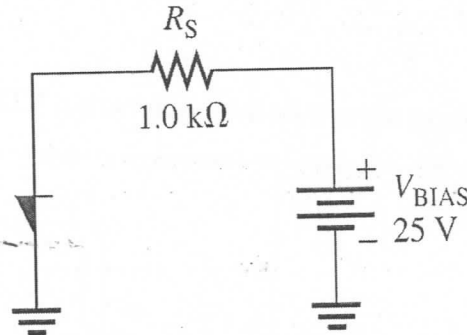
**Question Number (3)**

**(10 Points)**

(a) Determine the value of **anode current** in the Figure shown when the device is on.

Assume  $V_{BR(F)}=20V$  and the Diode forward voltage drop is  $0.9 V$

(b) Repeat part (a) for  $V_{BR(F)}=30V$ .



(c) Sketch only the **symbol** and the **transistor equivalent model** of the SCR.

(d) Explain with a diagram how an SCR can be **turned on**

**Question Number (4)**

**(10 Points)**

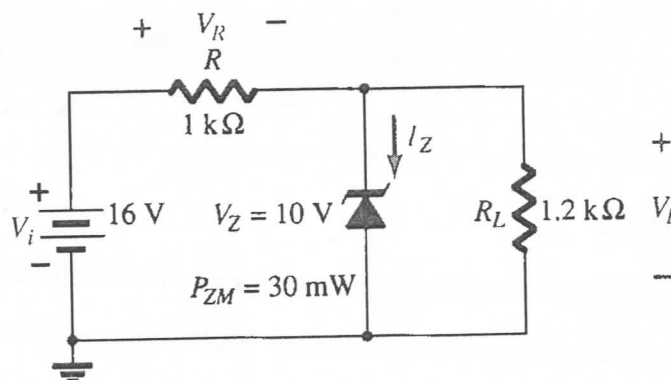
(a) **Define : Holding current and Switching current**

(e) Explain with a diagram **one way to turn off SCR**

(b) Calculate the ripple factor (r) for a certain power-supply filter which produces an output with a ripple of 200 mV peak-to-peak and a dc value of 20 V.

(c) For the Zener diode network, determine  $V_L$ ,  $V_R$ ,  $I_Z$ , and  $P_Z$ .

(d) Repeat part (c) with  $R_L = 3 k\Omega$



*With my best wishes*

*Dr / Nessim Mahmoud*



<b>Final Exam 2024/2025</b>		
<b>Renewable Energy Program</b>	<b>Time: 3 hours</b>	<b>Mark: 40</b>
<b>Date: 12 June 2025</b>	<b>Course: Power Generation from Renewable Sources (II)</b>	<b>Code: EPE483</b>

Answer all questions: (Diagrams, phasors and equations are mandatory for answers)  
Exam in Two pages

**Question 1: [10 Marks]**

State true ( $\checkmark$ ) or false ( $\times$ ) and correct the false statements. *It is sufficient to write down the question number followed by your choice* in your answer sheet:

1.	The material of the electrolyte of fuel cells has to provide a low resistance to the electrons and a very high resistance to the protons.
2.	Oxygen or air enters the fuel cell through the anode.
3.	For compact structure and high efficiency operation, low-temperature units have internal reformers.
4.	Hydrogen and oxygen are separated by the electrolyte, which allows electrons of hydrogen atoms to move through it.
5.	The efficiency of fuel cells can reach 70% for high temperature types.
6.	The fuel cell uses only liquid electrolytes.
7.	<i>For the V-I Characteristics of fuel cells</i> , the voltage drop in the third region is caused by the losses in the electrode structure and the electrolyte.
8.	All the direct power control (DPC) techniques for maximum power extraction of WECS generally use voltage and current perturbation to detect the search direction.
9.	Pumped-Hydro Energy storage is primarily suggested for its flexibility.
10.	Economic indicators are considered to evaluate the ability of the integrated system to meet load demand.
11.	For large scale on-grid hybrid renewable energy systems, the Hydro/PHS-PV-wind system is optimal.
12.	High flexibility implies the system can respond slowly to changes in net load.
13.	Storage is always useful, but may not be economic.
14.	Increases in variable generation on a system increase the variability of the 'net load'.
15.	Flexibility is the demand that must be supplied by conventional generation unless RE is deployed to provide flexibility.



**Question 2: [12 Marks]**

- [a] Explain the operation principles of fuel cells and draw its dynamic modelling considering all components. [3 Marks]
- [b] Discuss the main advantages and disadvantages of fuel cells and explain its main applications. [4 Marks]
- [c] Discuss, *with all suitable sketches and equations*, the various techniques for maximum power extraction of Wind Energy Conversion Systems (WECS). [3 Marks]
- [d] Show the main differences between the indirect power control (IPC) and the direct power control (DPC) techniques for maximum power extraction of WECS. [2 Marks]

**Question 3: [9 Marks]**

- [a] Explain the purpose of power management control (PMC) in hybrid energy systems and what are the main factors affecting the selection of the PMC strategy. [3 Marks]
- [b] Discuss the main considerations in optimal management controls. [2 Marks]
- [c] Summarize the main design objectives and constraints for energy management. [4 Marks]

**Question 4: [9 Marks]**

- [a] Give a clear definition for Greening the Grid and explain how to achieve it. [4 Marks]
- [b] Summarize the frequently used options to increase the flexibility of a power system. [3 Marks]
- [c] Does variable renewable energy generation require storage? Clarify your answer based on the wind/solar penetration levels. [2 Marks]

*Good Luck and Best Wishes*

*Dr. Mohamed Gamal Hussien*



Course Title: **Induction Machines**  
Date: **Jan. 19<sup>th</sup> 2025**

Course Code: **EPE324**  
Allowed time: **3 hrs**

Year: **RE Program**  
No. of Pages: **(3)**

Total Marks: **40 Marks**

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

**Question Number (1) (9 Marks)**

A three-phase, 240-V, 60-Hz, 1125 rpm, 6-pole, delta-connected squirrel-cage induction motor has the following equivalent circuit parameters:  $R_1 = 0.22 \Omega$ ,  $X_1 = X_2 = 0.74 \Omega$ ,  $R_c = 125 \Omega$ ,  $X_m = 40 \Omega$ . The motor develops the maximum torque at a speed of 1000 rpm. The friction loss is 5% of the developed power. **Answer the following:**

- Determine the referred rotor resistance.
- Determine the rated line current and power factor.
- Determine the rated air-gap power, developed power and shaft horsepower.
- Determine the rated developed torque and shaft torque.
- Determine the motor efficiency at rated conditions.
- Determine the magnitude and the frequency of the voltage induced in the rotor.
- Determine the speed of the rotor field with respect to the rotor structure, the stator structure, and the stator field.
- Aiding with the torque-speed curve, **name** the different modes of operation of a three-phase induction machine. **suggest** an appropriate method for fast stopping, **then**, **name** the operating mode **and draw** the corresponding power flow diagram.

**Question Number (2) (8 Marks)**

A three-phase, 9 hp, 430 V, 50 Hz, 4-poles, Y-connected wound-rotor induction motor. The friction and windage loss is 36 W and the stator resistance between any two-line terminals is 1.6  $\Omega$ . It gave the following readings when tested at the rated conditions.

No-load test: 5.75 A, 0.14 lagging pf

Blocked-rotor test: 92 V, 12 A, 660 W

- Find the parameters of the equivalent circuit and the full-load efficiency.
- Determine the starting torque, the breakdown torque and the corresponding power.
- If the rotor resistance of this machine is doubled, **calculate** the new value of starting torque and breakdown torque. **Sketch** the torque-speed curve both with the original rotor resistance and with the doubled value.
- If the induction machine is operated at 4% slip (**negative**), **determine** the mode of operation, the **motor speed**, and its **direction** relative to the rotating field.
- Repeat part (iv), if the induction machine operates at 150% slip (**positive**).
- If the shaft load of an induction motor is **increased**, how do the following quantities **change**?

(1) rotor speed	(2) slip	(3) slip speed	(4) synchronous speed
(5) rotor induced voltage	(6) rotor current	(7) rotor frequency	(8) rotor copper loss



**Question Number (3) (11 Marks)**

- a) **Illustrate** why it is necessary to reduce the **voltage** applied to an induction motor as the electrical **frequency** is reduced. **Illustrate** your answer with suitable sketches. **How** do the changes in the supply voltage and the supply frequency affect the torque-speed characteristics of an induction motor for the following two cases? (3 Marks)
- (i) Neglect the effect of the stator resistance and leakage reactance.
- (ii) The effect of the stator resistance and leakage reactance is included.
- b) A **100-hp**, three-phase, **60 Hz**, **430 V**, **four-pole**, **star-connected** wound-rotor induction motor controls a speed of **a constant-torque load** develops a **maximum torque** of **2.25 times** the full-load torque at a speed of **1500-rpm** when operated at rated voltage and frequency with its slip rings short-circuited. The resistance of the rotor winding is **0.15 Ω /phase**. *Neglect any effects of rotational and stray-load losses and stator resistance.* (8 Marks)
- (i) **Determine** the motor speed at full load torque in rpm.
- (ii) **Determine** the rotor copper loss at full load.
- (iii) **How much resistance** must be inserted in series with the rotor windings to **produce maximum starting torque**?
- (iv) **It is required to run the load at 1600-rpm**, **Illustrate, with suitable calculations, TWO different control methods** that can be used to get the required speed. The slip-torque relationship of the motor can be assumed to be linear from no load to full load conditions.
- (v) **Determine** the starting torque and the rotor current at starting in per unit of full-load rotor current.
- (vi) **Determine** the rotor current at maximum torque in per unit of full-load rotor current.

**Question Number (4) (12 Marks)**

- a) A three-phase **squirrel-cage** induction motor takes **1.65 times** full-load current when started by a **star/delta starter**. An autotransformer is used to start the motor at reduced voltage. (6 Marks)
- (i) **What** are starting code letters?
- (ii) **Determine** the **autotransformer tapping** for starting the motor so that the starting current should not exceed **2.2 times** the full-load current.
- (iii) **Determine** the ratio of the starting torque at the **reduced** voltage of **part (ii)** to the starting torque at the **rated** voltage.
- (iv) **What** will the motor starting current be in terms of full-load current corresponding to both **star/delta** and **auto-transformer starter**?
- (v) **Calculate** the starting torque in terms of full-load torque corresponding to both **star/delta** and **autotransformer starter**, given that the full-load slip is **5 %**.



Continue Question Number (4)

- b) Illustrate the main differences between the following terms (3 Marks)
- (i) deep-bar and double-cage squirrel-cage rotor
  - (ii) time harmonics and space harmonics
  - (iii) crawling and cogging
- a) Explain the principles of operation of three-phase induction generators. Illustrate the process of building up voltage in a stand-alone mode (State the different conditions). Support your answer with suitable sketches. (3 Marks)

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*End of questions.....*

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WISH YOU ALL THE BEST

*Prof. Said M. Allam*

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Course Title: **Induction Machines**Course Code: **EPE331**Year: **EES Program**Date: **Jan. 19<sup>th</sup> 2025**Allowed time: **2 hrs**No. of Pages: **(3)**Total Marks: **40 Marks**

الامتحان مكون من ثلاث صفحات

**Remarks:** (answer the following questions... assume any missing data... answers should be supported by sketches if possible)**Question Number (1) (9 Marks)**

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- Determine the referred rotor resistance.
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- Determine the rated air-gap power, developed power and shaft horsepower.
- Determine the rated developed torque and shaft torque.
- Determine the motor efficiency at rated conditions.
- Aiding with the torque-speed curve, name the different modes of operation of a three-phase induction machine. suggest an appropriate method for fast stopping, then, name the operating mode and draw the corresponding power flow diagram.

