

Second Question:- [15 Degrees]

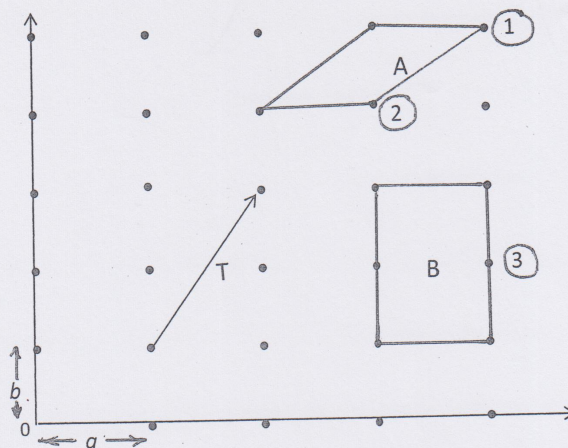
The density of the copper metal is 8.95 g/cm^3 , and the radius of copper atom is $1.28 \text{ \AA}$. The unit cell of the crystallized copper is face-centered cubic (*fcc*). Given the atomic mass of Cu = 63.5 g/mole and $N_A = 6.02 \times 10^{23} \text{ atom/mole}$, Calculate :

1-	The edge length of the unit cell (in $\text{\AA}$ units) =	..
2-	The distance of the nearest neighbors in the <i>fcc</i> unit cell =	..
3-	The number of the nearest neighbors in the <i>fcc</i> unit cell =	..
4-	The number of the lattice points related to one <i>fcc</i> unit cell is	
5-	The number of <i>fcc</i> unit cells per unit cm^3 is	..
6-	The number of <i>fcc</i> unit cells per one gram is	
7-	The number of <i>fcc</i> unit cells per one mole is	...
8-	The atomic packing factor is defined as	...
9-	The volume of one copper atom is	...
10-	The volume of one primitive unit cell in the above crystallized copper is	..

Answer All Questions

First Question :- [15 Degrees]

In the two-dimensional lattice given below, the primitive lattice vectors $a = 4$ nm, $b = 3$ nm.



1-	The number of lattice points related to the unit cell (A) =
2-	The number of lattice points related to the unit cell (B) =
3-	Lattice point (1) shares the unit cell (A) with a fraction =
4-	Lattice point (2) shares the unit cell (A) with a fraction =
5-	Lattice point (3) shares the unit cell (B) with a fraction =
6-	In terms of the primitive lattice vectors (a, b), the lattice vector $T =$
7-	The basis of the lattice point (1) in the above crystal lattice is
8-	The basis of the lattice point (2) in the above crystal lattice is
9-	The basis of the lattice point (3) in the above crystal lattice is
10-	(Crystal lattice + Basis) gives

3. How the specific heat at glass transition can be determined from the DSC curve. (3 marks)

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4. Goldschmidt offered a theory to explain the formation of oxide glass – state it briefly. (3 marks)

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5. Discuss the Meissner effect. (3 marks)

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Question (III): : Put true (✓) or false (X) for the following statements: (15 marks)

1. Materials in crystalline form are more stable than the amorphous form ().
2. The electron and hole mobility in a crystal becomes higher than that in the corresponding non-crystal ().
3. Condensed matter includes gases and solids ().
4. Silica is a main component of a glass formation ().

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[illegible]

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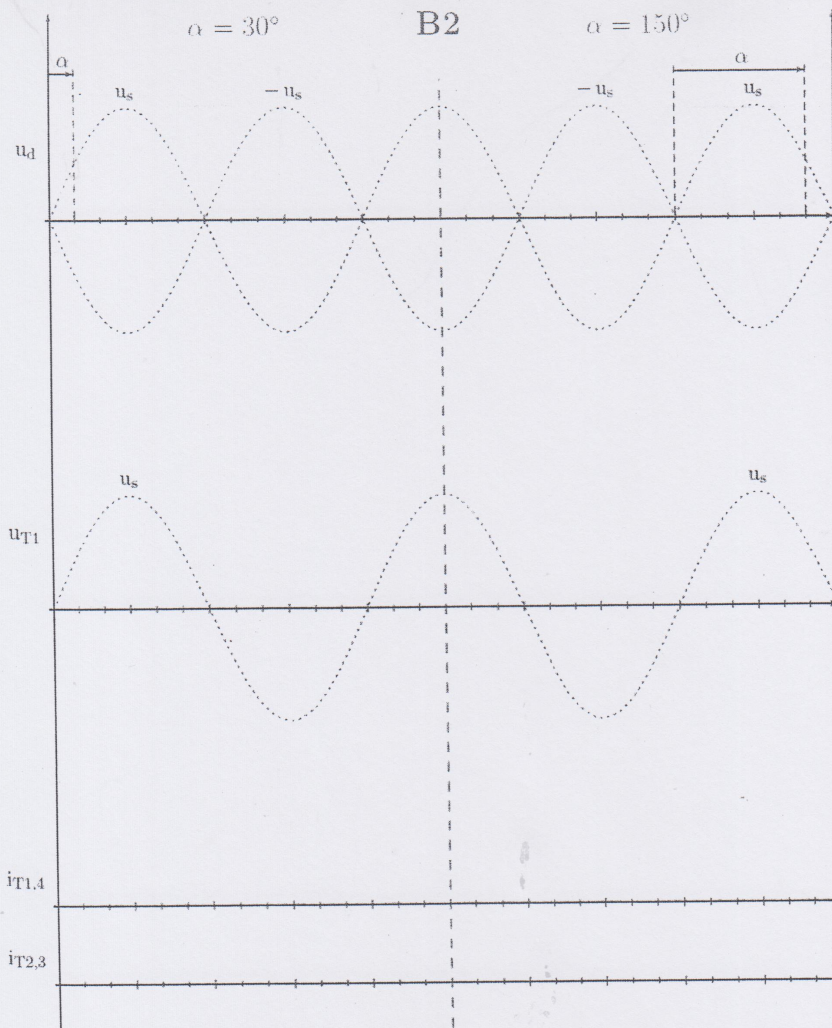


Answer the following questions

Question (I): Select the correct answer(s) for the following statements: (15 Marks)

1. The glass transition is a:
 - a. First-order phase transition.
 - b. Second-order phase transition.
 - c. Third-order phase transition.
 - d. None of the above.
2. A glassy and crystalline material, both formed from the same initial liquid and currently are at the same temperature, which one has a higher specific volume:
 - a. The crystalline material has a higher specific volume.
 - b. The glassy material has a higher specific volume.
 - c. Both have the same volume.
 - d. Cannot be determined from the given information.
3. The melting process of a solid material is an:
 - a. Endothermic process.
 - b. Exothermic process.
 - c. Both a and b.
 - d. Neither a nor b.
4. Which of the following materials may show glass transition:
 - a. Ionic compounds.
 - b. Ceramics.
 - c. Polymers.
 - d. Crystalline materials.
5. A fast-cooled liquid above the glass transition temperature is in a phase known as:
 - a. Crystal.
 - b. Gas.
 - c. Glass.
 - d. Super-cooled liquid.
6. In first-order phase transition, at the transition temperature, the enthalpy versus temperature curve will have:
 - a. Finite discontinuity.
 - b. Infinite discontinuity.
 - c. Only slope changed.
 - d. None of the above.
7. The glass transition for a higher cooling rate will occur at:
 - a. Higher temperatures.
 - b. Lower temperatures.
 - c. Does not depend on the cooling rate.
 - d. More information is needed to make a statement.
8. The best glass-forming alloys should have:
 - a. Higher viscosity.
 - b. Smallest volume change upon crystallization.
 - c. Small free volume at T_m .
 - d. All of the above.
9. is the property that enables a material to withstand shock and to be deformed without rupturing.
 - a. Fatigue strength.
 - b. Toughness.
 - c. Plasticity.
 - d. Ductility.
10. Chalcogenide glasses are amorphous semiconductors that contain at least one of the elements of the group in the periodic table:
 - a. IIIb.
 - b. IVb.
 - c. Vb.
 - d. VIb.

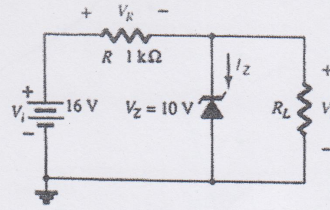
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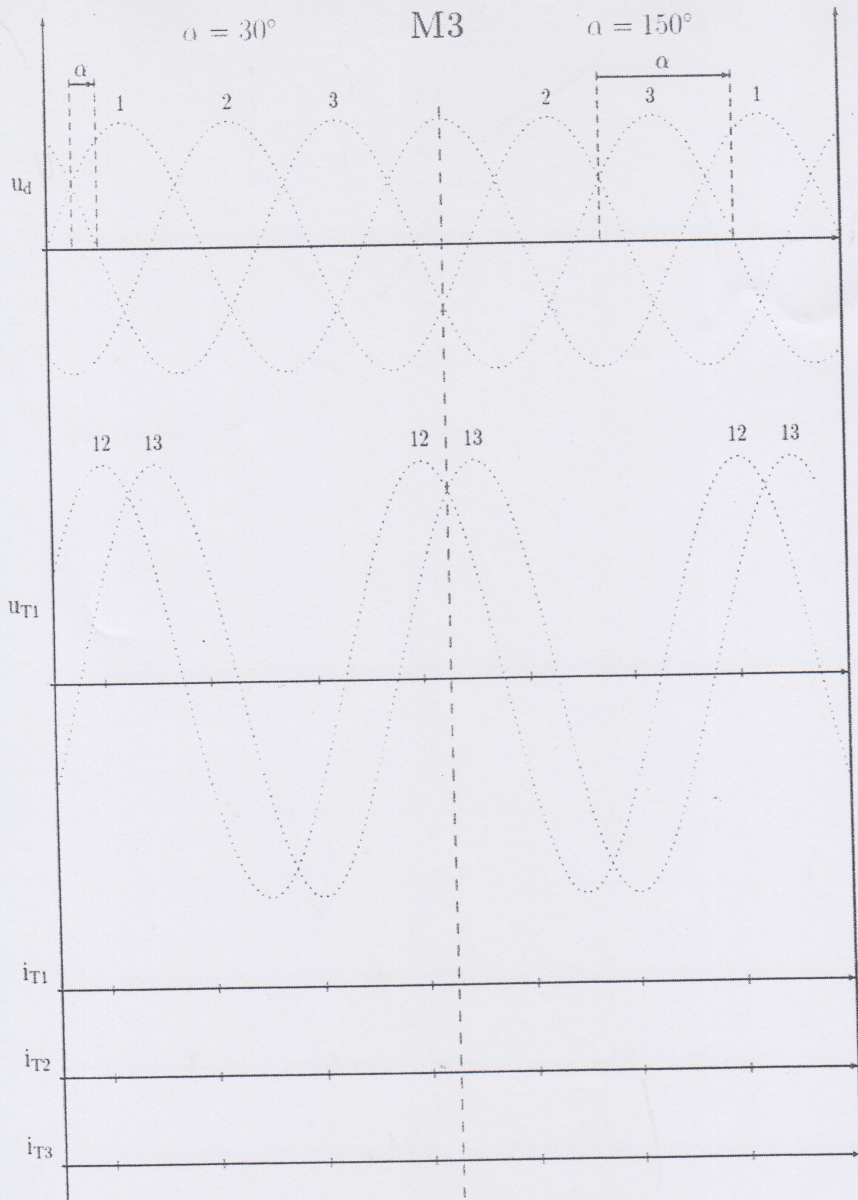
With my best wishes
Dr. Mohamed Abdelsater Swify

