

Vidyavardhini's College of Engineering & Technology, Vasai

First Year Engineering Academic Year 2024-25 Solution with Marking Scheme Internal Assessment - II

Sub: BSC102/AP Max. Marks: 15

Year/Sem: - FE/ I

Date: 04/11/24 Duration: -1 Hr

Course Outcomes:

Learners will be able to:

CO4: Illustrate the significance of Maxwell's equations in the field of modern technology.

CO5: Apply the foundations of quantum mechanics for the development of modern technology.

CO6: Explain the types of semiconductors based on variations in fermi level with temperature and doping

concentration

BL: Blooms Taxonomy level

CO: Course Outcome

Q.	Solutions	Marking Scheme	СО	BL
No.	Attempt the following questions.	Total Marks 05		
1. a)	What is the divergence of a vector field? Find the divergence of a field for $\vec{A} = x^2y \ i - 3xyz^2 \ j + 2xy \ k$ at $(1,1,1)$			
Any	The divergence of a Vector field is a			
	Scalor measurement That measures			
	how much a vector field is expanding			
	(diverging) or contracting (converging) at a given point.		4	2
	a given pours.			
	The divergence of vector field A is $\overrightarrow{\nabla} \cdot \overrightarrow{A}$			
	7. A = (12 + jg + ig =)(2y; -3ny22 + 2ny n	ĺ		
	======================================			
	= 2(1)(1) - 3(1)(1) = -1			
	·. 7.7= -1 at (1,1,1)		1	

The St. Let. The Vector
What is the curl of a vector field? Find the curl of a Vector field for $\vec{E} = 4x i + 2y j + 3z k$
And The curl of a vector field measures
the tendency of the field to rotate
around a point. It quantifies the
rotation or Circulation of the vector
Given == 42î + 2yî + 3zk
in a delimentar
$\overrightarrow{\nabla} \times \overrightarrow{E} = \begin{vmatrix} \hat{1} & \hat{1} & \hat{1} \\ \hat{2} & \hat{3} & \hat{2} \\ \hat{3} & \hat{3} & \hat{3} \\ \hat{4} & \hat{2} & \hat{3} & \hat{3} \\ \end{vmatrix} = 0 - 0 + 0$
1 2 2 32 = 0-0+0
The state of the s
TYE = 0
Derive Maxwell's 3 rd equation in differential form, which describes how the electric field circulates around the timevarying magnetic field.
electronagnetic Induction we know
that $e = -\frac{d\phi}{dt} - \frac{\omega}{\Omega}$
the magnetic flux associated with the 4 3
Therefore $\phi = \int \vec{B} \cdot d\vec{s}$ where B
s fild intensity and
is the magnetic field intensity and
the lines of force passing through the infiniterimal surface area ds.
Control of the state of the sta

from ean O and @ we can write $e = -\int \underbrace{a}_{S} \left(B \cdot ds \right) - \underbrace{a}_{S} \left(B \cdot ds \right)$ Also we know that the e-m-f e' induced inside the and can be written as $e = 6 \, \text{E} \cdot de$ fram egr 3 and B we con write $\oint \vec{E} \cdot d\vec{l} = -\int \left(\frac{\partial \vec{B}}{\partial t}\right) \cdot d\vec{s}$ as B(x,t)By using stokers curl theorem we am write $\int \left(\overrightarrow{\partial} \times \overrightarrow{E}' \right) \cdot d\overrightarrow{i} = - \int \left(\frac{\partial \overrightarrow{B}}{\partial \overrightarrow{F}} \right) \cdot d\overrightarrow{i}'$ $(\vec{\nabla} \times \vec{E}' + \frac{\partial \vec{B}'}{\partial \vec{T}}) \cdot d\vec{S} = 0$ The above integral is for any arbitary surface which implies $\forall x \vec{E} = -\frac{\partial \vec{E}}{\partial t}$ | $\forall x \vec{E}'$ and $\frac{\partial \vec{E}}{\partial t}$ must be zero as the element ds \$ 0

Derive Maxwell's first equation in differential form for static electric field produced by charge enclosed within a closed surface. According to anas Law DE'. dB = 90 When 9: charge enclosed by a closed surface E: electric field due to charge gy' and form Permittivity in free space. We know that 9= Jedw where 4 3
electric field produced by charge choices surface. According to Grass Law & E. ds = 9
According to avais Law & E. ds = 9
According to avais Law DE. ds = 9
where 90 charge enclosed by a closed surfee
where 90 charge enclosed by a closed surfee
When 91 charge enclosed by a closed surefree
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F. Eliant visca wat
Permitivity in face spale.
Pow where 4 3
we know may 9- 5-
I a The volume charge devying
can write $\oint \vec{E} \cdot d\vec{s} = \int (\vec{\nabla} \cdot \vec{E}) dV$
i, By wing Guass divergence
1 2 maithe 12 is (7.5) dv
CON WORKE OF COME
2 V
1 an an a cula can write
from () & (2) are a. (-) +
(9ch > 7.E = -/c)
(V.E) ON 2 7 G
from 0 & 0 we con write S(F.E) dv = Sedv > V.E = 3/60