**Question Number (2) (8 Marks)**

A three-phase, 9 hp, 430 V, 50 Hz, 4-poles, Y-connected wound-rotor induction motor. The friction and windage loss is 36 W and the stator resistance between any two-line terminals is 1.6  $\Omega$ . It gave the following readings when tested at the rated conditions.

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- Find the parameters of the equivalent circuit and the full-load efficiency.
- Determine the starting torque, the breakdown torque and the corresponding power.
- If the rotor resistance of this machine is doubled, **calculate** the new value of starting torque and breakdown torque. Sketch the torque-speed curve both with the original rotor resistance and with the doubled value.
- If the shaft load of an induction motor is increased, how do the following quantities **change**?

(1) rotor speed	(2) slip	(3) slip speed	(4) synchronous speed
(5) rotor induced voltage	(6) rotor current	(7) rotor frequency	(8) rotor copper loss

P.T.O



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  - (ii) The effect of the stator resistance and leakage reactance is included.
- b) A **100-hp**, three-phase, **60 Hz**, **430 V**, **four-pole**, **star-connected** wound-rotor induction motor controls a speed of **a constant-torque load** develops a **maximum torque** of **2.25 times** the full-load torque at a speed of **1500-rpm** when operated **at rated voltage and frequency** with its slip rings short-circuited. The resistance of the rotor winding is **0.15 Ω /phase**. **Neglect any effects of rotational and stray-load losses and stator resistance**. **(8 Marks)**
- (i) **Determine** the motor speed at full load torque in **rpm**.
  - (ii) **Determine** the rotor copper loss at full load.
  - (iii) **How much resistance** must be inserted in series with the rotor windings to **produce maximum starting torque**?
  - (iv) **It is required to run the load at 1600-rpm**, **Illustrate, with suitable calculations, ONE control method** that can be used to get the required speed. The **slip-torque** relationship of the motor can be assumed to be **linear** from no load to full load conditions.

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**Question Number (4) (12 Marks)**

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- (i) **What** are starting code letters?
  - (ii) **Determine** the **autotransformer tapping** for starting the motor so that the starting current should not exceed **2.2 times** the full-load current.
  - (iii) **What** will the **motor starting current** be in terms of full-load current corresponding to both **star/delta** and **auto-transformer starter**?
  - (iv) **Calculate** the **starting torque** in terms of **full-load torque** corresponding to both **star/delta** and **autotransformer starter**, given that the **full-load slip** is **5 %**.

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P.T.O



**Continue Question Number (4)**

- b) Illustrate the main differences between the following terms (3 Marks)
- (i) double-cage squirrel-cage rotor
  - (ii) time harmonics and space harmonics
  - (iii) crawling and cogging
- a) Explain the principles of operation of three-phase induction generators. Illustrate the process of building up voltage in a stand-alone mode (State the different conditions). Support your answer with suitable sketches. (3 Marks)

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*End of questions.....*

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WISH YOU ALL THE BEST

*Prof. Said M. Allam*

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Title: Distributed Generation Units  
Date: June, 2025

Allowed time: 2 hr

No. of Pages: (2)

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

- a) Explain the definition and classify the types of Distributed Generation (DG) units according to International Energy Agency. (5 Marks)
- b) With proper sketches and equations, explain how the DG units can be used to improve the voltage profile of distribution systems. (5 Marks)
- c) Analyze the protection blinding and false tripping issues in DG-integrated distribution systems. (5 Marks)
- d) Under Egypt Vision 2030, discuss the benefits of renewable energy-based DG units in strengthening energy sustainability. (5 Marks)
- e) Fig. 1 shows a simple distribution network. It consists of two radial feeders, each with 10 MW of capacity, that feed busbar B. A constant load of 10 MW is connected to B. The Forced outage rate (FOR) of the two feeders is given in the table in Fig. 1. Additionally, consider a 10 MW DG source with an availability factor of 71.5%. **Calculate** the expected number of hours in which the load experiences troubles for two cases; (i) without DG integration and (ii) with DG integration. **Comment** on the results. (5 Marks)

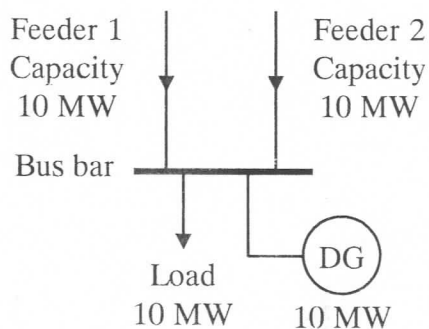


Fig. 1

Equipment	FOR (forced outage rate)
Feeder 1	0.04
Feeder 2	0.04

**Problem number (2)**                      **(15 Marks)**

- a) Discuss the Typical centralized, decentralized, and distributed control structures in microgrid. (3 Marks)
- b) Explain the problem of optimal planning and allocation (location and size) of DG units. (4 Marks)
- c) Explain Site selection for the PV and WT power is a critical issue due to its direct impact on the power performance, economic, environmental, social aspects, and existing as well as future infrastructures. (4 Marks)
- d) Compare between Hybrid AC-DC microgrids, AC-microgrids and DC microgrids. (4 Marks)
- 

**Good Luck**

**Course Committee: Assoc. Prof. Samir Dawoud**



Tanta University

Electrical Power and Machines Department  
Final EXAM 2024/2025 Second Term

لائحة جديدة



Faculty of Engineering

Course	Synchronous Machines (EPE323)	Time Allowed	2 hrs
Students	Electrical Energy and Systems Engineering Program	Total Points	40.
Date	June 11, 2024	Number of pages	Two

Answer ALL the following FOUR questions and problems:

Support your answer with clear and well-prepared illustration as you can

<b>The First Question</b> (13 marks)	
A)	Give notes and show the importance of the following: (3 points) 1) Distributing stator windings of synchronous generators. 2) Automatic Voltage Regulator (AVR).
B)	For a cylindrical rotor synchronous generator draw with sufficient information: (4 points) 1) Equivalent circuit (define all quantities) 2) Phasor diagram when supplying a capacitive load. 3) Torque against load angle characteristics (write down mathematical relation)
C)	A three-phase, Y-connected synchronous generator has 16-pole, 144-slot, 240 turns per phase. Coil span is 7 slots. The rotor is driven at 375 r/min. The flux per pole is 25 mWb. Determine frequency and rms value of generated voltage. (3 points)
D)	A Y-connected six-pole synchronous generator is of 50-kVA, 380-V, 50 Hz. It has a per phase synchronous impedance of $0.4 + j 1.2$ ohm. The generator has friction and windage losses of 1.5 kW and core losses of 1.0 kW. The field winding has been adjusted so that terminal voltage is 400-V at no-load. At full load current and unity power factor, calculate: a) Terminal voltage.      b) Generator efficiency (3 points)

<b>The Second Question</b> (7 marks)	
A)	For a synchronous generator, with all sufficient details, draw V-curves. (2 points)
B)	Graphically, show the effect of both excitation and prime mover speed on the external voltage and frequency characteristics of a stand-alone synchronous generator. Use a separate graph for each case. (2 points)

**Please Turn Over**

**The Second Question** Continued

- C) A three-phase alternator of 6.6 kV, 50 Hz has the open-circuit characteristics given by the following table:

O.C. line voltage, V	3100	4900	6600	7500	8300
Field current, A	16	25	37.5	50	70

On short circuit, a field current of 20 A was required to give full load current. The armature resistance and leakage flux are negligible. Using **mmf method**, determine at full load: **(4 points)**

- the percentage regulation at unity power factor.
- the power factor that gives zero percent voltage regulation

**The Third Question** (10 marks)

- A) Draw the Frequency-Power Characteristics of two synchronous generators in parallel and explain how to shift the system frequency without affecting power sharing. **(4 marks)**

- B) A three-phase 50 Hz the synchronous motor is rated at 750 kW and 2.2 kV. The total losses in the motor including electrical and mechanical losses are 20 kW. The motor is supplied with 0.8 pf lagging current when fully loaded. Compute the excitation voltage per phase at full load, given the synchronous reactance as 1.5  $\Omega$ /phase. The armature resistance is negligible. **(6 marks)**

**The Fourth Question** (10 marks)

- A) Explain the different types of Permanent Magnet Synchronous Motors (PMSMs) and illustrate their applications. **(4 marks)**

- B) A 2-pole, 50-Hz, 3-phase, turbo-alternator is excited to generate the bus-bar voltage of 11 kV on no-load. The machine is star-connected and the short-circuit current for this excitation is 1000 A. Calculate the synchronizing power per degree of mechanical displacement of the rotor and the corresponding synchronizing torque. **(6 marks)**

Good Luck and best wishes

Prof. Essam M. Rashad and Dr. Rawda Ramadan

**Question (1) (20 Marks)**

Consider the open-loop sampled-data system of Fig. 1. The sampling period is  $T = 1 \text{ sec}$ .

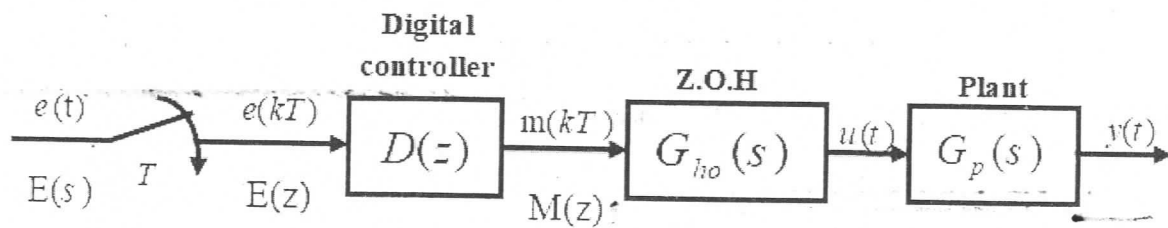


Fig. 1 Discrete-time system

The plant transfer function  $\left( G_p(s) = \frac{1}{s+0.2} \right)$  and the digital control signal is given by

$$(m(k+1) = (0.9)m(k) + (0.2)e(k+1))$$

- i) Find the transfer function  $\frac{Y(z)}{E(z)}$
- ii) Find the unit step response.
- iii) Calculate the unit-impulse response.

**Question (2) (20 Marks)**

Consider a sampled-data system with input  $e(k)$  and output  $y(k)$  and is represented by the following difference equation:

$$y(k+2) - \left(\frac{3}{4}\right)y(k+1) + \left(\frac{1}{8}\right)y(k) = e(k)$$

where

$$e(k) = \begin{cases} 1 & k=0,1 \\ 0 & k \geq 2 \end{cases} \quad \text{and} \quad y(0) = y(1) = 0$$

Solve the given difference equation for  $y(k)$  using:

- i) The recursive technique.
- ii) The z-transform.
- iii) Discuss the system stability.