Question (5)**(19 points)**

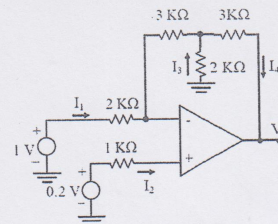
a) For the Zener diode regulator, for $R_L = 3 \text{ k}\Omega$ determine V_L , V_R , I_R , I_L , I_Z and P_Z



b) For B_2 circuit with Thyristors, draw the load voltage trajectory $u_d(t)$, the voltage drop $u_{T1}(t)$ across thyristor 1 and the semiconductor current trajectories $i_{T1}(t)$ for $\alpha = 30^\circ$ and $\alpha = 150^\circ$. In this case the load current $i_d(t)$ can be assumed to be constant, i. e. $i_d(t) = I_d = \text{const}$. Commutation losses can also be neglected.



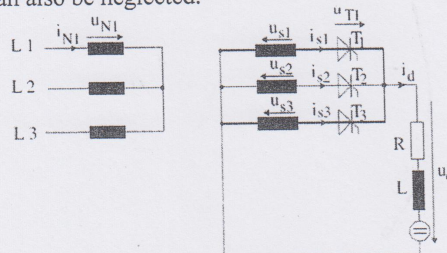
- b) The op-amp in the circuit is ideal.
Calculate I_1 , I_2 , I_3 , I_4 , and V_o .



Question (4)

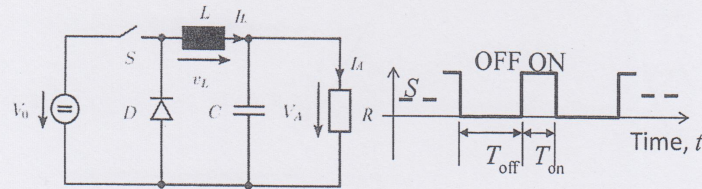
(10 points)

For M_3 circuit with Thyristors, draw the load voltage trajectory $u_d(t)$, the voltage drop $u_{T1}(t)$ across thyristor 1 and the semiconductor current trajectories $i_{T1}(t)$ for $\alpha = 30^\circ$ and $\alpha = 150^\circ$. In this case the load current $i_d(t)$ can be assumed to be constant, i. e. $i_d(t) = I_d = \text{const}$. Commutation losses can also be neglected.



Question (3)**(8 points)**

- a) A buck converter is shown in the following figure with $V_0 = 150 \text{ V}$, $L = 100 \text{ mH}$, $C = 200 \text{ }\mu\text{F}$, and $R = 20 \text{ }\Omega$. The switching sequence is given on the right side of the circuit with $T_{\text{on}} = 1 \text{ ms}$ and $T_{\text{off}} = 2 \text{ ms}$. The system already operates in stable state.



- 1- Calculate the average output voltage V_A .
- 2- Calculate the average inductor current I_L .
- 3- Calculate the maximum and minimum values of the inductor current I_L . Suppose the change of the inductor current is approximately linear.

3) In B_2 thyristor rectifier circuit, in order to get the same output voltage like B_2 diode rectifier, the firing angle should adjust to

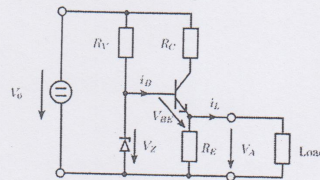
- ☐ A. 30 degree.
- ☐ B. 60 degree.
- ☐ C. 90 degree.
- ☐ D. zero degree.

4) Compared to linear power supplies, switching power supplies usually have the following characteristics:

- ☐ A. Higher efficiency.
- ☐ B. Lower efficiency.
- ☐ C. Lower ripple.
- ☐ D. Higher ripple.

5) In a linear power supply as shown in the following figure, the keys to keep the output voltage, V_A , stable are that

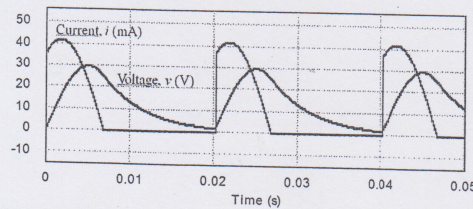
- ☐ A. the input voltage V_0 is stable.
- ☐ B. the zener diode V_z provides a stable voltage.
- ☐ C. the transistor operates in amplifying region.
- ☐ D. the switching frequency is very high.



6) A buck converter can

- ☐ A. convert a DC voltage to a lower DC voltage.
- ☐ B. generate a higher voltage than the input voltage.
- ☐ C. generate a sinusoidal voltage without DC component.
- ☐ D. operate without switching components.

7) The following current and voltage curves are measured at the load of a rectifier circuit. The following conclusions are true:



- ☐ A. This is an M1 circuit.
- ☐ B. This is a B2 circuit.
- ☐ C. The load is capacitive (RC load).
- ☐ D. The load is inductive (RL load).



Assiut University
Faculty of Engineering
Dep. of Electrical Eng.
Final Year Exam
2025

Faculty of Science
Department of Physics and Electronics
Course: Power Electronics – 3rd year
Time allowed 3 hours
Total Marks: 50 points



Important
remarks

- This exam measures ILOS no.: a.1 & b.1 & b.3 & c.1 & d.4
- No. of pages: 8 - No. of question: 6

Answer the following questions

Question (1) True or False

(6 points)

- 1) Currently, B_2/B_6 diode rectifiers are the most commonly used rectifiers in industry. ()
- 2) In order to get a smooth current from rectifier circuits, a large capacitor should be connected in parallel with the resistive load. ()
- 3) In diode rectifiers, it is possible to control the value of the output DC voltage by adjusting the firing angle. ()
- 4) In switching power supply circuits, the efficiency is higher than that of linear power supplies. ()
- 5) In the boost DC-DC power converter, the output voltage is lower than the input voltage. ()
- 6) The Ćuk DC-DC converter is preferred than the buck-boost one. ()

Question (2) Cross the correct answers (one or more selections are possible). (7 points)

- 1) For diode rectifiers, a one-way circuit
 - [] A. needs less switching components than a two-way circuit.
 - [] B. needs a more complex transformer than a two-way circuit.
 - [] C. has higher energy efficiency than a two-way circuit.
 - [] D. generates less electromagnetic interferences than a two-way circuit.
- 2) Compared with a B_2 rectifier circuit using diodes, an M_2 rectifier circuit under the same condition will output (ignoring the diode voltage drop)
 - [] A. more stable voltage.
 - [] B. the same voltage.
 - [] C. a higher voltage.
 - [] D. a lower voltage.

Question 2 14 Marks

i) Consider the following assembly lines, the shown part of memory, and the values of some registers:

	5B659 H	
MOV AX, 4E69H	5B658 H	
MOV CX, AX	5B657 H	2D H
MOV [BX+SI-12H], CX	5B656 H	87 H
MOV [DI], DX	5B655 H	
	5B654 H	

BX = 2E46 H, DX = 92AC H, SI = 5820 H, DI = 8658 H, and DS = 5300 H.

a) What is the addressing mode used in each line of the above assembly lines? (4 Marks)

b) Show the contents of the missing locations in the shown part of memory after the execution of the above assembly lines. (4 Marks)

ii) Check if the jump to Next will occur or not in the following cases: (6 Marks)

(Note: answer with occur or not occur, and also write the reason)

a) MOV AX, 92C7H
CMP AX, 4B2CH
JG NEXT

b) MOV AL, 0B7H
ADD AL, 53H
JC NEXT

c) MOV CX, 3
DEC CX
JCXZ NEXT

Question 3 16 Marks

i) Suppose that AL = 00101010 B. Using only logical instructions, write the assembly lines to perform the following operations, and then show the contents of AL: (8 Marks)

a) Multiply AL by 4

b) Divide AL by 8

c) Clear the bits No. 1, 3 and 5 in AL

d) Toggle the bits No. 0, 4 and 7 in AL

ii) Show the contents of BX and the flag bits (CF, ZF, SF, OF, PF, and AF) after the execution of the following assembly lines: (8 Marks)

STC
MOV BL, 5EH
ADC BL, 97H
MOV BH, 0C2H
SUB BH, 48H

Question 4 10 Marks

Write the assembly code that:

(8 Marks)

- adds and counts the even and odd numbers in the following series of byte size data: 43, 56, 18, 71, 36, 67, 92, 0, 31, 22, and 0.
- stores the sum and count of the even numbers in CL and CH, respectively
- stores the sum and count of the odd numbers in DL and DH, respectively
- stops when the number 0 is read

then show the contents of CX and DX after the execution of the assembly code.