Q. No. 2) What is Heisenberg's Uncertainty Principle? Prove that electron cannot exist in the nucleus using H.U.P. Hisenberg's uncertainty principle states that It is impatible to determine the exact possistion and momentum of purchase a numerable of the Mark of the Momentum of t		2 5.77 NIM 15 C	Total	СО	BL
the mathematically Discolar > 1 The mathematically Discolar > 5 The mathematically Discolar > 1			THE PERSON NAMED IN		
cannot exist in the nucleus using H.U.P. Hisenburg's uncertainty principle state that It is impassible to determine the exact possistion and momentum of paroticle accurately. 1.e. mathematically DMC DPn > th 1.e. mathematically DMC DPn > th An: uncertainty in the possistion. DPn: uncertainty in the momentum. along the a direction	a)	What is Heisenberg's Uncertainty Principle? Prove that electron	A- 1.0		3981
It is impossible to determine possible possible accurately. 1.e. mathematically Dic Dra > th 1.e. mathematically Dic Dra > th 1.e. mathematically Dic Dra > th Ax: uncertainty in the possible. Dra: uncertainty in the possible. Ala: uncertainty in the momentum along the or direction		cannot exist in the nucleus using H.U.P.	_		
It is impossible to determine possible possible accurately. 1.e. mathematically DRC Dra > th 1.e. mathematically DRC Dra > th 1.e. mathematically DRC Dra > th Ax: uncertainty in the possible. Dra: uncertainty in the possible. Ala: uncertainty in the momentum along the or direction	1000	Hisomorgs uncortanity principle since	14		
accurately. 1.e. mathematically DNC DPn > th 1.e. mathematically DNC DPn > 27 th = 1/2 Th is glank's constant Dn: uncertainty in the possistion. Dla: uncertainty in the Momentum along the ox direction		· · · · · · · · · · · · · · · · · · ·		721	
to mathematically DMC DPn > 1. to mathematically DMC DPn > 27 to = 1/2 to h: plank's constant Da: uncertainty in the posistion. DPa: uncertainty in the Momentum. along the ox direction		posistion and morning	3		
An: uncertainty in the potistion. An: uncertainty in the momentum along the or direction		accurately.	NA	5	3
An: uncertainty in the posistion. An: uncertainty in the momentum along the or direction	01	1.e. marhemarically 21	17		
Dha: uncertanify in the Momentum along me a direction	0148/	T = 1/21 h: planks constant			
Dha: uncertanify in the Momentum along me a direction		Da: uncertainty in the posistion.			
along me a quoection		Dra: uncertanity in the Momentum		1	
	Mac a serve	along me a direction	10/3030	3 (15)(3)	H
	(1) A	Now, Let us assume if an electron	13/11/		
can exist iniside a nucleus.	do La	can exist iniside a nucleus.			11

and the classe workers are another are a skinger and a series

The radius of of the nucleus of any atom is the order of 10's m so that if an electron is confined in the nucleus, the uncertainty in its posistion will be I the order '20' = Dx (say) i.e. drameter of the nucleus. But according to Hisenbergs uncestanity bomaifle $\Delta x \cdot \Delta P_n > \frac{t}{2}$ $\Rightarrow \Delta P_n \geq \frac{t}{2\Delta n}$ -. Substituting the values we get she > 1.054 × 15 34 2× 10-15 $\Rightarrow \Delta l_{\alpha} \geq 5.27 \times 10^{-20} \text{ kgm/s}$ Afe will tranform as Afe = Me Ave

We know that the momentum toansfoom's as P=mv

where me: man of an electron

Ne: Velocity of electron

1. 10 - 11

 $\Delta V_e = \frac{\Delta P_e}{m_e} = \frac{5.27 \times 10^{-20}}{9.11 \times 10^{-31}} = \frac{5.78 \times 10^{-10}}{9.11 \times 10^{-31}}$

The uncertainty in the Velocity of electrons comes out to be 5.78 × 108 m/s which exceeds the speed of light Hence a Contradiction to our assumption as to Such a enomous Velocity which is not Physical.

Derive Schrodinger Time dependent Wave Equation. b) Consider a particle of mass m' moving with velocity v' having total energy E associated is given as E = K-E + P.E. EZP2 + VA - 0 where P: momentum & V: Potential As we know that the particle has warefunction p(n+) associated with it along ets trajectory when in The wavefunction can be wortherney

4 m,+) = A e 1/4 (Por-E+) differentiating equal with x' Of(m,+) = Aeit (px-E+) i/4 (P) defferentiating once again wirt 2 we get

All (px-Et) (i/t)^2(p)^2 $\frac{2^{2}\psi}{2\pi^{2}} = -\frac{p^{2}}{4^{2}} + \frac{(m, +)}{4^{2}} + \frac{p^{2}}{4^{2}} + \frac{h^{2}}{2\pi^{2}} + \frac{h^{2}}{2\pi$ Now differentiating eqn @ w.r.t t'