Course Title	Energy conversion and Transformers	Final Exam	Course Code	EPE231
Date	24/5/2025	No. of Pages 2	Allowed time	3 Hour

**Question Number (1) (10 Points)**

A. For two magnetically -coupled coils, show that the total stored energy  $W_t$  is given by:

$$W_t = \frac{1}{2} L_{11} I_1^2 + \frac{1}{2} L_{22} I_2^2 \pm M I_1 I_2 \quad (2 \text{ Marks})$$

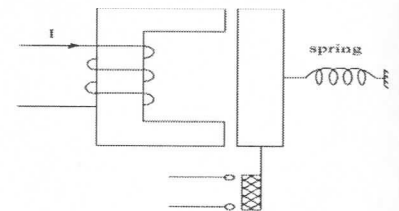
B. Compare between the Rotating systems and the Translational systems (2 Marks)

C. Sketch and write the equations for the space variation of self and mutual inductances for a doubly excited electromechanical energy conversion device having a salient stator and cylindrical rotor. (2 Marks)

D. The magnetic circuit of a primitive relay is shown in the figure. The coil has 500 turns and the mean core path is 360 mm. When the air-gap lengths are 1.5 mm each, a flux density of 0.8 Tesla is required to actuate the relay. The core is made of cast steel having B-H relation given in the following table:

<b>H (AT/m)</b>	<b>300</b>	<b>405</b>	<b>510</b>	<b>680</b>	<b>800</b>	<b>1000</b>
<b>B (wb/m<sup>2</sup>)</b>	<b>0.4</b>	<b>0.6</b>	<b>0.8</b>	<b>1.0</b>	<b>1.1</b>	<b>1.2</b>

- Find the current in the coil.
- Compute the values of the permeability and relative permeability of the core.
- If the air-gap is zero, find the current in the coil for the same flux density (0.8 Tesla) in the core

**(4 Marks)****Question Number (2) (15 Points)**

A. Explain with the suitable sketch the MMF Distribution of a Concentrated Single Coil fed by dc current. (3 Marks)

B. Derive an expression for the electromagnetic torque in singly-excited Rotating systems using the coenergy. (3 Marks)

C. The lifting magnetic system shown in the figure has a square cross-section of  $6 \times 6 \text{ cm}^2$ . The coil has 300 turns and a resistance of  $6 \Omega$ . The air-gap is held at 5 mm and a dc source of 120 V is connected to the coil. Determine The stored magnetic field. Neglect reluctance of the magnetic core and field fringing in the two air-gaps (4 Marks)



Course Title	Control of Electrical Power Systems	Academic Year 2025/2026 <b>First Semester Exam</b>	Course Code	EPE441
Year/ Level	Fourth		Allowed time	2 hrs
Date	31-Jun- 2025	No. of Pages (1)		
<b>Remarks: (answer the following questions)</b>				

**Question Number (1)**

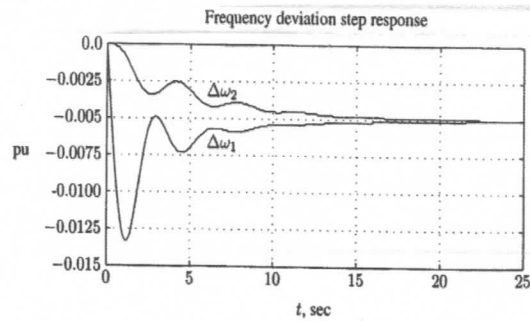
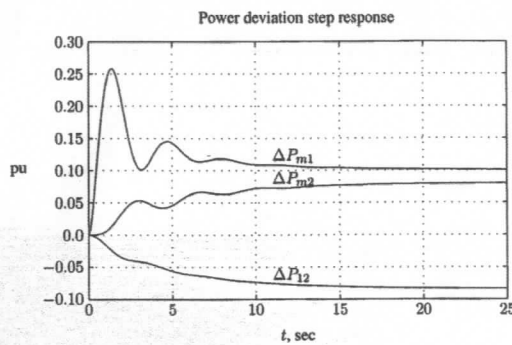
**(20 Points)**

- i. Define function of WAMS and mention the main component of the system.
- ii. Compare between droop and isochronous governor characteristics.
- iii. Mention the main objectives of AGC in connected and isolated areas.
- iv. 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.

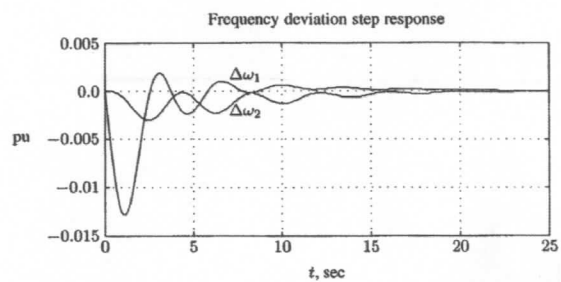
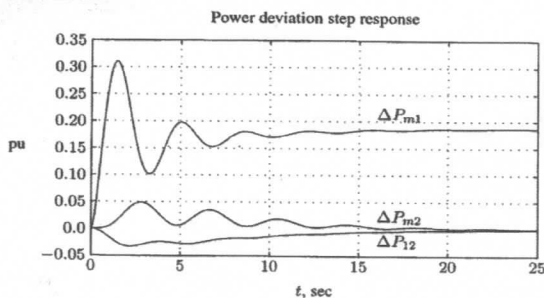
**Question Number (2)**

**(20 Points)**

- i. Compare between (case-a) and (case-b) of two connected areas presented in fig.1.
- ii. Explain the operation principles of STATCOM.
- iii. Define function of SCADA system, then mention its main components.
- iv. Explain how SVC (FC-TCR) could improve voltage profile in power system.



**Case-a**



**Case-b**

**Fig. 1**

## Final Exam: لائحة جديدة 2024-2025

Renewable Energy Program (Level 3)

Time: 2 hours

Mark: 40

Saturday, 28 June 2025

Course: Power Electronics (2)

Code: EPE341

*Answer all questions with the required graphs and equations*

### Question 1. [6 Marks]

[A] For three-phase full-wave AC voltage controller: [6 Marks]

- Plot** the three-phase bidirectional controller circuit.
- Plot** waveforms of input line voltages, input phase voltage, thyristor gate pulses, output phase voltage at delay angle of  $60^\circ$ .
- Explain** the operation, in detail, to show how the output phase voltage has been got at delay angle of  $60^\circ$  with suitable switching sequence.

### Question 2 [20 Marks]

[A] For a three-phase bridge inverter: [12 Marks]

- Plot** the circuit configuration of the three-phase bridge inverter.
- Explain** the operation of three-phase VSI with plotting the waveforms of gate pulses and line-to-line output voltages for  $180^\circ$  conduction.
- For Y-connected load, with the aid of equivalent circuits, **derive** the values of the phase voltages during the whole cycle and then **plot** its waveforms.

[B] In current source inverters: [8 Marks]

- Explain** the operation of full-bridge single-phase current source inverters
- Plot** the circuit of transistor current source inverter, gate signals, and load current and its fundamental.
- Right down** the state switches in table.

### Question 3: [14 Marks]

[A] For three-phase/single-phase cycloconverter: [7 Marks]

- Explain** with draw circuit, line voltages of 60 Hz supply, 12 Hz output voltage, and conduction periods for P and N converters.
- Explain** with configurations, **how much** thyristors could be required for building a full-wave three-phase/three-phase cycloconverter?

[B] In sinusoidal pulse-width modulation: [7 Marks]

- Explain**, with figure, **how** the gating signals are generated for turning on and off transistors (explain two ways).
- Draw** the gate signals for phase "a" of the VSI.
- Plot** the output voltage expected to be applied to this phase.
- Estimate** the RMS value of the output voltage.

With Best Wishes Prof. Abdelsalam Ahmed



Course Title	Electrical Power Engineering	Final Exam	Course Code	EPE221
Date	28/05/2025	No. of Pages 2	Allowed time	2 Hours

**Question Number (1) (10 Points)**

- A. Write brief comments about the following expressions: (3 Marks)
- Factors affecting corona discharge
  - Conductors budling
  - Shackle type insulators
- B. A 3-phase, 50-Hz overhead transmission line 100 km long has the following constants:  
Resistance/km/phase = 0.1  $\Omega$ ,  
Inductive reactance/km/phase = 0.2  $\Omega$ ,  
Capacitive susceptance/km/phase =  $0.04 \times 10^{-4}$  siemens.  
Determine: (i) the sending end current (ii) sending end voltage (iii) sending end power factor and (iv) transmission efficiency when supplying a balanced load of 10,000 kW at 66 kV, p.f. 0.8 lagging. Use nominal T-method. (7 Marks)

**Question Number (2) (10 Points)**

- A. An overhead transmission line conductor having a parabolic configuration weighs 1.925 kg per meter of length. The cross section area of the conductor is 2.2 cm<sup>2</sup> and the ultimate strength is 8000 kg/cm<sup>2</sup>. The supports are 600 m apart having 15 m difference of levels. Calculate the sag from the taller of the two supports which must be allowed so that the factor of safety shall be 5. Assume ice load is 1 kg per meter run and there is no wind pressure. (5 Marks)
- B. A single-phase AC distributing feeder 1 km long has a total per conductor resistance and reactance 0.1 and 0.15 ohm, respectively. At the far end, the voltage is 200 Volt and the current is 100 A at a power factor of 0.8 lagging. At the mid-point, a current of 100 A at a power factor of 0.6 lagging. All power factors are with reference to the voltage at the far end. Calculate:
- The voltage at mid-point.
  - The voltage at sending end.
- (5 Marks)

**Question Number (3) (10 Points)**

- A. Classify the main tests that can be carried out on underground cables. Explain the importance of each test type. (4 Marks)
- B. A 100 MVA, 13.2 kV generator (G) having a reactance of 10% is connected to a star-star transformer T1 that feeds a 132 kV line having an impedance per phase of  $20 + j50 \Omega$ . At the receiving end of the line is a star-star step down transformer T2. A load drawing 60 MVA at 0.9 lagging PF is connected to the secondary of transformer T2. The transformer ratings are:  
Transformer T1: 120 MVA, 13.2/132 kV, XT1=12%.  
Transformer T2: 100 MVA, 138/33 kV, XT2=15%.

Using a base of 100 MVA and a voltage base of 33 kV in the load side, draw the single-line diagram of the system showing all equipment parameters. Also, draw a system impedance diagram expressing all values in per unit.

(6 Marks)

**Question Number (4)**

**(10 Points)**

- A. Each line of a 3-phase system is suspended by a string of 3 identical insulators of self-capacitance  $C$  farad. The shunt capacitance of connecting metal work of each insulator is  $0.2 C$  to earth and  $0.1 C$  to line. Calculate the string efficiency of the system if a guard ring increases the capacitance to the line of metal work of the lowest insulator to  $0.3 C$ . (6 Points)
- B. Compare the volume of conductor material required in DC 2-wire system and DC 3-wire system assuming that: (4 points)
- The amount of power  $P$  transmitted is the same
  - The voltage  $V$  at the consumer's terminals is the same
  - The efficiency of transmission is the same
  - The area of X-section of neutral wire is the same of the outers.