(2 Marks)

Best Wishes

Dr. Abdelrahman Morsi



Physics Department
Faculty of Science
Assiut University
1st Semester - 2024/2025

3rd Year

Final-term Exam

Physics and Electronics Program
Course Code: EC 325

Microprocessors
(معالجات دقيقة)

Date: January 13th, 2025

Time: 9:00 am - 12:00 pm (3 hours)



Important Notes: Marks: 50, Number of Pages: 2, Number of Questions: 4

Answer All the Following Questions:

Question 1 10 Marks

Choose the correct answer to each of the following statements:

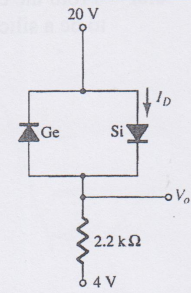
(1 Mark for Each Point)

(Note: multiple choices are not allowed)

- Babbage designed an analytical engine in 1830, which its input operation can be done using
☐ A gears and wheels ☐ B strings of beads
☐ C motor-driven adding machines ☐ D non of the previous
- The maximum size of a memory segment in the real mode operation is
☐ A 1 MB ☐ B 64 KB ☐ C 4 MB ☐ D 256 KB
- The computing machine which can be considered the first general-purpose computer is
☐ A Colossus ☐ B Z3 ☐ C ENIAC ☐ D Abacus
- The first microprocessor in Intel which has 3 integer processors is
☐ A Intel Pentium Pro ☐ B Intel 80386 ☐ C Intel 80486 ☐ D Intel Pentium
- The main processing unit in Intel 8086 which contains the IP register is
☐ A BIU ☐ B ALU ☐ C EU ☐ D non of the previous
- Consider $SS = 25E7H$, the starting address of the stack segment in $SS:153AH$ is
☐ A $273AAH$ ☐ B $25E70H$ ☐ C $35E6FH$ ☐ D $2539FH$
- can be considered as a suitable combination of segment:offset registers.
☐ A CS:SI ☐ B SS:BX ☐ C ES:BP ☐ D non of the previous
- If $SP = 582CH$, the offset address of the first location in the stack to pop data from is after the execution of the following assembly line: `PUSH AX`
☐ A $582EH$ ☐ B $582CH$ ☐ C $582AH$ ☐ D $5828H$
- Consider $CF = 1$ and $AL = 10100011B$. After the execution of `RCL AL, 2`
☐ A $AL = 01000111B$ ☐ B $AL = 10001111B$ ☐ C $AL = 10001110B$ ☐ D $AL = 11101000B$
- Assume that the machine code of `MOV AL, 06H` is $B406H$. The value $B406H$ is stored in the
☐ A data segment ☐ B extra segment ☐ C code segment ☐ D stack segment

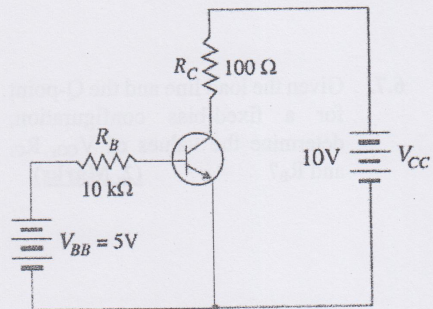
6.4. Determine V_o and I_D for the networks shown of figure?

(2, Marks)

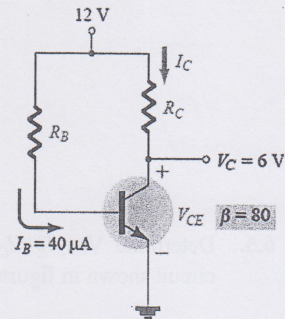


6.5. Determine V_{CB} , I_C , V_{CE} , I_B and the transistor power dissipation in the transistor circuit shown in figure. The transistor is made of silicon and has $\beta = 150$?

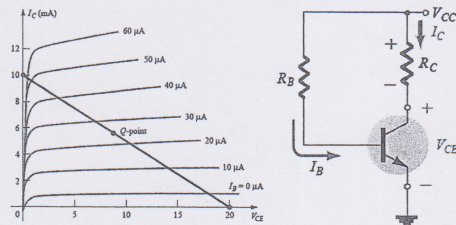
(3, Marks)



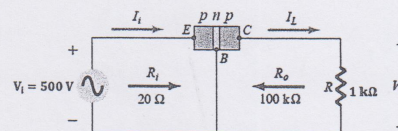
- 6.6. From the circuit shown, determine: I_C , R_C , R_B , V_E , and V_{CE} , assume the transistor to be a silicon? **(3, Marks)**



- 6.7. Given the load line and the Q-point for a fixed-bias configuration, determine the values of V_{CC} , R_C , and R_B ? **(2. Marks)**



- 6.8. In the given circuit, calculate the gain voltage, assume that α to be nearly one? **(2. Marks)**

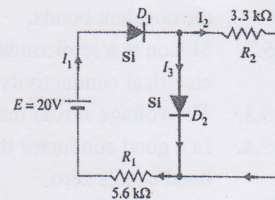


With my best regards
Dr. Amina abdelsamea

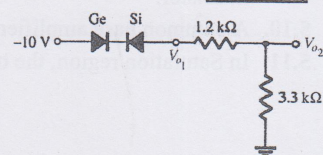
6. Answer on the following questions:

- 6.1. Determine the thermal voltage and the diode current for a silicon diode at 20°C with $\eta = 2$, $I_s = 0.1 \mu\text{A}$ at a reverse-bias potential of -10 V ? **(2, Marks)**

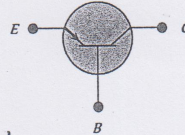
- 6.2. Determine the current I_1 , I_2 and I_3 for the given circuit? **(2, Marks)**



- 6.3. Determine V_{o1} and V_{o2} for the shown network? **(1, Mark)**



- b) To control the current flow between the emitter and collector
 - c) To dissipate excess heat generated in the transistor
 - d) To provide a voltage reference for the transistor
- 4.9. What happens when a bipolar transistor is in cut-off mode?
- a) It allows maximum current flow between the collector and emitter
 - b) It acts as an open switch
 - c) It amplifies the input signal
 - d) It is turned off
- 4.10. In a bipolar junction transistor (BJT), which terminal is responsible for supplying majority charge carriers into the base region?
- a) Emitter
 - b) Base
 - c) Collector
 - d) Substrate
- 4.11. The given symbol in figure represents
- a) forward biased PN junction diode
 - b) reverse biased NP junction diode
 - c) PNP transistor
 - d) NPN transistor



5. State True or False on the following sentences: (10, Marks)

- 5.1. Zener breakdown creates when the electric field becomes too high that it breaks the covalent bonds.
- 5.2. Silicon is a semiconductor. If a small amount of As is added to it, then its electrical conductivity increases.
- 5.3. The voltage across the ideal diode equals zero.
- 5.4. In a good conductor the energy gap between the conduction band and the valence band equals zero.
- 5.5. The forward voltage causes the depletion region to narrow.
- 5.6. A transistor can be used as a switch as well as an amplifier.
- 5.7. The emitter region of a bipolar transistor is heavily doped compared to the base region.
- 5.8. The symbol for a bipolar transistor includes arrows indicating the direction of current flow.
- 5.9. The collector current is always smaller than the emitter current in a bipolar transistor.
- 5.10. A common base amplifier configuration has high input impedance.
- 5.11. In Saturation region, the transistor acts as a closed switch.

3. Write the scientific term of each of the following:

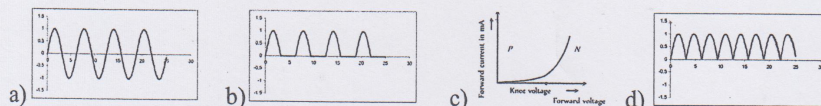
(5, Marks)

- 3.1. A combination of diodes and capacitors to multiple the output voltage of rectifier circuits.
- 3.2. External voltage is applied across the p - n junction in the same polarity as the p - and n -type materials.
- 3.3. The ratio of the collector current to the base current in a bipolar junction transistor (BJT).
- 3.4. A bipolar junction transistor (BJT) layer, is typically lightly doped to ensure high resistance and prevent excessive current flow between the emitter and collector.
- 3.5. A three-layer semiconductor device (Emitter, Base, Collector).
- 3.6. An operating region in bipolar transistor can only operate when the base-emitter junction is forward-biased, while the base-collector junction is reversed biased.

4. Choose the correct answer:

(10, Marks)

- 4.1. The potential barrier, in the depletion layer, is due to:
a) Ions b) Holes c) neutrons d) Electrons
- 4.2. To obtain electrons as the majority charge carriers in a semiconductor, the doping impurity is:
a) Monovalent b) pentavalent c) divalent d) trivalent
- 4.3. In a semiconductor, the concentration of electrons is $8 \times 10^{10}/\text{cm}^3$ and that of the holes is $5 \times 10^{12}/\text{cm}^3$. The semiconductor is:
a) NPN-type b) N-type c) Extrinsic d) P-type
- 4.4. Which is the correct diagram representing a half-wave rectifier?



- 4.5. When the P end of P-N junction is connected to the negative terminal of the battery and the N end to the positive terminal of the battery, then the P-N junction behaves like:
a) An insulator b) A conductor c) A super-conductor d) A semi-conductor
- 4.6. What is the typical biasing configuration for ensuring a bipolar transistor operates in the saturation region?
a) Forward bias the collector-base junction and reverse bias the emitter-base junction.
b) Reverse bias both junctions.
c) Forward bias the emitter-base junction and collector-base junction.
d) Forward bias the emitter-base junction and reverse bias the collector-base junction
- 4.7. In a common collector configuration, the input is taken from which terminal?
a) Emitter b) Base c) Collector d) Ground
- 4.8. What is the primary function of the base terminal in a bipolar transistor?
a) To provide a high impedance path for current



Course: Electronic
Code: 361P
First-term Exam (50 Marks)

Exam date: Tuesday, 14/1/2025
Exam Time: 3 hours
1st semester 2024-2025

Plank constant (h): 6.6×10^{-34} J/sec	Boltzmann constant (k): 1.38×10^{-23} J/K
Speed of light (c): 3×10^8 m/sec	Charge of electron or proton (e): 1.6×10^{-19} C
Knee voltage (V) _{Si} =0.7 V →	(V) _{red} =1.8 V, (V) _{GaAs} =1.2 V, (V) _{Ge} : 0.3 V

The exam is written in (6) pages

1. Answer on the following questions:

(3, Marks)

1.1. Explain the principle of operation of a p-n junction diode?

1.2. What happens to a bipolar transistor when the base-emitter junction is reverse-biased?

1.3. What is the purpose of biasing a transistor in a circuit?

2. Complete the following sentences:

(5, Marks)

- 2.1. A P-type semiconductor can be obtained by addingto a pure silicon.
- 2.2. The PN junction diode is used as
- 2.3. When the diode is reverse-biased, it is equivalent to an
- 2.4. There are two types of bipolar transistors are (draw)
- 2.5. A bipolar transistor can operate in three modes are
- 2.6. The depletion layer in silicon diode is 1 μ m wide and the knee potential is 0.6 V, then the electric field in the depletion layer will be



Question no. 5

25 Points

A) Apply Demorgan's Law to $f = (\overline{ACB} + (\overline{B} + D) + AC)(\overline{AB} + \overline{CD})$

B) Express the following function in sum-of-minterms form:

$$F_1(X, Y, Z) = \Pi(3, 5, 7)$$

$$F_2(X, Y, Z) = \Pi(1, 2, 6)$$

$$F_3(X, Y, Z) = X'YZ + X'Y'Z + XYZ$$

2. Simplify the following Boolean functions, using three-variable K maps

a. $F(A, B, C) = \Sigma m(0, 2, 6, 7)$

b. $F(A, B, C) = \Sigma m(0, 1, 2, 3, 7)$

With Our Best Wishes



Question no. 4

15 Points (10+5)

A) For the Full adder combinational circuit shown in Figure (8),

- Complete its Function table below,

X	Y	C _{in}	C _{out}	S
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

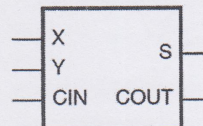


Figure (8)

- Using K-map, write the Boolean expression of the two outputs C_{out} , S .