The (Ae'k (PM-Et)) = -i/E f(M,t)

The the contractions are the contractions ar $E = i \frac{1}{2} \frac{2 \cdot f(m,t)}{m} - \frac{1}{2}$ (m,+) be 8+ + tout and sund substituting egn (4) & 3 in egn (1) we get $\frac{it}{\sqrt{m,+}} \frac{\partial \phi_{m,+}}{\partial t} = -\frac{t^2}{2m\phi_{m,+}} \frac{\partial \phi_{m,+}}{\partial x^2} + \sqrt{max} \frac{\partial \phi_{m,+}}{\partial x^2}$ After simply-fing we get $\frac{it}{2m} \frac{\partial \phi_{m,+}}{\partial x^2} + \sqrt{\phi_{m,+}}$ $\frac{it}{2m} \frac{\partial \phi_{m,+}}{\partial x^2} = -\frac{t^2}{2m} \frac{\partial^2 \phi_{m,+}}{\partial x^2} + \sqrt{\phi_{m,+}}$

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	continues of north and agent	2140	Mary I	
	15.00 = 3004/5000 0000 = 3/1			1
Q.No. 3)	Solve any one	Total marks	СО	BL
a)	Explain conductivity and mobility. Calculate the conductivity of a Ge specimen if the donor impurity added to Ge is 1.5 x 10^{25} atoms / m ³ . Given mobility of electron is 3900 cm ² /V-sec		en.	1
	Conductivity: It is the physical property			
	that characterizes the conducting ability of a material. It depends on			
	the number of charge Coronierde (electron	a		
	material: It is denoteday of the			
	a = 9 (ye +yp) n where			
	9= Charge of the consider 1.6×1019c			
	n: Cornier Concentration Me: mobility of electron			
	of mobility of holes.			
	mobility: The mobility is defined as to magnitude of drift velocity according by the charge carriers in a unit of	n		
	huthe charge cooriers in a unit e	erector's	field	,
	of the state of th			

The mobility is denoted by 4 : $y = \frac{V_d}{E}$ where V_d : drift relocity of the charge corried E: Applied electric field. Givendata: ne = 1.5 × 1025 atoms/m3 Me = 3900 cm²/ v-see = 0.39 m²/v-see To find: Conductivity Formula; a = eyene = 1.6×10 × 0.39 × 1.5×10 : 0= 936000 U/m A findensh in all chanding Total 100 CH + All) A = C

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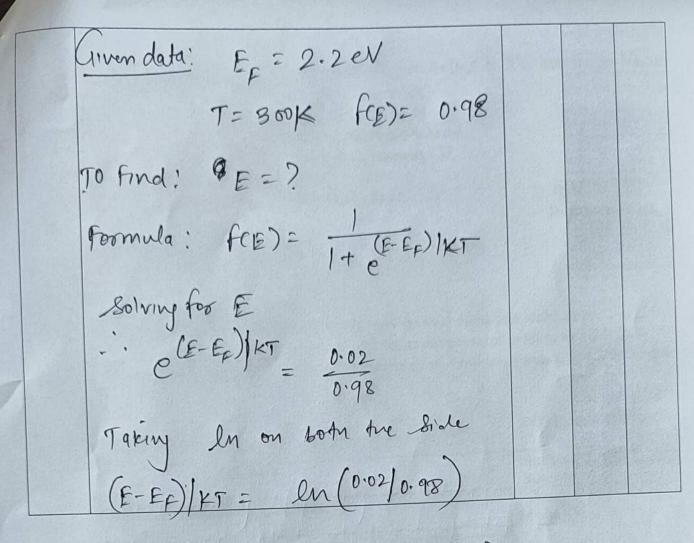
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thought property of the population the there is no market agent and

Edward propose to beet with min compact the the standard and allowed the tox colders to 200 Explain Fermi-Dirac distribution function. If the fermi level in K is 2.2eV, Calculate the energy for which the probability of a) occupancy at 300°K is 0.98? The probablity of finding an electron in The energy state E at the temporeation 7.0 (1 T is mathematically empressed as Fermi-Dirac distribution. F(E) = (E-E)/KT where K: Boltzman Constant E: Fermi Energy and T: absolute Tempreature. 1) AT T=OK & E < Ep | E-Ep is negative :. f(E) = 1+ = 00 = 1+0 = 1

F(F)=1 implies that all energy levels lying below Ex are occupied by the electrons. 2) AT F=OKSE>E= E-E is positive : f(E) = 1 = 0 f(E)=0 implies that all levels above E use vacant 3) At T>Ox 8 E=Ep E-Ep = 0 -'. F(E) = 1 = 1 = 1 FCE) = 0.5 implies the ocupancy of of fermi level at any temporative above OK is 50% monds in a second (ELE) EF (EXE) 1 7 717 3 75 7 307 1



Substituting the values & xi in el meget $E = 2.0993 \, \text{eV}$

is 0.98 is 2.0993eV.