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*Good Luck and best wishes Assoc. Prof. Amr Salah*



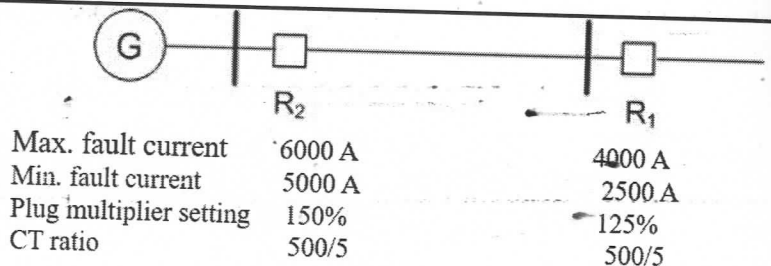
Course Title	Protection of Electrical Systems	Final Exam	Course Code	EPE471
Date	4/6/2025	No. of Pages 1	Allowed time	3 Hour

**Question Number (1) (10 Points)**

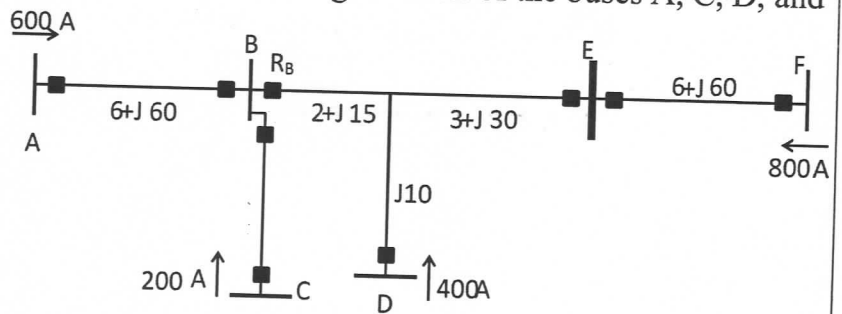
- A. Compare the redundancy and backup concepts used in the protection system? Explain the definition of protection system reliability, dependability, and security? (5 Points)
- B. State the methods used for fault detection? Give an example to show the locations of the CTs for the dead and life tank circuit breakers for two overlapping unit protection zones. (5 Points)

**Question Number (2) (10 Points)**

- A. For the radial system shown, calculate the time multiplier settings for the relay R2. The coordination margin should be selected as 0.3 s and TDS for R1 is 0.1. (5 Points)



- B. Consider the multi-terminal line in the system shown in Fig. 2. Each of the buses A, C, D, and F has a source of power behind it. The contributions from each of the sources are as shown in the figure. Assume that the fault current contributions from each of these sources remain unchanged as the fault is moved throughout the system. Determine the zones 1, 2 and 3 for the distance relay R<sub>B</sub>. (5 points)



**Question Number (3) (10 Points)**

- A. Compare among the differential protection connections for star (one CT per phase– two CT per phase), delta, and split winding generator used to provide fully phase-fault primary protection. (5 Points)
- B. Explain the methods used to provide the backup protection against phase-fault for generator. (5 Points)

**Question Number (4) (10 Points)**

- A. Explain using graph only; the typical protection for three-phase induction motor. Complete this statement: For an instantaneous over current relay to be applied for IM which has locked rotor current 1970 A, the minimum line-line fault at terminals is....., where ( $P_R=P_F=2$ ). (4 Points)
- B. In applying differential protection schemes on the power transformers, what factors must be considered? Draw the connection diagram of a differential relay for the protection of a Y-Δ transformer. (3 Marks)
- C. What is the principle used to make a differential relay insensitive to magnetizing inrush current? (3 Marks)



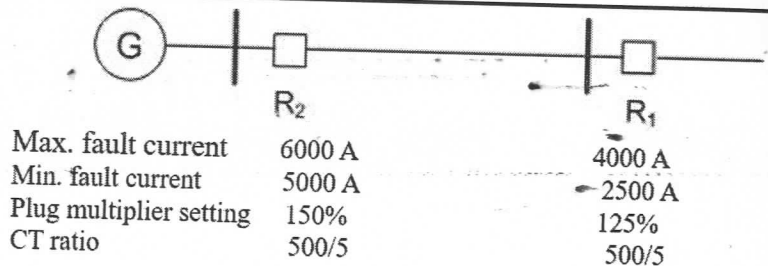
Course Title	Protection of Electrical Systems	Final Exam	Course Code	EPE421
Date	4/6/2025	No. of Pages 1	Allowed time	2 Hour

**Question Number (1) (10 Points)**

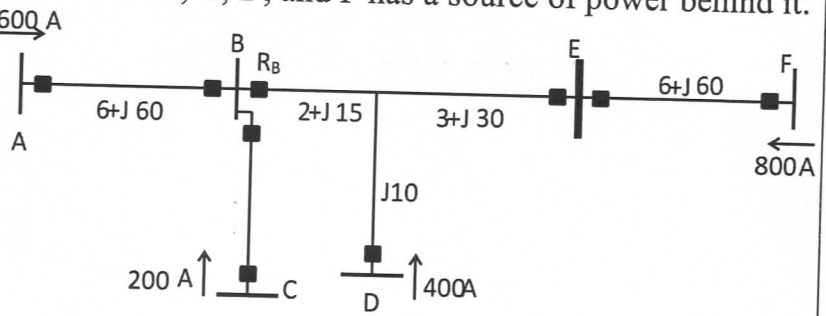
- A. Compare the redundancy and backup concepts used in the protection system? Explain the definition of protection system reliability, dependability, and security? (5 Points)
- B. State the methods used for fault detection? Give an example to show the locations of the CTs for the dead and life tank circuit breakers for two overlapping unit protection zones. (5 Points)

**Question Number (2) (10 Points)**

- A. For the radial system shown, calculate the time multiplier settings for the relay R2. The coordination margin should be selected as 0.3 s and TDS for R1 is 0.1. (5 Points)



- B. Consider the multi-terminal line in the system shown in Fig. 2. Each of the buses A, C, D, and F has a source of power behind it. The contributions from each of the sources are as shown in the figure. Assume that the fault current contributions from each of these sources remain unchanged as the fault is moved throughout the system. Determine the zones 1, 2 and 3 for the distance relay R<sub>B</sub>. (5 points)



**Question Number (3) (10 Points)**

- A. Compare among the differential protection connections for star (one CT per phase– two CT per phase), delta, and split winding generator used to provide fully phase-fault primary protection. (5 Points)
- B. Explain the methods used to provide the backup protection against phase-fault for generator. (5 Points)

**Question Number (4) (10 Points)**

- A. Explain using graph only; the typical protection for three-phase induction motor. Complete this statement: For an instantaneous over current relay to be applied for IM which has locked rotor current 1970 A, the minimum line-line fault at terminals is....., where ( $P_R = P_F = 2$ ). (5 Points)
- B. In applying differential protection schemes on the power transformers, what factors must be considered? Draw the connection diagram of a differential relay for the protection of a Y-Δ transformer. (5 Marks)



Course Title	Heat Transfer	Academic Year 2024/2025	Course Code	MEP212
Year/ Level	All levels	Second Semester Final Exam		
Date	23-June-2025	No. of Pages (3)	Allowed time	2 hrs
Total Assessment Marks: 40				

Remarks: Notes for Students: Neat and clear answers will be appreciated.

**Question Number (01)**

**(08 Points)**

- a) Define the following: radiation heat transfer, thermal conductivity of a material, thermal insulators, and thermal contact resistance. **(02 points)**
- b) Explain the mechanism of heat transfer by convection, classify convection heat transfer and mention all the variables influencing convection heat transfer coefficient. **(02 points)**
- c) Consider a sealed 20-cm-high electronic box whose base dimensions are 50 cm \* 50 cm placed in a vacuum chamber (see Fig.1). The emissivity of the outer surface of the box is 0.95. If the electronic components in the box dissipate a total of 120 W of power and the outer surface temperature of the box is not to exceed 55°C, determine the temperature at which the surrounding surfaces must be kept if this box is to be cooled by radiation alone. Assume the heat transfer from the bottom surface of the box to the stand to be negligible. **(04 points)**

**Question Number (02)**

**(10 Points)**

- a) Draw the temperature distribution and heat flow lines along two solid plates pressed against each other for the case of perfect and imperfect contact and mention all factors that influence the value of thermal contact resistance. **(03 points)**
- b) Although there are three mechanisms of heat transfer, a medium may involve only two of them simultaneously. Explain with the aid of sketches and give examples. **(02 points)**
- c) Consider the base plate of an 800-W household iron (see Fig.2) with a thickness of  $L = 0.6$  cm, base area of  $A = 160$  cm<sup>2</sup>, and thermal conductivity of  $k = 60$  W/m.K. The inner surface of the base plate is subjected to uniform heat flux generated by the resistance heaters inside. When steady operating conditions are reached, the outer surface temperature of the plate is measured to be 112°C. Disregarding any heat loss through the upper part of the iron, (a) express the differential equation and the boundary conditions for steady one-dimensional heat conduction through the plate, (b) obtain a relation for the variation of temperature in the base plate by solving the differential equation, and (c) evaluate the inner surface temperature. **(05 points)**



**Question Number (03)**

**(08 Points)**

- a) Applying the energy balance on a thin cylindrical shell element of thickness  $\Delta r$  from a long cylinder (see Fig.3) during a small-time interval  $\Delta t$  to obtain the equation  $\frac{1}{r} \frac{\partial}{\partial r} \left( r \frac{\partial T}{\partial r} \right) + \frac{\dot{e}_{gen}}{k} = \frac{1}{\alpha} \frac{\partial T}{\partial t}$  and reduce this equation under three specified conditions. **(04 points)**
- b) A composite wall is constructed as schematically shown in (see Fig.4) The thermal conductivities of the used materials are:  $k_A = 150$  W/m.°C,  $k_B = 30$  W/m.°C,  $k_C = 70$  W/m.°C, and  $k_D = 50$  W/m.°C. If the heat flow through the wall is assumed to be one-dimensional, determine the rate of heat transfer per unit area of the wall. The area perpendicular to the heat transfer direction for all layers of the composite wall are as follow:  $A_D = 1$  m<sup>2</sup> and  $A_A = A_D = 2A_B = 2A_C$ . **(04 points)**

**Question Number (04)**

**(06 Points)**

- a) Draw a schematic diagram and the corresponding thermal resistance network for heat transfer through a two-layer plane wall subjected to convection on both sides and write down the total resistance equation. **(02 points)**
- b) Consider a large 3 cm thick stainless-steel plate ( $k = 15.1$  W/m.°C) in which heat is generated uniformly at a rate of  $5 \times 10^5$  W/m<sup>3</sup>. Both sides of the plate are exposed to an environment at 30 °C with a heat transfer coefficient of 60 W/m<sup>2</sup>.°C. Explain where in the plate the highest and lowest temperatures will occur and determine their values. **(04 points)**

**Question Number (05)**

**(08 Points)**

- a) How can the thermal contact resistance be minimized? Give practical example. **(02 points)**
- b) Explain why fins are widely used in engineering applications. Give examples. **(02 points)**
- c) An insulated tip copper rod of 6.4 mm diameter ( $k = 372$  W/m.°C) is exposed to an environment at 20 °C. The base temperature of the rod is 150 °C. The heat transfer coefficient between the rod and environment is  $h = 15$  W/m<sup>2</sup>.°C. Determine (1) the heat given up by the rod (2) fin effectiveness (3) fin efficiency. **(04 points)**

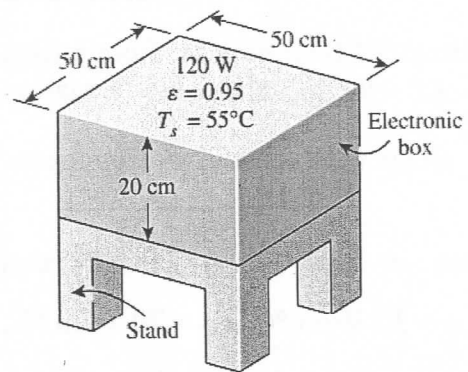


Fig. 1 - Problem No.1 (c)

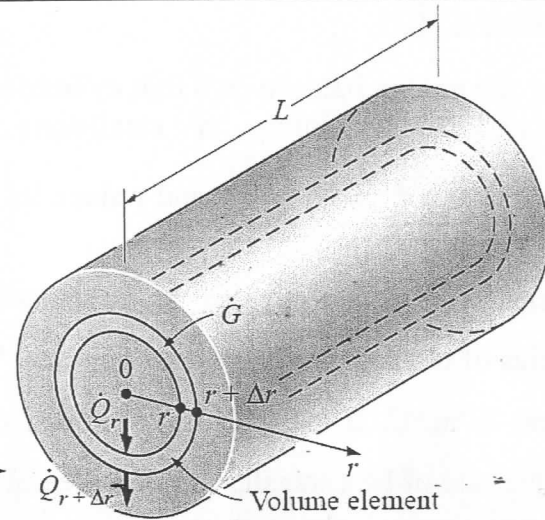


Fig. 3 - Problem No.3 (a)

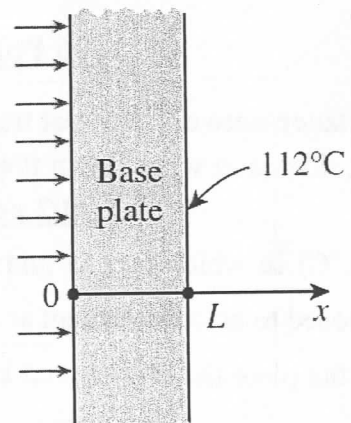


Fig. 2 - Problem No.2 (c)

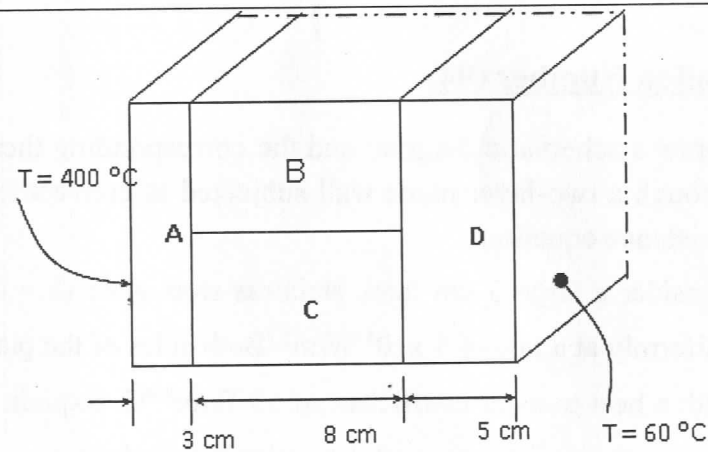


Fig. 4 - Problem No. 3 (b)

End of questions.....