- Implement C_{out} , and S with suitable logic gates.

B) From the following truth table, write the equations of the Boolean expressions of f_1 as a sum of minterms and f_2 as a product of maxterms, canonical form.

A	B	C	f_1	f_2
0	0	0	1	1
0	0	1	0	1
0	1	0	1	0
0	1	1	1	1
1	0	0	1	0
1	0	1	1	1
1	1	0	0	0
1	1	1	1	0

Question no. 3

15 Points (9+6)

A) –Find the output Boolean expression of the logic circuit shown in Figure (5).

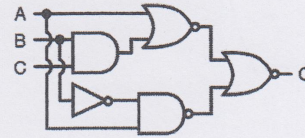


Figure (5)

B) The adder-subtractor circuit of **Figure (7)** has the shown values for the mode input **M** and data inputs **A** and **B** in the following table. In each case, determine the values of: S_0 , S_1 , S_2 , S_3 , and C .

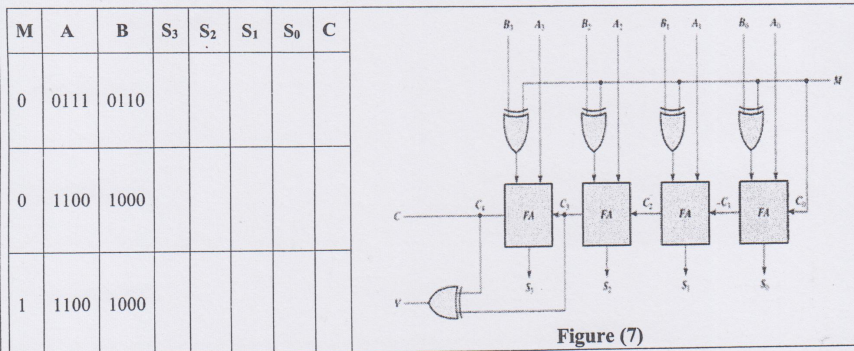


Figure (7)

Draft Area for your Calculations

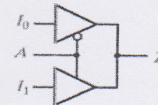


B) For the following questions fill in the given table with the correct choice (a, b, c, or d)

Q Number	i	ii	iii	iv	v	vi	vii	viii	ix	x
Answer										

i) The simplification of the Boolean expression $(\overline{A}BC) + (\overline{A}BC)$ is ...
a. 0 b. 1 c. A d. BC

ii) If A=0 in the circuit shown, the value of Z is



a. I_0 b. I_1 c. A d. 1

iii) The NAND gate output is low if the two inputs are ...
a. 00 b. 10 c. 11 d. 01

iv) The Full-Adder has

a. 2 inputs /3 outputs b. 3 inputs /2 outputs c. 2 inputs /2 outputs

v) The output of a logic gate is 1 when all its inputs are at logic 0; the gate is either a/an...

a. NAND or an XOR b. OR or an XNOR
c. AND or an XOR d. NOR or an EXNOR

vi) The output F of the OR gate shown represents ...



a. M_6 b. M_4 c. m_1 d. m_4

vii) The maxterm M_3 of a Boolean function $F(X,Y,Z)$ is

a) $X+Y+Z'$ b) $X+Y'+Z'$ c) $X'+Y+Z'$ d) $X+Y'+Z$

viii) The Boolean function $F(A, B, C) = \sum m(0, 2, 5, 6, 7)$ can be represented also by the following form...

a. $F(A,B,C) = \prod M(1, 3, 4)$ b. $F(A,B,C) = \sum m(1, 3, 4)$ c. $F(A,B,C) = \sum m(0, 2, 5, 6)$

ix) The device which changes from serial data to parallel data is.....

a. counter b. multiplexer c. demultiplexer d. decoder

x) The Using Boolean Algebra simplify the following expression: $x'y' + x'x + x'x'y$

a) $x' + y'$ b) $x + y$ c) x' d) y'



Question no.2

20 Points (15+15)

A) Read the following statements carefully and fill the following table by putting the letter (T) for the correct statements and letter (F) for the wrong ones and correct these ones.

Branch #	1	2	3	4	5	6	7	8	9	10
T or F										

- The output of a combination logic circuit depends only on its current inputs.
- A Tri-state is a Buffer gate with enable input line.
- An 8-to-1 MUX has 2 selection lines.
- For multi-input XOR gate, the output is "1" when the total number of ones in the input signals is odd.
- For the Boolean Function $F = A' + B.C + B$, the dual function is $F^D = A.(B' + C').B'$
- The conversion of the decimal **27.25** to binary is 11011.11.
- If we connect the two inputs of **NAND** gate to a single line **A**, the output 1 will be

8. Figure (2) shows the implementation of the Boolean function $F(x, y, z) = \Pi(3, 5, 7)$.

9. For the gate shown in Figure (3), if $B=1$, the output X is A.

10. The Boolean expression for the shown Figure (4) is $\bar{A}. \bar{B} + (A+B)$

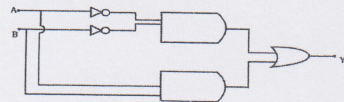


Figure (4)

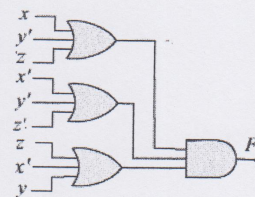


Figure (2)



Figure (3)



- 3) Write the Boolean expression of the output Z of the binary device shown in Figure (1-a), and implement it logic circuit.

Draft Area for your Calculations



Question no.1

25 Points (10+15)

A) Complete the following table of equivalent values

Binary	Decimal	Octal	Hexadecimal
11010011		323	
	153		99
		240	A0
	45		

B) Complete the following table:

1) Write the name and size of the binary device shown in Figure (1-a), briefly explain its function

Device name:

Device size:

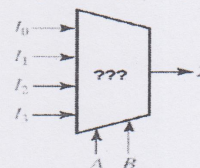


Figure (1-a)

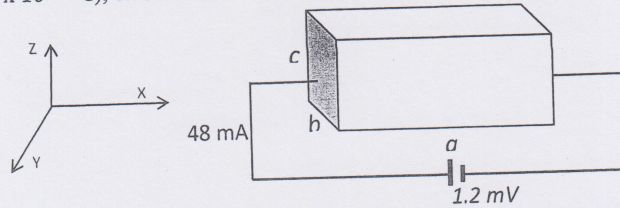
2) Fill in its Function Table shown in Figure (1-b).

A	B	Z

Figure (1-b)

Fourth Question:- [10 Degrees]

An electric current 48 mA is passing through monovalent metal ($a = 10$ cm, $b = 2$ cm, $c = 3$ cm) when connected to an applied voltage 1.2 mV, as shown below. Considering : the atomic weight $W = 58.69$, the metal density $= 8.83$ g/cm³, Avogadro's number $N_A = 6.02 \times 10^{23}$ atom/mole, and the electron charge $e = 1.6 \times 10^{-19}$ C, calculate :-



1-	The electric field (V/cm) inside the metal $E_x =$
2-	The current density (A/cm ²) inside the metal $J_x =$
3-	The electrical conductivity (ohm. cm) ⁻¹ of the metal $\sigma =$
4-	The electrical resistivity (ohm. cm) of the metal $=$
5-	The number of atoms per unit cube (atoms/cm ³) $n_a =$
6-	The number of free electrons per unit cube (electrons/cm ³) $n =$
7-	Hall coefficient of the metal piece $R_H =$
8-	Apply magnetic field ($B_z = 2$ Tesla), the built-in electric field $E_y =$
9-	The built -in voltage in y-direction $V_y =$
10-	The electric force acting on one electron in y-direction $F_y =$

انتهت الأسئلة مع تمنياتي بالتوفيق والنجاح

Third Question:- [10 Degrees]

A neutral sodium (Na^{11}_{23}) atom interact with a chlorine ($Cl^{17}_{35.5}$) atom gives sodium chloride ($NaCl$) molecule. Complete the followings

1-	The electronic configuration of the chlorine ($Cl^{17}_{35.5}$) atom is
2-	The electronic configuration of the sodium (Na^{11}_{23}) atom is
3-	Energy required to remove one electron from a neutral metallic atom to create a positive ion is called as the
4-	Energy released from creating a negative chlorine ion when a neutral atom accepts an extra electron is called as the
5-	The energy released when a positive sodium ions interact with a negative chlorine ions to give sodium chloride molecule is called as the
6-	The bond type between sodium and chlorine atoms in sodium chloride salt is called the
7-	The bond type between two water molecules inside ice crystals is called as the
8-	The total spin quantum number of a negative chlorine ion equals
9-	The total spin quantum number of a neutral sodium atom equals
10-	The four quantum numbers of the 11 th electron in neutral sodium atom is

Second Question:- [15 Degrees]

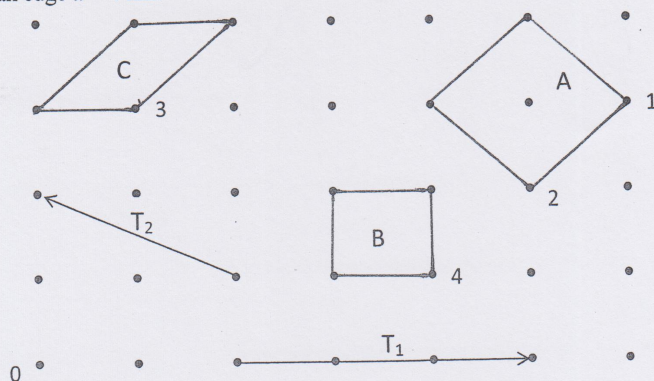
Copper crystallizes in face centered cube with an edge $a = 3.65 \text{ \AA}$. If its atomic weight $W = 63.55 \text{ g/mole}$ and density $\rho = 8.64 \text{ g/cm}^3$, $N_A = 6.02 \times 10^{23} \text{ atom/mole}$, calculate :-

1-	The number of the lattice points related to one <i>fcc</i> unit cell is
2-	The number of the nearest neighbors in the above crystal is
3-	The radius (R) of one copper atom is
4-	The volume of one copper atom is
5-	The number of <i>fcc</i> unit cells per unit cm^3 is
6-	The number of <i>fcc</i> unit cells per gram is
7-	The number of <i>fcc</i> unit cells per one mole is
8-	The atomic packing factor is defined as
9-	The distance between the nearest neighbors is
10-	The distance between two cube diagonal lattice points is

Answer All Questions

First Question :- [15 Degrees]

In two-dimensional lattice given below, the primitive unit cell is a square one with an edge $a = 4$ nm.



1-	The number of lattice points related to the unit cell (A)
2-	The number of lattice points related to the unit cell (B)
3-	Lattice point (1) shares the unit cell (A) with a fraction
4-	Lattice point (2) shares the unit cell (A) with a fraction
5-	Lattice point (3) shares the unit cell (C) with a fraction
6-	In terms of the primitive lattice vectors (a), the lattice vector $T_1 =$
7-	In terms of the primitive lattice vectors (a), the vector $T = T_1 + T_2$
8-	Sketch the lattice vector (T) in the above lattice
9-	The basis of the lattice point (3) in the above crystal lattice is
10-	The basis of the lattice point (4) in the above crystal lattice is

Question (4):

(10 Marks)

- 1- The wave function of a free electron is, $\psi(x) = Ae^{i(10^{10}x)}$ where x is in meters. Calculate,
(a) the de Broglie wavelength,
(b) its momentum,
(c) its kinetic energy,
(d) uncertainty in position and momentum.
- 2- If we assume that the electron in a hydrogen atom bound to the nucleus is represented by an electron confined in an infinite potential well, and if we know that the wavelength of the first line in the Lyman series is 121.567 nm, what is the width of the potential well?

Question (5):

(10 Marks)

- 1- Normalize the ground state wave function ψ_0 for the simple harmonic oscillator, where:
 $\psi_0(x) = C_0 \exp(-m\omega x^2/2\hbar)$
- 2- The $\ell = 0$ to $\ell = 1$ rotational transition of the CO molecule occurs at a frequency of 1.15×10^{11} Hz. Use this information to:
i- Calculate the moment of inertia of the molecule about its center of mass.
ii- Calculate the bond length of the molecule.

Plank's constant h	6.626×10^{-34} Joul.sec	Light velocity c	3×10^8 m.sec ⁻¹
Electron mass m_e	9.1×10^{-31} kg	Proton mass m_p	1.672×10^{-27} kg
mass of a carbon atom	1.994×10^{-26} kg	mass of an oxygen atom	2.6567×10^{-26} kg



Answer all the five (5) following questions:

Question (1):

(10 Marks)

The simple pendulum is a physical system consist of a mass m at the end of a weightless rigid rod of length ℓ , which pivots in a plane around the suspension point .

- 1- What is the kind of the constraint?
- 2- How many degree of freedom that system has? and what its generalized coordinates?
- 3- Write the relations between the generalized coordinates and the Cartesian coordinates.
- 4- Deduce the Lagrangian of that system.
- 5- Deduce the Lagrange's equations.

Question (2):

(10 Marks)

- 1- Deduce the time-dependent Schrodinger equation by using de Broglie's postulate.
- 2- If the potential energy of the system is time-independent, deduce the time -independent Schrödinger equation by the method of separation of variables.
- 3- The solving the time-independent Schrödinger equation, yields an infinite set of solutions $\{\psi_n(x)\}$, each with its associated energy $\{E_n\}$. Does $\psi_n(x)$ represent a wave function "function of state"? Why?
- 4- Write the solutions of the time-dependent Schrödinger equation. Are that solutions, wave functions "functions of state" . Prove your answer?
- 5- What is meant by the stationary states?

Question (3):

(10 Marks)

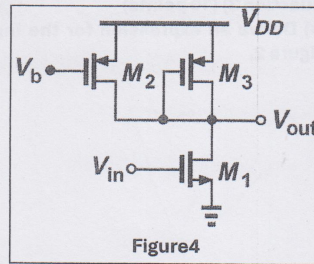
Prove that:

- 1- Any set of mutually orthogonal functions is linearly independent.
- 2- If the operators $\hat{A}$ and $\hat{B}$ commute, there exists a complete set of functions which are simultaneously the eigen functions for both $\hat{A}$ and $\hat{B}$.
- 3- Classically, the angular momentum of a particle with respect to the origin is $\vec{L} = \vec{r} \times \vec{p}$ where p is the linear momentum. Deduce the z-component of the angular momentum operator $\hat{L}_z$ in the Schrodinger representation.
- 4- Calculate $[\hat{x}, \hat{p}_x]$.

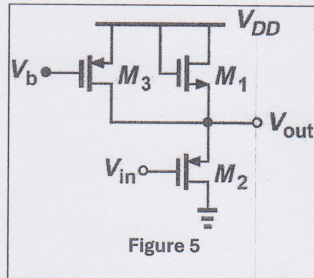
turn the paper

Q4) (10 points) Use your understanding for the basic amplifier topologies to:

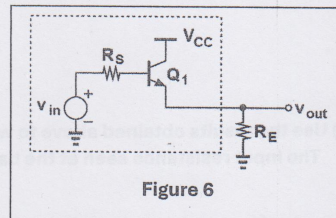
a) Write an expression for V_{out}/V_{in} for the circuit in Figure 4. For this point, do not ignore channel-length modulation.



b) Write an expression for V_{out}/V_{in} for the circuit in Figure 5. For this point, do not ignore channel-length modulation.



c) Show how can the circuit in Figure 6 can be modeled by a voltage divider. Write expressions for the voltage gain and the output impedance of the circuit in Figure 6. Assume $V_A = \infty$.



Question 3) (10 points)

(a) Derive an expression for the input resistance of the circuit in Figure 2.

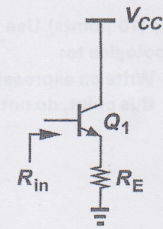


Figure 2

b) Use the results obtained above to write an expression for

- **The input resistance seen at the base of Q2 in Figure 3.**

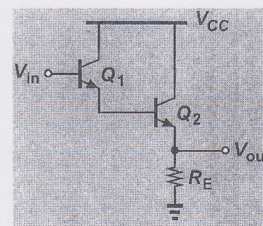


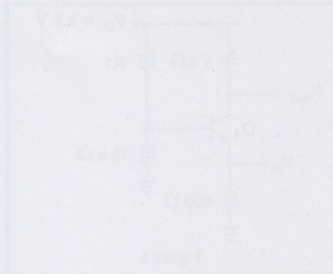
Figure 3

- **The input resistance of the entire circuit in Figure 3**

Q 2) (15 points) Consider a common-source amplifier with NMOS input transistor and a resistive load:

- a) Sketch the circuit indicating the locations where the input signal is applied, and the output signal is sensed.
- b) Construct a small-signal model and derive an expression for the voltage gain, input resistance and output resistance.
- c) Replace the resistive load with a current source load. Sketch the circuit and write an expression for the voltage gain of the modified circuit.
- d) Replace the resistive load with a diode-connected load. Sketch the circuit and write an expression for the voltage gain of the modified circuit.

d) Derive an expression for the voltage gain, input impedance, and output impedance



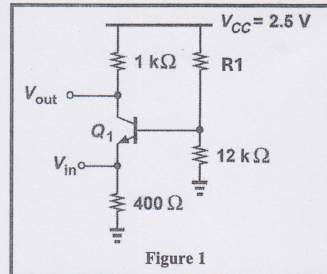


Important remarks

- Number of questions: 4
- Number of pages: 3
- Answer All Questions

Q (1) (15 marks) Consider the common-base stage depicted in Figure 1, where $\beta = 100$, $I_S = 8 \times 10^{-16}$ A, and $V_A = \infty$. The circuit is designed for a collector current of 1mA.

a) Determine the required value of R_1 .



b) Calculate the following

V_{CE}	I_B
Region of operation:	g_m
r_π	r_o

c) Construct the small-signal model

السؤال الثالث: (اختياري - 11 درجة)

3. a) Apply the law of momentum conservation for the scattering γ -ray photon and deflected electron of the target material, and if the energy conservation's law expressed as: $(h/\lambda - h/\lambda') = (mv^2 / 2C)$, Determine the change of the wavelengths (considering that m and v are the mass and the velocity of the deflected electron).
- b) Compare between: (i) The atomic radius of the simple cubic and FCC- systems. (ii) The Bragg's angle of the first and second order reflections.

السؤال الرابع: (اختياري - 11 درجة)

4. a) Prove that the correction factor of Bragg's law for the reflection order ($n > 3$) depends on the refractive index (μ) of the crystalline material given as: $C = [1 - \frac{2d^2(1-\mu^2)}{n^2\lambda^2}]$.
- b) A certain crystal reflect monochromatic X-rays strongly when the Bragg's angle of the 2nd order is 31° , satisfy the Bragg's reflection for the 1st and 3^d order spectrum. If the Miller indices: $h^2 + k^2 + \ell^2 = 13, 7$, and 19 determine the different available crystal planes in the XRD graphic.

السؤال الخامس: (اختياري - 11 درجة)

5. a) Explain the necessary conditions required for using the reciprocal lattice to study the XRD by applying the Bragg's law. Find the dependence of the incident X-ray wavelength on d-spacing for the 2nd, and 3^d order reflections.
- b) Determine the energy of X-ray beam when Bragg's angle of 19.21° is observed during in (111) plane of FCC structure (given: $w = 27, \rho = 2.7 \text{ gm/cm}^3, N_A = 6.023 \times 10^{23}$).

انتهت الأسئلة

أ.د. عبد المنعم سلطان



كلية العلوم - قسم الفيزياء



جامعة أسيوط

Final Exam. "Diffraction rays & its applications" (352 P)

time: 3 hours

Dec. 2024

السؤال الأول (إجباري): 17 درجة

I) Choose the right answer between brackets:

- 1) The basis of the crystal structure represented by (doped - identical - interstitial) atom.
- 2) Single crystal is characterized by (broadening - sharp - highest - sharp highest) peak of the XRD.
- 3) The face of the simple cubic structure includes (one - two - half) atom.
- 4) The diameter of the simple reflection circle ($\lambda/2 - 2/\lambda - 2\lambda$), where λ is the incident X-ray wavelength.
- 5) The reflected angle at the center of the simple reflected circle must be (equal - double - half) of the Bragg's angle.
- 6) The energy of the incident X-ray corresponding to ($1\text{\AA}^0$) wave length equal (1.24 - 2.14 - 12.4) KeV.
- 7) The incident intensity of X-ray decreases (linearly - nonlinearly - exponentially) with the transmitted intensity.
- 8) The atomic radius of BCC crystalline system equal [(0.34 a) - (0.43a) - (3.4a)], where a is the lattice constant

I) Transfer the following sentences after putting a check mark right or wrong:

- 1) The energy of incident neutron at $\lambda = 1\text{\AA}^0$ must be equal the energy of the atomic oscillator at temp. higher than R.T
- 2) The reciprocal lattice vector equal ($1/d_{hkl}$) in K - space while the unit cell of the reciprocal lattice equal ($\pi/2a$).
- 3) Polycrystalline material is characterized by different broadening peaks in the XRD.
- 4) Bragg's law including the refractive index of the crystal for the fourth reflection order.
- 5) The deflection angle of the electron is higher than the scattering angle of γ -ray.
- 6) For BCC and FCC crystalline systems the packing of the atoms described by a pyramidal packing.
- 7) Both the d-spacing and Bragg's angle are inversely proportional with the incident X-ray energy.
- 8) The crystal plane passing through the center of the simple reflection circle is normal to the reciprocal lattice vector.
- 9) If the incident X-ray beam directed align the symmetric axis of the crystal its unit cell contains 6-symmetric folders.