Best of Luck

Dr. Ahmed Mostafa Khaira



Course Title	Thermal Power Stations	Academic Year 2024/2025 First Semester Final Exam	Course Code	(MEP211)
Year/ Level	All levels		Allowed time	3 hrs
Date	23-June-2025	No. of Pages (3)	Total Assessment Marks: 40	

**Remarks: Request from the Exam Committee:**

Kindly allow students to use their Thermodynamics Steam Tables and Chart, however students are not allowed to write in or exchange these materials.

**Notes for Students:** Neat and clear answers will be appreciated.

**Question Number (1) (10 Points)**

- Gas power systems or simply "Gas turbines" are used in a very wide range of engineering applications. Mention the engineering applications of Gas Turbines. **(02 points)**
- What are the advantages and disadvantages of Gas turbines compared with steam power plants? **(02 points)**
- Air enters the compressor of a **regenerative** Brayton cycle at 100 kPa, 300 K, with a volumetric flow rate of 5 m<sup>3</sup>/s. The compressor pressure ratio is 9. The turbine inlet temperature is 1350 K. If the turbine and compressor each have an isentropic efficiency of 85%, and a regenerator effectiveness of 75%. **Draw** the flow and (T-S) diagrams, then **determine:** (a) the thermal efficiency of the cycle, (b) the back work ratio, (c) the net power developed, in kW. **(06 points)**

**Question Number (2) (11 Points)**

- Why is excessive moisture in steam undesirable in steam turbines? What is the highest moisture content allowed? How can you overcome this problem? **(02 points)**
- Is it possible to maintain a pressure of 10 kPa in a condenser that is being cooled by river water entering at 20°C? **(01 point)**
- Consider a steam power plant that operates on the ideal regenerative Rankine cycle with a closed feedwater heater. The plant maintains the turbine inlet at 3000 kPa and 350°C; and operates the condenser at 20 kPa. Steam is extracted at 1000 kPa to serve the closed feedwater heater, which discharges into the condenser after being throttled to condenser pressure. Calculate the work produced by the turbine, the work consumed by the pump, and the heat supply in the boiler for this cycle per unit of boiler flow rate. **(08 points)**



**Question Number (3) (12 Points)**

- What is meant by regeneration and cogeneration? Mention the effects of them. **(02 points)**
- What are the advantages of Gas turbines plants with water/steam injection? **(02 points)**
- The gas-turbine portion of a combined gas-steam power plant has a pressure ratio of 16. Air enters the compressor at 300 K at a rate of 14 kg/s and is heated to 1500 K in the combustion chamber. The combustion gases leaving the gas turbine are used to heat the steam to 400°C at 10 MPa in a heat exchanger. The combustion gases leave the heat exchanger at 420 K. The steam leaving the turbine is condensed at 15 kPa. Assuming all the compression and expansion processes to be isentropic, determine (a) the mass flow rate of the steam, (b) the net power output, and (c) the thermal efficiency of the combined cycle. For air, assume constant specific heats at room temperature. **(08 points)**

**Question Number (04) (07 Points)**

- Estimate the main properties of a De Laval turbine and compare between the impulse and reaction turbine. **(02 points)**
- Steam enters the nozzles of a single stage impulse turbine at a pressure of 2.6 bar with a velocity of approach of 60 m/s with a dryness fraction of 96 %. Pressure drops along the nozzles to 0.5 bar and 5 % of the available heat drop is absorbed in overcoming friction. The nozzles are inclined at an angle of 18° to the plane of wheel. Blade speed ratio is 0.45 and the blade velocity coefficient is 0.85. **Calculate:** i, blade angles so that the steam may enter without shock and leaves in axial direction, ii. total force on the blades and the axial thrust per 1 kg/s of steam. **(05 points)**

*End of questions.....*

*Best of Luck*

*Dr. Ahmed M. Khaira*



T °C	P bar	Enthalpy			Entropy			Internal Energy			Specific volume	
		$h_f$ Sat. Liq.	$h_{fg}$ $h_g - h_f$	$h_g$ Sat. Vap.	$s_f$ Sat. Liq.	$s_{fg}$ $s_g - s_f$	$s_g$ Sat. Vap.	$u_f$ Sat. Liq.	$u_{fg}$ $u_g - u_f$	$u_g$ Sat. Vap.	$v_f$ Sat. Liq.	$v_g$ Sat. Vap.
18.0	0.020624	75.5	2459.0	2534.5	0.2677	8.4458	8.7135	75.5	2324.8	2400.3	0.001001	65.087
19.0	0.021957	79.7	2456.7	2536.4	0.2820	8.4088	8.6908	79.7	2322.0	2401.7	0.001002	61.341
20.0	0.023366	83.9	2454.3	2538.2	0.2963	8.3721	8.6684	83.9	2319.2	2403.1	0.001002	57.838

Table (2) Pressure Table

P bar	T °C	Enthalpy			Entropy			Internal Energy			Specific volume	
		$h_f$ Sat. Liq.	$h_{fg}$ $h_g - h_f$	$h_g$ Sat. Vap.	$s_f$ Sat. Liq.	$s_{fg}$ $s_g - s_f$	$s_g$ Sat. Vap.	$u_f$ Sat. Liq.	$u_{fg}$ $u_g - u_f$	$u_g$ Sat. Vap.	$v_f$ Sat. Liq.	$v_g$ Sat. Vap.
0.140	52.58	220.0	2376.7	2596.7	0.7367	7.2966	8.0333	220.0	2227.0	2447.0	0.001013	10.693
0.145	53.30	223.0	2375.0	2598.0	0.7460	7.2751	8.0211	223.0	2225.0	2448.0	0.001014	10.347
0.150	54.00	226.0	2373.2	2599.2	0.7549	7.2544	8.0093	226.0	2222.9	2448.9	0.001014	10.022
0.190	58.98	246.8	2361.1	2607.9	0.8182	7.1090	7.9272	246.8	2208.6	2455.4	0.001017	8.0256
0.195	59.54	249.2	2359.7	2608.9	0.8252	7.0930	7.9182	249.2	2207.0	2456.2	0.001017	7.8332
0.200	60.09	251.5	2358.4	2609.9	0.8321	7.0773	7.9094	251.5	2205.4	2456.9	0.001017	7.6492
0.48	80.33	336.3	2308.0	2644.3	1.0792	6.5294	7.6086	336.3	2146.5	2482.7	0.001029	3.3663
0.49	80.84	338.5	2306.7	2645.2	1.0853	6.5163	7.6016	338.5	2145.0	2483.4	0.001030	3.3020
0.50	81.35	340.6	2305.4	2646.0	1.0912	6.5035	7.5947	340.6	2143.4	2484.0	0.001030	3.2401
2.4	126.09	529.6	2184.9	2714.5	1.5929	5.4728	7.0657	529.3	2006.0	2535.4	0.001066	0.7464
2.5	127.43	535.4	2181.0	2716.4	1.6072	5.4448	7.0520	535.1	2001.7	2536.8	0.001068	0.7184
2.6	128.73	540.9	2177.3	2718.2	1.6209	5.4180	7.0389	540.6	1997.5	2538.2	0.001069	0.6925
10.0	179.88	762.6	2013.6	2776.2	2.1382	4.4446	6.5828	761.5	1820.4	2581.9	0.001127	0.1943
10.2	180.74	766.4	2011.2	2777.6	2.1465	4.4295	6.5760	765.3	1817.9	2583.1	0.001129	0.1907
10.4	181.59	770.2	2008.1	2778.3	2.1547	4.4145	6.5692	769.0	1814.6	2583.7	0.001130	0.1872
29.0	231.96	999.5	1802.7	2802.2	2.6282	3.5687	6.1969	996.0	1606.3	2602.2	0.001213	0.06895
29.5	232.91	1003.9	1798.3	2802.2	2.6369	3.5534	6.1903	1000.3	1602.0	2602.3	0.001215	0.06777
30.0	233.84	1008.3	1794.0	2802.3	2.6455	3.5383	6.1838	1004.7	1597.8	2602.4	0.001216	0.06663
98.0	309.48	1399.4	1331.8	2731.2	3.3462	2.2858	5.6320	1385.2	1164.7	2550.0	0.001446	0.01849
99.0	310.23	1403.7	1325.8	2729.5	3.3534	2.2695	5.6229	1389.4	1159.3	2548.7	0.001449	0.01827
100.0	310.96	1408.1	1319.6	2727.7	3.3606	2.2592	5.6198	1393.6	1153.7	2547.3	0.001453	0.01804

Table (3) Subcooled and Superheated Steam

Subcooled and Superheated Steam P = 25 - 35

T °C	P = 25.0 bar (Ts = 223.9 °C)				P = 30.0 bar (Ts = 233.8 °C)			
	h	s	v	u	h	s	v	u
f	961.9	2.5542	0.0012	958.91	1008.3	2.6455	0.00122	1004.7
g	2800.9	6.2537	0.07992	2601.1	2802.3	6.1838	0.06663	2602.4
340	3105.3	6.8071	0.10764	2836.2	3093.9	6.7088	0.08871	2827.8
350	3123.2	6.8442	0.10975	2848.9	3117.5	6.7471	0.09053	2845.9
360	3151.0	6.8804	0.11184	2871.4	3140.9	6.7844	0.09232	2863.9
T °C	P = 90.0 bar (Ts = 303.3 °C)				P = 100 bar (Ts = 311.0 °C)			
	h	s	v	u	h	s	v	u
380	3060.5	6.2000	0.02837	2805.2	3035.7	6.1213	0.02493	2786.4
390	3091.4	6.2469	0.02916	2828.9	3068.5	6.1711	0.02568	2811.7
400	3121.2	6.2915	0.02993	2851.8	3099.9	6.2182	0.02641	2835.8



Final Exam

Time: 2 hours	Date: May 28, 2025	Marks: 40
Course Title: Electrical Installations		Level 4

ATTEMPT ALL the following questions and problems:

السؤال الأول:

وضح ان كانت كل من الجمل التالية (صحيحة) أو (خاطئة)، مع تصحيح الجمل الخاطئة:

(15 درجة)

1	المكتب الاستشاري دوره تنفيذ الأعمال الواردة في مخططات المشروع وتصميماته.
2	المخططات التصميمية تحتوي على تفاصيل أكثر من المخططات التنفيذية shop drawings.
3	لوحة ال RMU تحتوي على نفس المكونات الموجودة في الموزع distributor لكن على نطاق أصغر.
4	الموزع distributor يتكون بشكل أساسي من قواطع كهربية وقضبان توزيع.
5	محول مكتوب عليه الرقم 881250، هذا يعني أن المحول تم تصنيعه في شهر 12 سنة 1988 بقدرة 50 كيلو فولت امبير.
6	ال ATS هو مصدر طاقة بديل لتغذية الأحمال الهامة.
7	ال UPS يستخدم كمصدر طاقة احتياطي لتغذية الأحمال الهامة في حال انتهاء وقود مولد الطوارئ.
8	العازل الداخلي والعازل الخارجي وشريط التسليح الصلب هي مكونات مطلوبة في كل الكابلات المستخدمة في التمديدات الكهربائية.
9	يتم تمديد كابلات التغذية الرئيسية للمبنى القادمه من شبكة الكهرباء على حوامل كابلات لضمان جودة التهوية.
10	تمديد الأسلاك داخل مواسير بلاستيكية مرنة هو الخيار الأفضل في المكاتب الادارية لسهولة تغيير أماكن مأخذ التيار فيها.
11	ماسوره بقطر 20 ملليمتر تعتبر مناسبة لتمديد ثلاثة كابلات قطر كل منها 6 ملليمتر.
12	الكابل ال single phase والذي يحتوي على طرفين line and neutral يجب أن لا يتم تمديده داخل ماسورة معدنية.
13	يمكن تمديد الكابلات العادية وكابلات الطوارئ على نفس حامل الكابلات اذا تم استخدام fire barrier.
14	ال PVC هو العازل الأكثر شيوعا لكابلات الجهد المنخفض.
15	الكابلات ال multi-core هي المستخدمة دائما في دوائر ال three phase.
16	كابل توصيفه $25\text{mm}^2 + (50 + 3 \times 95)$ هو كابل multi core خماسي، موصل ال neutral فيه يختلف عن موصل الأرضي في القطر.
17	قواطع ال MCCB تستخدم عادة مع الدوائر الرئيسية.
18	قاطع MCB مكتوب عليه 25A, 10kA -- هذا معناه ان القاطع يفصل فوريا في حالة مرور تيار أكبر من 25 وأقل من 10 kA.
19	ال contactor يستخدم لتشغيل إضاءة الأماكن العامة، في حين أنه لا ينصح باستخدامه مع المواتير نظرا لتيار بدنها العالي.
20	الكمية التي تصف مدى راحة العين في النظر المباشر إلي المصدر الضوئي هي السطوع brightness.
21	عامل الطلب demand factor يتعامل مع نفس نوعية الحمل على عكس معامل التباعد diversity factor والذي يتعامل مع أنواع أحمال مختلفة.
22	عامل الطلب demand factor لأحمال المصاعد يزيد كلما زاد عدد المصاعد في المبنى.
23	تقدير الأحمال باستخدام الجداول المتاحة في المواصفات القياسية للبلد مهم لعملية التصميم النهائية.
24	اختبار ال short circuit يتم إجراؤه للتأكد من تحمل الكابل لأقصى تيار قصر متوقع مروره فيه لمدة 3 ثواني.
25	اختبار مساحة مقطع الكابل الرئيسي لا يتأثر بطول الكابل حيث أن التيار المتوقع مروره يرتبط فقط بمساحة مقطع الكابل وليس طوله.

السؤال الثاني:

(25 درجة)

1	مطلوب تصميم نظام اضاءة لغرفة اجتماعات يحقق اضاءة 1000 lux علما بأن ارتفاع منضدة الاجتماعات فيها 70 سم. أبعاد الغرفة كالتالي: الطول 15 متر، العرض 8 متر، الارتفاع 3.4 متر. علما بأن الانعكاس من السقف والحوائط والأرضيات
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متاح مصباحين للاختيار: المصباح الأول: يعطي 1800 lumen بقدرة 50 watt ومعامل فقد ضوئي 0.6 - ثمن المصباح 500 جنيه المصباح الثاني: يعطي 1600 lumen بقدرة 60 watt ومعامل فقد ضوئي 0.5 -- ثمن المصباح 400 جنيه	علما بأن الغرفة تضاء فقط في ساعات العمل الرسمية (8 ساعات يوميا - خمسة أيام أسبوعيا)، وأن العمر الافتراضي للمصباحين 3 سنوات وأن سعر الكيلو وات ساعه كهرباء هو 80 قرشا.
1. حدد المصباح الذي يحقق أقل تكلفة اجمالية على المالك. 2. حدد المصباح الذي اذا استخدم سيتحقق استخدام أقل عدد ممكن من المصابيح.	
(10 درجة)	
صمم القاطع الرئيسي (rated current and short-circuit capacity) وكذلك عدد الكابلات اللازمة لتغذية لوحة توزيع مجموع أحمالها 1 MVA وتبعد عن محول التوزيع مسافة 350 متر. علما بأن:	2
MVA_base = 1 MVA MVA_source = 500 MVA X_transformer = 0.05 pu Z_cable = 0.014 Ohm	
علما بأن جهد التشغيل 380 فولت وأن الكابلات المتاحة نحاسية مساحة مقطعها 240 mm <sup>2</sup> وأنه سيتم تمديدتها مدفونة في تربة درجة حرارتها 40 درجة مئوية على عمق 80 سم.	
(15 درجة)	

Good Luck and best wishes

Dr. Mohamed Almozayen

معاملات الانعكاس	
Ceiling	0.8 0.8 0.8 0.5 0.5 0.8 0.8 0.5 0.5 0.3
Wall	0.8 0.5 0.3 0.5 0.3 0.8 0.3 0.5 0.3 0.3
Surface	0.3 0.3 0.3 0.3 0.3 0.1 0.1 0.1 0.1 0.1
Room Index Factor, k	Room Utilization Factor in %
0.6	73 46 37 44 36 66 36 42 35 35
0.8	82 57 47 54 46 74 45 51 44 44
1.0	91 66 56 62 54 80 53 59 52 51
1.25	98 75 65 70 62 85 61 66 60 59
1.5	103 82 73 76 69 89 67 72 66 65
2.0	109 91 82 84 78 94 75 78 73 72
2.5	114 98 90 90 84 97 81 83 79 77
3.0	117 103 96 95 90 99 86 87 83 82
4.0	120 109 103 100 95 101 91 91 88 86
5.0	122 113 107 103 98 103 93 93 91 89

مساحة المقطع م <sup>2</sup>	التيار وجه واحد بالامبير	التيار ذو ثلاثة اوجه بالامبير
1.5	17	15
2.5	23	21
4	31	28
6	40	36
10	55	50
16	74	66
25	97	88
35	120	109
50	146	131
70	185	167
95	225	202
120	260	234
150	299	269
185	341	307
240	401	360

C.B Standard

6, 10, 15, 16, 20, 25, 32, 40, 50, 63, 100, 125, 150, 163, 200, 225, 250, 300, 400, 500, 630, 800, 1000, 1200, 1500, 1750, 2000, 2200, 2500, 3000, 3200, 4000, 5000,

6300

جدول 4-8 : تصحيح التحميل حسب درجة حرارة التربة

55	50	45	40	35	30	25	درجة حرارة التربة
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Voltage drop for multi core L.V cables

عق الكابل mm <sup>2</sup>	مقطع الكابل	
	Up to 240 mm <sup>2</sup>	Up to 70 mm <sup>2</sup>
Above 300 mm <sup>2</sup>	1.00	1.00
50	0.97	1.00
60	0.98	0.99
80	0.94	0.97
100	0.92	0.95
125	0.89	0.92
150	0.87	0.93
175	0.86	0.92
200	0.85	0.91

جول 4-9 : مداخل صحیح عق الكابل

Copper conductor	Voltage drop (mv / A.MF / Meter)		C.S.A mm <sup>2</sup>
	PVC insulation & PVC sheathed		
	XLPE insulation & PVC sheathed		
1.5	20.345	20.341	1.5
2.5	12.397	13.197	2.5
4	7.741	7.731	4
6	5.199	5.191	6
10	3.101	3.094	10
16	1.988	1.982	16
25	1.280	1.276	25
35	0.959	0.955	35
50	0.720	0.715	50
70	0.524	0.520	70
95	0.398	0.394	95
120	0.341	0.337	120
150	0.285	0.282	150
185	0.244	0.241	185
240	0.204	0.201	240
300	0.180	0.177	300
400	0.157	0.155	400



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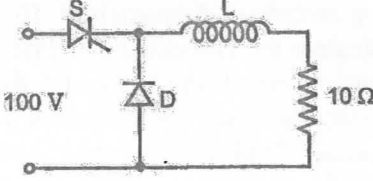
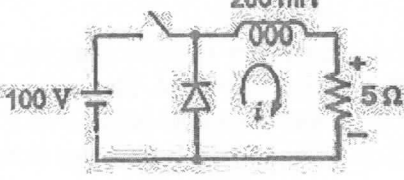
Final Exam – Second Term 2024/2025

3<sup>rd</sup> Year: Electrical Power and Machines Engineering | Time: 3 hours | Marks: 60

Date: 17 June 2025 | Course: Power Electronics (II) | Code: EPM3213

Question one [20 Marks]:

Choose the correct answer for the following statements. *It is sufficient to write down the question number followed by your choice* in your answer sheet:

- A dc chopper has a  $T_{ON}$  of 1.0 ms and its frequency is 500 Hz. What will be its duty cycle?  
(a) 100 % (b) 75 %  
(c) 50 % (d) 25 %
  - In a buck dc chopper, if  $T_{ON}$  is the ON period and  $f$  the chopping frequency, the output voltage in terms of the input voltage,  $V_s$ , is given by  
(a)  $V_s T_{ON}/f$  (b)  $V_s f/T_{ON}$   
(c)  $V_s/(f T_{ON})$  (d)  $V_s f T_{ON}$
  - For a step-up dc-dc chopper with an input dc voltage of 220 volts, if the output voltage required is 330 volts and the ON time of thyristor is 100  $\mu$ s, the non-conducting time of thyristor would be  
(a) 66.6  $\mu$ s (b) 100  $\mu$ s  
(c) 150  $\mu$ s (d) 200  $\mu$ s
  - The given figure shows a chopper operating from a 100 V dc input. The duty ratio of the main switch S is 0.8. The load is sufficiently inductive so that the load current is ripple free. The average current through the diode under steady state is  
(a) 1.6 A (b) 6.4 A  
(c) 8.0 A (d) 10.0 A
- 
- An ideal chopper is operating at a frequency of 500 Hz, supplies a load having resistance of 3 ohms and inductance of 9 mH from a 60 V battery. The mean value of the load voltage for on/off ratio of 4/1, (assuming that load is shunted by a perfect commutating diode) is  
(a) 240 V (b) 48 V  
(c) 15 V (d) 4 V
  - The given figure shows a step-down chopper switched at 1 kHz with a duty ratio  $D = 0.5$ . The peak-peak ripple in the load current is close to  
(a) 10 A (b) 0.5 A  
(c) 0.125 A (d) 0.25 A
- 
- A load resistance of 10  $\Omega$  is fed through a single-phase voltage controller from a voltage source of  $200 \sin 314t$ . If the power delivered to the load is 1 kW, the firing angle delay is  
(a) 30° (b) 60°  
(c) 45° (d) 90°