أجب عن ثلاثة أسئلة فقط مما يلي:

السؤال الثاني: (اختياري - 11 درجة)

2. a) Illustrate with the eqns. the necessary conditions used for studying the crystal structure by neutron diffraction.
- b) X-ray beam with energy 2.7 KeV incident on BCC crystal with angle 30° , determine the crystalline plane reflected the 1st the order spectrum (given: atomic radius of 0.2 nm, and $h = 6.62 \times 10^{-27}$ erg. sec).

← للأسئلة بقية في الورقة التالية

This image shows a full page of primary-ruled paper. It features multiple horizontal rows of small, evenly spaced dots, designed to guide young learners in writing their letters. The dots are arranged in straight, parallel lines across the entire width of the page. There are no margins, text, or other markings present.

[illegible]

With all my best wishes

Dr. Essam F. Abo Zeid

00

Part (II) (25 Marks)

Q2: Discuss part :

(5 Mark each)

A. Enumerate what do you know about sono-chemical and the parameters that influence sono-chemical Method of nanomaterial preparation?

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the paper.

40. Here agglomeration will occur because the electrical double layer is particularly
 C. Isoelectric point B. Not neutral A. Neutralized
41. A compound with a molar absorptivity of $32667 \text{ mol}^{-1} \text{ L}^{-1} \text{ cm}^{-1}$ (at 740nm) exhibits an absorbance of 0.81 when placed within a 1cm pathlength cuvette in a UV-Vis spectrophotometer. The Calculated concentration of the compound is?
 C. $4.88 \times 10^{-5} \text{ mol L}^{-1}$ B. $2.48 \times 10^{-5} \text{ mol L}^{-1}$ A. $1.24 \times 10^{-4} \text{ mol L}^{-1}$
42. Absorption of UV-Visible energy by a molecule result in transition .
 C. Electronic B. Nuclear A. Vibration
43. At hydrothermal method, Metal salts or oxides must be dissolved in aqueous solution to create before mixing with other solvents or additives.
 C. Predecessors B. Precursors A. Precipitates
44. Zeta Potential measurements is
 C. none of these B. fast, accurate and repeatable A. fast and not repeatable
45. Zeta measurements range size
 C. 0.3 nm -300 mm B. 0.3 Nm- 10 Mm A. 300-200 Mm
46. Cryochemical synthesis of metal oxides, leading toparticle sizes and higher surface area.
 C. Medium B. Smaller A. Higher
47. At cryogenic temperatures, the rate of most chemical reactions typically decreases significantly due to lowered.....
 C. kinetic energy B. Chemical energy A. Potential energy
48. The autoclave's role in the hydrothermal method is to create high pressure andconditions.
 C. Temperature B. Density A. Volume
49. The repellent electrostatic force overcomes the surface tension because increase of intensity of the field.
 C. Thermal B. Electric A. Magnetic
50.is from STM component which controls the tip's position in 3D (X, Y, and Z axes).
 C. Electronics B. Piezoelectric Scanner A. Tib

OC

24. The scanning tunneling microscope (STM) is the first instrument capable of directly obtaining images of solid surfaces with atomic resolution.
 C. 1D B. 3D A. 2D
25. STM is utilized for imaging dimensions with high-resolution information.
 C. macro to atomic B. macro to micro A. micro to atomic
26. To maintain a constant tunneling current (in constant current mode), the tip is adjusted in directionin real time by a feedback loop.
 C. X-axis B. Y-axis A. Z- axis
27. Fromof STM is Sensitive to environmental noise and vibrations.
 C. Application B. Disadvantages A. Advantage
28. What type of surface is best for scanning using AFM in Contact Mode?
 C. Fluid surfaces B. Hard surface A. Soft surfaces
29. Scanning Tunneling Microscopy (STM) works by using metal tip to scan the surface of a material.
 C. Thin B. Thick A. Sharp
30. The interface of the electrical double layer with the surrounding liquid is called
 C. electrical double layer B. Zeta Potential A. slipping plane
31. The electric potential at this Slipping plane is called the.....
 C. Zeta Potential B. zeta Potential measurements A. Slipping plane
32. The Zeta Potential changes from positive to negative values as the
 C. stability of pH value B. pH decrease A. pH increase
33. Zeta Potential is specified inand is usually in the range between
 C. mv , 200 to + 200 B. mv , +2000 to - 200 A. Mm , 300 to 400
34. Zeta Potential measurements is on the one hand based on partial properties ,
 C. A&B B. surface condition A. type of material
35. Zeta Potential is determined by
 C. type of material B. pH value A. dissolved ions
36. Range to light used in the UV-Visible spectroscopy?
 C. (200-700nm) B. (400-700nm) A. (200-400nm)
37. The pH at which the Zeta Potential is zero is also called
 C. surface condition B. dissolved ions A. isoelectric point
38. Deuterium andlamps are used as a light source in UV-Visible spectrophotometers ?
 C. Magnesium B. Cadmium A. Tungsten
39. The basic equation used to calculate absorption in UV-Visible spectroscopy?
 C. $C = \epsilon \cdot A \cdot l$ B. $l = A \cdot c \cdot l$ A. $A = \epsilon \cdot c \cdot l$

9. In which mode does the AFM tip maintain constant contact with the surface?
 C. Contact Mode B. Tapping Mode A. Non-Contact Mode
10. In hydrothermal method the solution preparation stage, stabilizers or surfactants are added to.....
 C. Speed up the evaporation process B. Increase the solution concentration A. Control the product properties
11. The changes as the tip moves over surface features (atoms, bumps, etc.)
 C. Width B. Length A. Height
12. The role in the hydrothermal method is to create high pressure and temperature conditions.
 C. Microwave B. Ultrasonic A. Autoclave's
13. The hydrothermal method allows the production of nanomaterials with
 C. Undefined properties B. High crystallinity A. Medium crystallinity
14. In Ball milling, the length of mill is approximately its diameter.
 C. smaller than B. bigger than A. Equal to
15. Disadvantages of UV visible spectroscopy Limited Range of
 C. Use B. Materials A. Analysis
16. In Ball milling, at speed attrition occur and size reduction hence becomes more efficient.
 C. Low B. High A. Medium
17. Advantages of UV visible spectroscopy is.....analysis.
 C. Cumulative B. Destructive A. Non destructive
18. -In the inert gas method, the particles formed in the gas phase drift byto a cold column.
 C. Thermo synthesis B. Thermo heating A. Thermophoresis
19. The electrospinning method was utilized to produce TE the like
 C. Metal collector B. carbon nano fibers A. polymer solution
20. Function of detector in UV-Visible spectroscopy is..... the transmitted light and records the absorption
 C. Emit B. Select A. Measures
21. Metal tip in STM scans the surface of a material and measure the Quantum Tunneling that flows between the tip and the surface.
 C. Current B. Electron A. Voltage
22. The repellent electrostatic force overcomes the surface tension because..... of intensity of the electric field
 C. Stabilize B. Increase A. Decrease
23. One of these is correct in the advantages of the electros pining.....
 C. Low temperature window B. low pressure A. Transparent



Assiut University - Faculty of Science
First semester- Final Exam 2024-2025
Department of Physics

Program: Materials
science
Level : (3)
Date:31/1/2024
Time: 2 hours



Course title: Preparation & characterization

Code: 303 Phy

Important: No. of pages 7

No. of questions 2

Total marks: 50 degrees

تنبيه هام

قبل البدء في الإجابة الرجاء قراءة هذه التعليمات جيدا

1. تأكد من أن كراسة الإمتحان تتكون من (7) صفحات مختلفة (3) ورقات و في حالة التكرار أو النقص يطلب إستبدالها فوراً.
2. الإمتحان يتكون من سؤالين فقط: السؤال الأول اختيار من متعدد والسؤال الثاني مقالتي و مطلوب الإجابة عليها جميعاً.
3. يجب تخصيص الوقت المناسب لإجابة كل سؤال و مراعاة عدم تجاوزة حتى يتسنى لك إجابة جميع الأسئلة.
4. محاولة الإستعانة بالآخرين أو إعانتهم في إجابة الإمتحان يعرضك للمسائلة القانونية من الجامعة وما يترتب عليها.

Part (I) (25 Marks)

Q1: Choose the correct answer A, B, C or D:

(0.5 Mark each)

1. STM measure the quantum tunneling that flows between the tip and the surface.
C. Resistance B. Current A. Voltage
2. Which of the following components is responsible for analyzing data and generating surface images in an AFM?
C. Cantilever B. Controller A. Sample
3. To obtain oxides by the inert gas method, a small amount of oxygen is introduced into the system scraping the powder from the cold column.
C. after B. Before A. During
4. SEM is much resolution compared to optical microscopy.
C. Worst B. Greater A. Lower
5. Sonochemical method usesintensity Ultrasonic waves which create cavitation bubbles in liquid to drive chemical reaction.
C. High B. Low A. Medium
6. The concentration of homogeneous solution in sono-chemical method should be optimized, typically in the range of 0.01 to M.
C. 0.01 B. 0.001 A. 0.1
7. The temperature and pressure released from collapse of micro bubbles can reach.....
C. 3000K,2000atm B. 5000K,1000atm A. 500K, 100 atm
8. After growth,.....are often introduced to coat the nanoparticles, to prevent agglomeration.
C. Solvent B. Stablizing agent A. Precursors



Assiut University – Faculty of Science
Physics Department
2024-2025 – 1st semester (December 31, 2024)



Plasma & Applications - Code: P332 / Level Three

Final Exam

Time: 3h

Instructor: Prof. Dr. Azza Hashem

1- Put write or wrong to the following: - (10 marks)

- Plasma is one of four fundamental states of matter.
- The plasma is called corona, when the ionization degree is high.
- A plasma is electrically conductive.
- Temperature is only one of the basic variable useful in the study of plasma.
- Artificial plasmas are generated by the application of electric and/or magnetic fields through a gas.
- Electric field pull the bound electrons toward the cathode.
- Partially-ionized gas, containing ions, electrons only.
- Plasmas are affected by electrical and magnetic fields.
- Pinch effect is not a type of magnetic confinement fusion device. -
- Plasma discharge current measured directly using a Rogowski coil.

2- Write short notes on four of the following: - (10 marks)

- I- The collision cross section.
- II- Anode corona.
- III- magnetic-mirror.
- V- Cathode corona.
- VI- Plasma oscillations.
- VII- Ambipolar Diffusion.

3- Writ in details about three of the following :- (15 marks)

- Plasma characterization.
- The factors that reduce the number of charges particles in plasma.
- Photoelectric emission.
- Methods of producing charged particles in plasma

4- Answer two of the following questions using drawing if needs: - (15 marks)

- What is the concept of pinch effect confinement in plasma?
- Explain the equations of motion of a charged particle (+, -) in a uniform magnetic field.
- Explain a method to measure plasma current and voltage.

Best wishes

Prof. Azza Hashem

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(b) A system with two particles within volume V . Either particle can exist in any of the three quantum levels with energies, $\varepsilon_1 = 0$, $\varepsilon_2 = 1$, $\varepsilon_3 = 2$. Calculate the partition function if:

A- [2 marks] The particles follow the Maxwell-Boltzmann statistic.

B- [2 marks] The particles follow the Bose-Einstein statistic.

C- [1 mark] The particles follow the Fermi-Dirac statistic.

(Table your answer).

End of Question

Best wishes

Dr. Hadeer El-Hawary

Important formulas:

$$\delta \left(\ln \left(\frac{a}{a-x} \right) \right) = \frac{-x}{a(a-x)}$$

$$\delta \left(\ln \left(\frac{a-x}{x} \right) \right) = \frac{1}{(a-x)}$$

$$\int_0^{\infty} \sqrt{y} e^{-y} dy = \frac{\sqrt{\pi}}{2}$$

$$\ln(n!) = \int_1^n \ln(k) dk = [k \ln(k) - k]_1^n = n \ln(n) - n$$

$$\frac{\partial}{\partial \beta} Z_{sp} = \frac{\partial}{\partial \beta} \sum_i g_i e^{-\beta \varepsilon_i} = - \sum_i \varepsilon_i g_i e^{-\beta \varepsilon_i}$$

$$\left(\frac{\partial Z_{sp}}{\partial V} \right)_{T,N} = -\beta \sum_i g_i e^{-\beta \varepsilon_i} \left(\frac{\partial \varepsilon_i}{\partial V} \right)_{T,N}$$

$$P = - \left(\frac{\partial F}{\partial V} \right)_{T,N}$$

$$S = - \left(\frac{\partial F}{\partial T} \right)_{T,N}$$

$$F = U - ST$$

$$F = -T k_B \ln(Z_{sp})^N$$

4- (a) [5 marks] Prove that for distinguishable and identical particles, the total partition function is given by $Z_N = (Z_{sp})^N$, and explain why this formula is not applicable to indistinguishable particles. Additionally, write the correct formula for indistinguishable particles.

(b) [5 marks] If the density function of the degenerated levels is known as:

$$g(\epsilon) = 2\pi V \left(\frac{2m}{h^2} \right)^{3/2} \sqrt{\epsilon}$$

Prove that the partition function for continuous levels expressed as:

$$\ln(Z_N) = N \ln(V) + \frac{3}{2} N \ln \left(\frac{2\pi m k_B}{h^2} \right) + \frac{3}{2} N \ln(T)$$

5- (a) [5 marks] If the total number of microstates probability of Fermi-Dirac statistics is:

$$\Omega_{FD} = \prod_j \frac{g_j!}{n_j! (g_j - n_j)!}$$

Prove that the Fermi-Dirac distribution function is:

$$f(\epsilon_j) = \frac{n_j}{g_j} = \frac{1}{e^{(\epsilon_j - \mu)/k_B T} + 1}$$

Hint (Take the logarithm of the microscopic probability number equation - apply the Sterling formula and use Lagrange coefficients with the restriction that the number of particles and energy are constant).

(b) [5 marks] Plot the functions of the three distributions: Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distributions. And write your comments on it.

6- (a) Suppose a system consisting of four particles and three energy levels. The first level is binary, meaning that $g_1 = 2$, and it is saturated with two particles. The second and third levels are monolithic $g_2 = g_3 = 1$ and each is saturated with only one particle. Calculate the number of microstates if:

A- [2 marks] The particles follow the Maxwell-Boltzmann statistic.

B- [2 marks] The particles follow the Bose-Einstein statistic.

C- [1 mark] The particles follow the Fermi-Dirac statistic.



The final exam is in 3 pages (50 marks)

Answer ONLY SIX of the following questions (10 marks each)

1- (a) [4 marks] Prove that the statistical definition of entropy is compatible with the third law of thermodynamics.

(b) [6 marks] a simple system consisting of six particles $N=6$ and levels given by:

$$\varepsilon_i = i \times 10^{-20} \text{ J}, \quad i = 0, 1, 2, 3, 4$$

If we can arrange the particles to fulfill the condition that the total energy $U = 5 \times 10^{-20} \text{ J}$, calculate the number of microscopic states that satisfy these conditions. Find the distributions that reduce the Helmholtz free energy at room temperature (298.1 K). ($k_B \approx 1.4 \times 10^{-23} \text{ J K}^{-1}$)

2- The partition function of a system satisfying Maxwell-Boltzmann statistics takes the form

$$Z = aVT^4$$

where a is constant, Prove that

A- [4 marks] the internal energy is $U = 4Nk_B T$,

B- [3 marks] the pressure P is $P = \frac{Nk_B T}{V}$ and,

C- [4 marks] the entropy of this system is $S = Nk_B(4 + \ln(aVT^4))$.

3- (a) [5 marks] A system consists of i levels, each level has g_i degenerated levels and has number of indistinguishable particles n_i . Prove that

$$\ln(\hat{\omega}) = \sum_i n_i \left(\ln \frac{g_i}{n_i} + 1 \right)$$

(b) [5 marks] A system consisting of three energy levels as follows: $\varepsilon_1 = 0$, $\varepsilon_2 = 100 k_B$, $\varepsilon_3 = 200 k_B$ and $g_1 = 1$, $g_2 = 3$, $g_3 = 5$. Calculate the relative population between levels at temperature $T = 100 \text{ K}$.

47) The height of the liquid on the capillary tube doesn't depends on:			
A. Surface tension	B. density	C. tube material	D. tube radius
48) A parallel plate capacitor has plates of dimensions $2\text{ cm} \times 3\text{ cm}$, separated by a 1 mm thickness of paper ($K=3.7$) its capacitance equal (Hint: $\epsilon_0=8.85 \times 10^{-12}$)			
A. $1.96 \times 10^{-11}\text{ mf}$		B. $1.96 \times 10^{11}\text{ f}$	
C. $1.96 \times 10^{-14}\text{ f}$		D. $1.96 \times 10^{-11}\text{ f}$	
49) Object A has a charge of $-4\text{ }\mu\text{C}$, and object B has a charge of $-8\text{ }\mu\text{C}$. Which statement is true about the electric forces on the object?			
A. $F_{AB}=-F_{BA}$	B. $F_{AB}=-2F_{BA}$	C. $F_{AB}=2F_{BA}$	D. $F_{AB}=F_{BA}$
50) The process of heat conduction involves the increase of internal energy in the material.			
A. Free convection		B. Forced convection	
C. Conduction		D. Radiation	

- A. Energy travels from the larger object to the smaller object.
 B. Energy travels from the object with more mass to the one with less mass.
 C. Energy travels from the object at a higher temperature to the object at a lower temperature.
 D. None of the above

40) Which type of heat transfer process is characterizing the conducting solids.

- | | |
|--------------------|----------------------|
| A. Free convection | B. Forced convection |
| C. Conduction | D. Radiation |

41) Which part of the neuron transfer the information to the next cell

- | | | | |
|--------------|------------------|---------------------|---------|
| A. Dendrites | B. Myelin sheath | C. Terminal buttons | D. Axon |
|--------------|------------------|---------------------|---------|

42) If a person is standing erect, the blood pressure in the artery located in is lesser than the blood pressure in the heart.

- | | | | |
|---------|---------|---------|-----------|
| A. Head | B. feet | C. legs | D. Pelvis |
|---------|---------|---------|-----------|

43) The flow rate of blood through the aorta is typically 0.08 liter/s. If it takes 1 minute for all your blood to pass through the aorta, what is the volume of blood in your body.

- | | |
|---------------|--------------|
| A. 4.8 liters | B. 10 liters |
| C. 8.0 liters | D. 1.0 liter |

44) Which of the following sentences is true?

- A. When the Cohesion < Adhesion, the Contact Angle < 90° like Water-Glass
 B. When the Cohesion > Adhesion, the Contact Angle > 90° such as Water-glass
 C. When the Cohesion < Adhesion, the Contact Angle > 90° like Water-Glass
 D. When the Cohesion > Adhesion, the Contact Angle < 90° such as Water-wax

45) The pressure increases in the fluid in a syringe when a nurse applies a force of 42 N to the syringe's circular piston, which has a radius of 1.1 cm equal

- | | |
|---------------------------------|---------------------------------|
| A. $1.1 \times 10^5 \text{ Pa}$ | B. $1.1 \times 10^4 \text{ Pa}$ |
| C. $2.1 \times 10^5 \text{ Pa}$ | D. $2.1 \times 10^4 \text{ Pa}$ |

46) The stages of an action potential in which the large positive value on the membrane stimulate it to become more permeable to K^+ ions and impermeable Na^+ ions, causing a rapid diffusion of K^+ ions outwards is called:

- | | |
|-------------------|-----------------------|
| A. Stimulus | B. Repolarization |
| C. Depolarization | D. Hyper-polarization |

32) At high temperatures, some of the electromagnetic radiation is in the region, and the body is observed to glow.			
A. Visible		B. ultraviolet	
C. infrared		D. none of previous	
33) In synaptic conduction, the transmission is chemically assisted by positive transmitter called:			
A. Dopamine		B. Acetylcholine	
C. Glutamate		D. Serotonin	
34) The glass tube of the probe that used for measuring the cell membrane potential difference filled with solution			
A. KCl		B. NaCl	
C. HCl		D. CaCl	
35) is the quantity of heat required to raise the temperature of 1 g of a substance by 1 degree.			
A. Heat Capacity		B. Specific Heat	
C. Calorie		D. Latent Heat	
36) The amount of thermal energy required to raise the temperature of an object one degree?			
A. Specific Heat		B. Heat Capacity	
C. Latent Heats		D. Calorie	
37) The resistances of a platinum resistance thermometer at lower and upper fixed points ($0^{\circ}\text{C} - 100^{\circ}\text{C}$) are $3.50\ \Omega$ and $3.65\ \Omega$, respectively. Then find the resistance of platinum wire at 37°C ?			
A. $3.50\ \Omega$		B. $35.5\ \Omega$	
C. $3.55\ \Omega$		D. $3.05\ \Omega$	
38) thermometer works by an expanding liquid in a vacuum, moving against a scale.			
A. Liquid-Filled Glass Thermometers			
B. Constant Pressure Gas Thermometer ($V \propto T$)			
C. Constant Volume Gas Thermometer ($P \propto T$)			
D. Infrared (IR) Thermometer			
39) Two objects, with different sizes, masses, and temperatures, are placed in thermal contact. In which direction does the energy travel?			