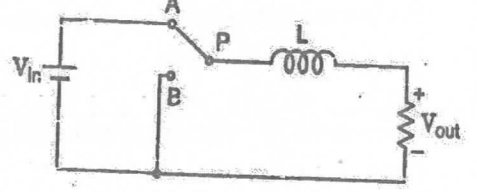
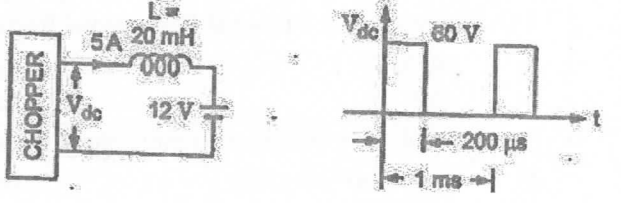


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- The power electronic converter shown in the figure has a single-pole double-throw switch. The pole P of the switch is connected alternately to throws A and B. The converter shown is a  
(a) Half-wave rectifier  
(b) Step-down chopper  
(c) Buck-boost converter  
(d) Step-up chopper
- 
- A dc to dc transistor chopper supplied from a fixed voltage dc source feeds a fixed resistive inductive load and a freewheeling diode. The chopper operates at 1 kHz and 50% duty cycle. Without changing the value of the average dc current through the load, if it is desired to reduce the ripple content of the load current, the control action needed will be to  
(a) increase the chopper frequency keeping its duty cycle constant  
(b) increase the chopper frequency and duty cycle in equal ratio  
(c) decrease only the chopper frequency  
(d) decrease only the duty cycle
  - A chopper is employed to charge a battery as shown in the figure. The charging current is 5 A. The chopper output voltage is also shown in the figure. The peak to peak ripple current in the charging current is  
(a) 0.48 A (b) 1.2 A  
(c) 2.4 A (d) 1 A
- 
- A purely inductive load is controlled by a single-phase AC voltage controller using back to back connected SCRs. If the firing angle of the SCRs is 75°, the current through the two SCRs will flow for  
(a) 285° and 0° (b) 210° and 0°  
(c) 105° and 0° (d) 105° and 105°
  - A single-phase ac voltage controller feeding a pure resistive load has a load voltage of 200 V (rms) when fed from a source of 250 V (rms). The input power factor of the controller is  
(a) 0.64 (b) 0.8  
(c) 0.894 (d) difficult to estimate because of insufficiently of data
  - An ideal chopper is operating at a frequency of 500 Hz from a 60 V battery input. It is supplying a load having 3  $\Omega$  resistance and 9 mH inductance. Assume the load is shunted by a perfect commutating diode and assuming battery is lossless, what is the mean load current at an on/off ratio of 1/1 ?  
(a) 10 A (b) 15 A  
(c) 20 A (d) None of these



14. In a single-phase to single-phase cycloconverter, if  $\alpha_1$  and  $\alpha_2$  are the trigger angles of the positive converter and negative converter, then

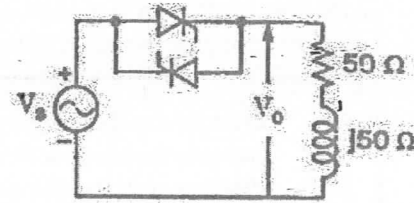
- (a)  $\alpha_1 + \alpha_2 = \pi/2$  (b)  $\alpha_1 + \alpha_2 = \pi$   
(c)  $\alpha_1 + \alpha_2 = 3\pi/2$  (d)  $\alpha_1 + \alpha_2 = 2\pi$

15. How many switches are used to construct a three-phase to three-phase cycloconverter?

- (a) 3 (b) 6  
(c) 12 (d) 18

16. In the single-phase voltage controller circuit shown in the figure, for what range of triggering angle ( $\alpha$ ), the output voltage ( $V_o$ ) is not controllable?

- (a)  $0^\circ < \alpha < 45^\circ$   
(b)  $45^\circ < \alpha < 135^\circ$   
(c)  $90^\circ < \alpha < 180^\circ$   
(d)  $135^\circ < \alpha < 180^\circ$



17. A single-phase, half-bridge inverter has an input dc voltage of 48 V. Inverter is feeding a load of  $2.4 \Omega$ . The rms output voltage at fundamental frequency is

- (a) 30.56 V (b) 21.6 V  
(c) 43.2 V (d) 48 V

18. The output voltage waveform of a three-phase square-wave inverter contains

- (a) Only even harmonics (b) Both odd and even harmonics  
(c) Only odd harmonics (d) Only triple harmonics

19. A cycloconverter power electronic equipment is a

- (a) frequency converter which has no intermediate dc state  
(b) device which converts ac to dc  
(c) device which converts dc to ac  
(d) none of the above

20. In the ac regulator of Fig. 1, the supply voltage and gate currents waveforms are as in Fig. 2, what is the load current waveform?

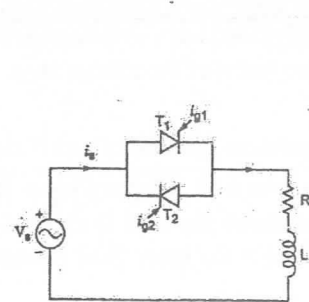


Fig.1

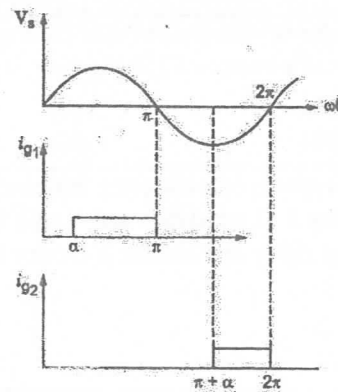
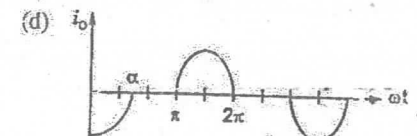
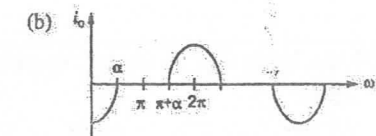
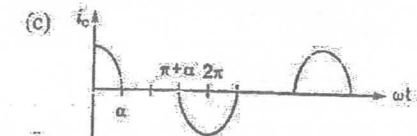
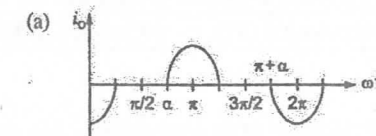
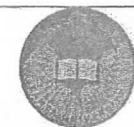


Fig.2



**Question Two [20 Marks]**

[a] A single-phase full-wave controller supplies an RL load. The input rms voltage is  $V_s = 120V$ , 60 Hz. The load is such that  $L = 6.5 \text{ mH}$  and  $R = 2.5 \Omega$ . The delay angles of thyristors T1 and T2 are equal:  $\alpha_1 = \alpha_2 = \alpha = \pi/2$ . **Determine** the rms output voltage and the input power factor. [8 Marks]

[b] In a step-up converter, the duty ratio is adjusted to regulate the output voltage  $V_o$  at 48 V. The input voltage varies in a wide range from 12 to 36 V. The maximum power output is 120 W. The switching frequency is 50 kHz. Assuming ideal components and  $C$  as very large, **calculate** the maximum ON time of thyristor for this operation and the corresponding average input current. If the value of  $L$  that can be used is set at  $9 \mu\text{H}$ , **find** the ON time of thyristor required to reach the maximum average output current at the edge of continuous conduction ( $I_{oB,max}$ ). **Will** this converter operate in a continuous or discontinuous current conduction mode? [12 Marks]

**Question Three [20 Marks]**

[a] A single-phase bridge voltage-source inverter has an RLC load with  $R = 10 \Omega$ ,  $L = 31.5\text{mH}$ , and  $C = 112\mu\text{F}$ . The inverter frequency is  $f_0 = 60\text{Hz}$  and dc input voltage is  $V_s = 220V$ . **Calculate** (a) the THD of the load current, (b) the rms and peak current of each transistor, and (c) the effective load power factor. [12 Marks]

[b] A buck converter is feeding an RL load with an input voltage  $V_s = 550 \text{ V}$ ,  $R = 0.25 \Omega$ , and battery voltage  $E = 0 \text{ V}$ . The average load current  $I_a = 200 \text{ A}$  and chopping frequency  $f = 250 \text{ Hz}$ . **Calculate** the load inductance  $L$ , which would limit the maximum load ripple current to 10% of average load current and **determine** the duty cycle at this condition. [8 Marks]

With Best Regards

Dr. Mohamed Gamal Hussien



Course Title	Electrochemical Engineering	Final Exam	Course Code	EMP 131
Date	1 / 7 / 2025		Allowed time	2 hour

Answer all questions, Show all calculations where necessary.

**Question 1: Choose the Correct Answer** .....( 25 marks )

- What causes the **liquid-junction potential** in an electrochemical cell? (a) Temperature differences between electrodes (b) Pressure changes in the electrolyte (c) Unequal diffusion rates of ions at the junction (d) Electrode surface roughness.
- Which electrode is commonly used for **DNA detection** and biosensors? (a) Zinc electrode (b) Gold electrode (c) Calomel electrode (d) Silver electrode
- Which substance is commonly used in a salt bridge to reduce liquid-junction potential? (a) HCl (b) Na<sub>2</sub>SO<sub>4</sub> (c) KCl (d) CuSO<sub>4</sub>
- In a concentration cell, which factor generates the EMF? (a) Different electrodes (b) Salt bridge potential (c) Difference in electrolyte concentrations (d) Temperature gradient
- What is the EMF of a copper concentration cell with Cu<sup>2+</sup> concentrations of 0.01 M and 1.0 M? (a) 0.118 V (b) 0.059 V (c) 0.236 V (d) 0.020 V
- The equation for EMF in a concentration cell is: (a)  $E = nF/RT \cdot \ln(C1/C2)$  (b)  $E = RT/nF \cdot \ln(C1/C2)$  (c)  $E = RnT/F \cdot \log(C2/C1)$  (d)  $E = F/RT \cdot \log(C1/C2)$
- In a pH measurement using a hydrogen concentration cell, what is the potential when [H<sup>+</sup>] = 10<sup>-4</sup> M? (a) 0.118 V (b) 0.236 V (c) 0.059 V (d) 0.472 V
- What is the electrode reaction in a Silver/Silver Chloride (Ag/AgCl) electrode? (a)  $Ag + Cl^- \rightarrow AgCl + e^-$  (b)  $AgCl + e^- \rightleftharpoons Ag + Cl^-$  (c)  $Ag^+ + e^- \rightleftharpoons Ag$  (d)  $Ag + H^+ \rightleftharpoons Ag^+ + H_2$
- Which of the following is **not** a working electrode? (a) Gold (b) Glass (c) Platinum (d) Carbon
- What is a major advantage of platinum as a working electrode? (a) High reactivity (b) Easily oxidized (c) Corrosion resistance and high conductivity (d) Biodegradability
- Which of the following is used in measuring **pH** of solutions? (a) Calomel electrode (b) Glass electrode (c) Ion-selective membrane electrode (d) Silver/silver chloride electrode



- The fluoride ion-selective electrode is based on which material? (a) NaF (b) CaF<sub>2</sub> (c) LaF<sub>3</sub> (d) BaF<sub>2</sub>
- A **counter electrode** must be made of: (a) Reactive metals (b) Biodegradable materials (c) Inert and conductive materials (d) Porous and insulating materials
- In gas electrodes, which of the following is the correct cathodic reaction in **acidic media**? (a)  $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$  (b)  $O_2 + 2OH^- \rightarrow 2H_2O$  (c)  $H_2O \rightarrow O_2 + H^+ + e^-$  (d)  $H_2 + 2OH^- \rightarrow 2H_2O$
- Which of the following best defines a **reversible electrochemical process**? (a) A reaction that stops when voltage is applied (b) A process with high energy loss (c) A reaction that can proceed in both directions near equilibrium (d) A system that only works with salt bridges
- A **reversible electrode** is characterized by: (a) High voltage drop across electrodes (b) Dynamic equilibrium between oxidation and reduction (c) Constant gas release during operation (d) Use of AC current for activation
- If a galvanic cell is supplied with a slightly higher external current than its EMF, what occurs? (a) Voltage increases (b) The cell acts as an electrolytic cell (c) Salt bridge breaks down (d) The electrodes corrode rapidly
- When two galvanic cells with different voltages are connected in parallel, the cell with **lower voltage** will: (a) Increase its current (b) Stop functioning (c) Become an electrolytic cell (d) Explode
- The **Nernst equation** helps calculate: (a) Only EMF under standard conditions (b) Electrode potentials under non-standard conditions (c) Molar mass of ions (d) Concentration of inert gases
- If  $\Delta G < 0$  for an electrochemical cell, the reaction is: (a) At equilibrium (b) Non-spontaneous (c) Spontaneous (d) Reversible only under pressure
- What is the value of  $\Delta G$  for a cell with  $E^\circ = 1.10$  V and 2 moles of electrons transferred? (a) -96500 J/mol (b) -193000 J/mol (c) -212300 J/mol (d) -110000 J/mol
- In electrochemical thermodynamics,  $\Delta H$  represents: (a) Electromotive force (b) Heat absorbed or released (c) Cell resistance (d) Salt bridge strength
- Which of the following is **NOT** a valid reference electrode? (a) Calomel electrode (b) Silver-silver chloride electrode (c) Copper electrode (d) Standard Hydrogen Electrode
- A **large equilibrium constant (K)** for a redox reaction indicates: (a) The cell is non-spontaneous (b) The EMF is zero (c) The reaction is highly spontaneous (d) The electrolyte is inactive
- What unit is used for **Faraday's constant (F)**? (a) V/mol (b) J/mol·K (c) C/mol (d) mol/s



26. Why can't the single electrode potential be measured directly?  
 (a) It varies with time (b) It requires a voltmeter only (c) A potential difference must be measured between two electrodes (d) Electrons cannot be transferred in such systems
27. Which of the following is a commonly used reference electrode with  $E^\circ = 0.334 \text{ V}$ ?  
 (a) Standard Hydrogen Electrode (b) Calomel Electrode (0.1 M KCl) (c) Zinc Electrode (d) Copper Electrode
28. What happens when a galvanic cell is connected to a current source supplying more electricity than the cell produces?  
 (a) It explodes (b) It shuts off automatically (c) It produces more electricity (d) It acts as an electrolytic cell
29. If two galvanic cells with different voltages are connected in parallel, what happens to the one with lower voltage?  
 (a) It produces more current (b) It becomes an electrolytic cell (c) It discharges faster (d) It heats up
30. What is a key feature of fuel cells that distinguishes them from conventional galvanic cells?  
 (a) Use of carbon electrodes only (b) Use of salt bridges (c) Continuous feeding of fuel and oxidizer (d) Use of platinum wires only
31. Which of the following is a fuel cell that operates at high temperature?  
 (a) Mercury Cell (b) Hydrogen-Oxygen Cell (c) Natural Gas Cell (d) Dry Cell
32. What is the main **anodic reaction** in a Hydrogen-Oxygen fuel cell?  
 (a)  $\text{O}_2 + \text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$  (b)  $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$   
 (c)  $\text{CH}_4 + \text{OH}^- \rightarrow \text{CO}_3^{2-} + \text{H}_2\text{O}$  (d)  $\text{Zn} + 2\text{OH}^- \rightarrow \text{ZnO} + \text{H}_2\text{O} + 2\text{e}^-$
33. What is the catalyst typically used at the **anode** of a Hydrogen-Oxygen fuel cell?  
 (a) Iron oxide (b) Nickel (c) Platinum or Palladium (d) Manganese dioxide
34. In a mercury cell, the overall cell reaction is:  
 (a)  $\text{Zn} + \text{HgO} \rightarrow \text{ZnO} + \text{Hg}$   
 (b)  $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$  (c)  $\text{Zn} + \text{Ag}^+ \rightarrow \text{Zn}^{2+} + \text{Ag}$  (d)  $\text{Zn} + 2\text{Cl}^- \rightarrow \text{ZnCl}_2$
35. Which of the following is NOT a true advantage of a mercury cell?  
 (a) Constant voltage output (b) Small and portable (c) Used in watches and cameras (d) Operates at high temperature only
36. What is the **maximum efficiency** of a fuel cell compared to traditional power generation?  
 (a) 40% (b) 60% (c) 95% (d) 20%
37. In traditional energy conversion, which stage causes **unavoidable** heat loss?  
 (a) Combustion (b) Mechanical conversion (turbine) (c) Steam generation (d) Electrical output
38. A **disadvantage** of high-temperature fuel cells is:  
 (a) Corrosion and short electrode life (b) High fuel cost (c) Long life of electrodes (d) Low energy output
39. Which fuel is **cheap and commonly used** in high-temperature fuel cells?  
 (a) Hydrogen peroxide (b) Methane ( $\text{CH}_4$ ) (c) Carbon dioxide (d) Ethanol



40. What is the standard cell potential ( $E^\circ$ ) for the following half-reactions?  
 $\text{Fe}^{3+} + 3\text{e}^- \rightarrow \text{Fe}$  ( $E^\circ = -0.04 \text{ V}$ ),  $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$  ( $E^\circ = +0.80 \text{ V}$ )  
 (a) 0.36 V (b) 0.84 V (c) -0.76 V (d) 0.44 V
41. Which of the following is a fuel cell that operates at high temperature?  
 (a) Mercury Cell (b) Hydrogen-Oxygen Cell (c) Natural Gas Cell (d) Dry Cell
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**Question 2:.....( 25 marks )**

- What are the basic components of a cell in a Nickel-Cadmium battery?
- Why should water be added to a Ni-Cd battery only when it is fully charged?
- Write briefly on the Memory Effect with drawing
- Write the structure of solar cell with drawing.
- Draw a full sketch for (PEM)
- Mention advantages and disadvantages of fuel cells
- Mention the Components of MFCs and draw a full sketch for MFC

**Standard Reduction Potentials ( $E^\circ$ ) You'll Need**

Half-Reaction	$E^\circ$ (V)
$\text{H}^+ + \text{e}^- \rightarrow \frac{1}{2} \text{H}_2$ (Standard Hydrogen Electrode)	0.00
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	+0.80
$\text{AgCl} + \text{e}^- \rightarrow \text{Ag} + \text{Cl}^-$	+0.22 (approx)
$\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$	-0.13
$\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$	-0.76
$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$	+0.34
$\text{Fe}^{2+} + 2\text{e}^- \rightarrow \text{Fe}$	-0.44
$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	-1.66
$\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$	-2.90
$-2.37 \text{ V Ba}^{2+} + 2\text{e}^- \rightarrow \text{Ba}$	
$\text{Br}_2 + 2\text{e}^- \rightarrow 2\text{Br}^-$	+1.36
$\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$	+1.33
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+0.10 to +0.30 (avg. ~ +0.30)
$\text{HgO} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Hg} + 2\text{OH}^-$	(To be calculated based on cell $E^\circ$ )
$\text{Pu}^{4+} + \text{e}^- \rightarrow \text{Pu}^{3+}$	+1.23
$\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}$	

End of questions ..... Best Wishes

Prof. Mona Ahmed Darweesh Assoc. Prof. Wafaa Ahmed Hammed



Course Title	Engineering Chemistry	Final Exam	Course Code	BAS 212
Date	1 / 7 / 2025		Allowed time	2 hour

Answer all questions, Show all calculations where necessary.

**Question 1: Choose the Correct Answer** .....( 25 marks )

- What causes the **liquid-junction potential** in an electrochemical cell? (a) Temperature differences between electrodes (b) Pressure changes in the electrolyte (c) Unequal diffusion rates of ions at the junction (d) Electrode surface roughness.
- Which electrode is commonly used for **DNA detection** and biosensors? (a) Zinc electrode (b) Gold electrode (c) Calomel electrode (d) Silver electrode
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- A **counter electrode** must be made of: (a) Reactive metals (b) Biodegradable materials (c) Inert and conductive materials (d) Porous and insulating materials
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- Which of the following is **NOT** a valid reference electrode? (a) Calomel electrode (b) Silver-silver chloride electrode (c) Copper electrode (d) Standard Hydrogen Electrode
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27. Which of the following is a commonly used reference electrode with  $E^\circ = 0.334 \text{ V}$ ?  
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30. What is a key feature of fuel cells that distinguishes them from conventional galvanic cells?  
 (a) Use of carbon electrodes only (b) Use of salt bridges  
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31. Which of the following is a fuel cell that operates at high temperature?  
 (a) Mercury Cell (b) Hydrogen-Oxygen Cell (c) Natural Gas Cell (d) Dry Cell
32. What is the main **anodic reaction** in a Hydrogen-Oxygen fuel cell?  
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 (c)  $\text{CH}_4 + \text{OH}^- \rightarrow \text{CO}_3^{2-} + \text{H}_2\text{O}$  (d)  $\text{Zn} + 2\text{OH}^- \rightarrow \text{ZnO} + \text{H}_2\text{O} + 2\text{e}^-$
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34. In a mercury cell, the overall cell reaction is:  
 (a)  $\text{Zn} + \text{HgO} \rightarrow \text{ZnO} + \text{Hg}$   
 (b)  $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$  (c)  $\text{Zn} + \text{Ag}^+ \rightarrow \text{Zn}^{2+} + \text{Ag}$  (d)  $\text{Zn} + 2\text{Cl}^- \rightarrow \text{ZnCl}_2$
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 (a) Mercury Cell (b) Hydrogen-Oxygen Cell (c) Natural Gas Cell (d) Dry Cell
42. What is the main **anodic reaction** in a Hydrogen-Oxygen fuel cell?  
 (a)  $\text{O}_2 + \text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$  (b)  $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$   
 (c)  $\text{CH}_4 + \text{OH}^- \rightarrow \text{CO}_3^{2-} + \text{H}_2\text{O}$  (d)  $\text{Zn} + 2\text{OH}^- \rightarrow \text{ZnO} + \text{H}_2\text{O} + 2\text{e}^-$

**Question 2:.....( 25 marks )**

- a) What are the basic components of a cell in a Nickel-Cadmium battery?  
 b) Why should water be added to a Ni-Cd battery only when it is fully charged?  
 c) Write briefly on the Memory Effect with drawing  
 d) Write the structure of solar cell with drawing.  
 e) Draw a full sketch for (PEM)  
 f) Mention advantages and disadvantages of fuel cells  
 g) Mention the Components of MFCs and draw a full sketch for MFC

**Standard Reduction Potentials ( $E^\circ$ ) You'll Need**

Half-Reaction	$E^\circ$ (V)
$\text{H}^+ + \text{e}^- \rightarrow \frac{1}{2} \text{H}_2$ (Standard Hydrogen Electrode)	0.00
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	+0.80
$\text{AgCl} + \text{e}^- \rightarrow \text{Ag} + \text{Cl}^-$	+0.22 (approx)
$\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$	-0.13
$\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$	-0.76
$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$	+0.34
$\text{Fe}^{2+} + 2\text{e}^- \rightarrow \text{Fe}$	-0.44
$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	-1.66
$\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$	-2.90
$-2.37 \text{ V Ba}^{2+} + 2\text{e}^- \rightarrow \text{Ba}$	-2.90
$\text{Br}_2 + 2\text{e}^- \rightarrow 2\text{Br}^-$	+1.36
$\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$	+1.33
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1.33
$\text{HgO} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Hg} + 2\text{OH}^-$	+0.10 to +0.30 (avg ~ +0.30)
$\text{Pu}^{4+} + \text{e}^- \rightarrow \text{Pu}^{3+}$	(To be calculated based on cell $E^\circ$ )
$\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}$	+1.23

End of questions ..... Best Wishes

Prof. Mona Ahmed Darweesh

Assoc. Prof. Wafaa Ahmed Hamed