B. The refracted ray in the second medium is bent toward the normal if $v_2 < v_1$ and vice versa.			
C. The lowest index of refraction, the lowest the optical density.			
D. The angle between the incident ray and the normal is equal to the angle between the refracted ray and the normal			
25) The critical angle for the diamond-air boundary..... (for diamond $n=2.42$)			
A. 20.4°	B. 42.4°	C. 24.4°	D. 2.44°
26) Light passes from a material with index of refraction 1.3 into one with an index of refraction 1.2. Compared to the incident ray, the refracted ray...			
A. bends toward the normal.			
B. is un-deflected.			
C. bends away from the normal.			
D. cannot defined			
27) In Sodium-potassium (Na^+/K^+) pump, enzyme uses metabolic energy to pump Na^+ outward and K^+ inward			
A. Adenosine diphosphate (ADP)		B. Adenosine triphosphatase (ATP)	
C. Adenosine monophosphate (AMP)		D. Adenosine deaminase (ADA)	
28) Which type of heat transfer process occurs by the transfer of electromagnetic waves			
A. Free convection		B. Forced convection	
C. Conduction		D. Radiation	
29) Which part of the neuron starts the excitation and increases the pulse propagation speed			
A. Dendrites	B. Myelin sheath	C. Soma	D. Axon
30) The person begins to feel discomfort due to radiation if the temperature difference between the exposed skin and the radiating environment exceeds about $^\circ\text{C}$.			
A. 8	B. 6	C. 9	D. 3
31) The conductivity of a material considered as the reciprocal of			
A. Resistance		B. resistivity	
C. current density		D. permittivity	

14) The temperature is a qualitative measure of the hotness of a body however, the internal energy is a quantitative measure of hotness.
15) In the resting state, the membrane is somewhat slightly permeable to K ⁺ ions but much less permeable to Na ⁺ ions.
16) The internal energy decreases as we go from the solid to the liquid to the gas phase
17) Calorimeter is an instrument designed to measure heat energy or specific heat of a substance.
18) Conduction in synapse takes place in any direction.
19) The greater the pressure differential between two points, the lesser the flow rate.
20) Pascal's Principle can be applied to all the phases of the materials.

Second question: Choose the correct answer:

(30 Marks)

21)is a transparent layer forming the front of the eye, covered with a film of tears and has a radius of curvature $r \cong 8 \text{ mm}$			
A. Pupil	B. Cornea	C. Retina	D. Fovea
22)is one of the sight defects that suffer from weakness of power of accommodation			
A. Myopia	B. Hypermetropia	C. Presbyopia	D. Astigmatism
23) Which one of these statements corresponding to the compound microscope is incorrect?			
A. The object is just outside the focal length of the objective lens (a real image is formed) i.e., $f_1 < X < 2f_1$.			
B. The image from the objective lens falls just inside the eyepiece focal length and a virtual image is formed by the eyepiece i.e., $0 < X < f_2$.			
C. The focal lengths of the two lenses do not overlap i.e. $d > f_1 + f_2$.			
D. It consists of a convex lens of short focal length with the object placed closer than the focal point i.e., $0 < X < f$.			
24) Which one of these statements corresponding to Golden Rules for Refraction is incorrect?			
A. All rays and the normal lie in the same plane.			



The exam is in 3 pages (50 degree)

First question: Circle T for the true statement and F for the false one: (20 Marks)

1) Plano-Cylindrical Lens has both a plane side and a cylindrical side.
2) Aqueous Humor is a jelly-like substance with refractive index 1.34
3) Fovea is a spot on the retina which is directly opposite to the Pupil and having the maximum sensitivity
4) In a simple microscope the image is formed by the high power objective lens and then is magnified by another lens called the ocular or eyepiece.
5) A semicircular set of lines is used to detect the axis of which the lens is put in order to obtain the best image for the astigmatic eye.
6) The near point of the hypermetropic eye lies longer than 25 cm while nearer than 25 cm in the myopic eye.
7) Standards of length is based on speed of light in any medium.
8) The amount of radiation emitted by vibrating charged particles is proportional to the speed of vibration in the process of heat radiation transfer.
9) In heat transfer by convection in human body, the exposed area is generally smaller than the total surface area of the body.
10) The mechanism in passive transport of moving substances through the membrane is occurs in combination with a carrier protein, against concentration gradient, and with the need of energy.
11) Emission and absorption of radiation are not related phenomena.
12) The cell membrane is acts as a capacitor with positively charged inside and negatively charged outside.
13) Metabolic rate is approximately the same for most people.

3. The oceans act as a huge reservoir or SO_2 , as phytoplankton in surface water. ()
4. Carbon dioxide and water vapor release the energy out of the earth and decrease the temperature of it. ()
5. The method of transferring heat by radiation does not require a link between the source of heat and the object to which the heat is transmitted. ()

B) Write a short brief on of the following ,Conference objectives and most important recommendations of (COP27) for climate changes at Sharm El Sheikh Egypt. (5 Marks)

Question (4) :

- A) Explain why the sky is blue during the day and black at night. (2 Marks)
- B) Explain by using equations, types of Beta particles. (4 Marks)
- C) What is Carbon cycle of the atmospheric energy? Explain by using equations

Question (5) : Write a short brief on of the following:- (10 Marks)

- I) The main differences between Rayleigh scattering and Mie scattering. (3 Marks)
- II) Quantitative Description of Radiation and illustrate Radiometric Definitions (3 Marks)
- III) Green Hydrogen (4 Marks)

Question (6) :

- 1) The geopotential at any point in the Earth's atmosphere Potential Temperature(Θ). (4 Marks)
- 2) Manufacturing of Photovoltaic **Solar cells** as a clean energy, How do Photovoltaic Solar Cells work and illustrate the operation of basic of PV cells. (6 Marks)

The End of Questions
best wishes, Dr. Mohamed Mansour

	Assiut University Faculty of Science Physics Department	Final Exam Environmental Physics Code : 383 P	Date 21/1/2025 Level : Three Time :3Hour	
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Answer Five questions only: (every question 10 Marks)

Question (1):

Choose the correct answer

(10 Marks)

- 1- Rainbows are created by theof light in water droplets.
a. reflection b. increasing c. refraction d. scattering
- 2- The upper part of the stratosphere contains
a. carbon dioxide b. Ionosphere c. Thermosphere d. all above
- 3- act as solar cells when irradiated by solar energy.
a. Black LED's b. Red LED's c. Ozone d. CO₂
- 4- Mesosphere is region of the atmosphere.
a. the coldest b. the smallest c. the hottest d. non of above
- 5- Greenhouse gas
a. water vapour b. carbon dioxide c. a and b d. non of above

Question (2):

A) Complete the following sentences :

(7 Marks)

- 1) A ring of light encircling and extending outward from the sun or moon is called
- 2) In β^- emission one of the; In the nucleus changes into a
- 3) In the atmosphere, the solar radiation is attenuated by.....and
- 4) Enthalpy (h) of a unit mass of the material, is defined by
- 5) Γ_d is called the dry adiabatic lapse rate, because.....

B) Explain how the earth's atmospheric greenhouse effect work. (3 Marks)

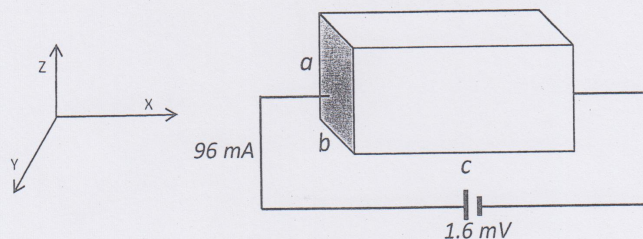
Question (3): A) Put (true) or (false) and correct the error (5 Marks)

1. Ozone (O₃) in the stratosphere protects life from harmful infrared radiation. ()
2. Both air pressure and air density decrease with increasing altitude. ()

أنظر خلفه

Fourth Question:- [10 Degrees]

An electric current 96 mA is passing through a metallic piece ($a = 3$ cm, $b = 2$ cm, $c = 10$ cm) when connected to an applied voltage 1.6 mV, as shown below. If the electron charge ($e = 1.6 \times 10^{-19}$ C) and the electron mass ($m = 9.1 \times 10^{-31}$ kg), calculate :-



- | |
|---|
| 1- The electric field (V/cm) inside the metal is |
| 2- The electric force (Newton) on one electron equals = |
| 3- The current density (A/cm ²) inside the metal = |
| 4- The electrical conductivity (ohm. cm) ⁻¹ of the metal = |
| 5- The acceleration of an electron is |

إنتهت الامتلاء مع تمنياتي بالتوفيق والنجاح

Third Question:- [10 Degrees]

A neutral sodium (Na^{11}_{23}) atom interact with a chlorine ($Cl^{17}_{35.5}$) atom gives sodium chloride ($NaCl$) molecule. Complete the followings

1-	The electronic configuration of the chlorine ($Cl^{17}_{35.5}$) atom is
2-	The electronic configuration of the sodium (Na^{11}_{23}) atom is
3-	Energy required to remove one electron from a neutral sodium atom to create a positive ion is called as the
4-	Energy released from creating a negative chlorine ion when a neutral atom accepts an extra electron is called as the
5-	The energy released when a positive sodium ions interact with a negative chlorine ions to give sodium chloride molecule is called as the
6-	The bond type between sodium and chlorine atoms in sodium chloride salt is called the
7-	The bond type between two water molecules inside ice crystals is called as the
8-	The total spin quantum number of a negative chlorine ion equals
9-	The total spin quantum number of a neutral sodium atom equals
10-	The four quantum numbers of the 11 th electron in neutral sodium atom is