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MD IFTAKHAR KABIR SAKUR

 25^{th} BATCH

COMPUTER AND COMMUNICATION ENGINEERING

International Islamic University Chittagong

COURSE CODE: CCE-3511

COURSE TITLE: Electro Magnetic Field

COURSE TEACHER:

<u>Hassan Jaki</u>

Lecturer CCE

CCE-3511] Flectro Magnetic Field & eblait 23 Field I have green black Field I have gote not variant with time they are produced 10 Broche Charges on Prelate Field - Freid State Magno Steady Magnetic Fieldsvilsbore Steldsvilpsröduce by steady cubicity These wie the fields which are constant with time. grand c Dobjectives: - noitspoilgan 1-, would principal ?--> App of Ms Field , + will (coursed (--> Faradays induction law, Blot-Savart law and Force law for current element -> Energy stoned in Magnetic Field -> Energy stoned in Magnetic Field -> Energy stoned in Magnetic Field -> Energy waves In Em waves:-Objectives:--) Application of EM wave -) wave equations & solutions -? wave propagation -2 wave propagation characteristics -2 wave in conductors, & dielectrics (does not allow

Electrosstatic Flelds

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ES Fields are also Called static electric Fields on steady electric field. These are not variant with time. They are produced by static charges on charge distribution. Steady Magnetic Field Static outset glissite outset Applications, of relectrostatic phases ud -> charge Distribution, Implying a sugar deinder > Coulombs, law, + Application + limit picker (1) -> Grauss's law + " blog an 10 991. -> poissions & Leplace Equations of has -> potential Function hardle fibraria --) Energy stoned in ES Field 12) Em wows: abderererives:-

- PPRLication OF EM CHONG

) wave equations & solutions

War al pstupogaction Characteriustics

Line Providuetory, & dichertales literates

(Coulomb's law (Coulomb's law) $\vec{F} \propto \frac{g_1 \cdot g_2}{(n)^2} = \frac{g_1 \cdot g_2}{(n)^2} = \frac{g_1 \cdot g_2}{(n)^2}$ =) Coulomb's Lawinistates that there enjots a Fonce between charged bodies & it is -) proportional to the product of the two charges mild statx 128.8 The Ponce also depends on the medium in which the charges are located. The Fonce is a Vector quantity & Tit is attractive if the Charges are unlike & repulsive if of the charges are alike, reprovide quitte · ~?, Mothemati cally Ee= $\int f \propto \frac{g_1 \cdot g_2}{pr} \times cop$ where k=a $F = K \cdot \frac{g_1 \cdot g_2}{pr} \times a_p$ Constant of proportionality Unit = N (newton) = / 476

E = permitivity of of the medium in which the 0000 charges are located (F/m), 8 2 $= \mathcal{E}_{p} \mathcal{E}_{p} \mathcal{I}_{p} \mathcal{I}_{p}$ 0 1 (1 0 0 0 9 9 9 (0 = 8.854 × 10-12 F/m 20 Brown 1. Owt e Epodotelative permitivity of the medium with 1 37 1 0 devides ni multiment no chrageb alle sonst sur 0 0 0 Kin Bree space beaded onle sogiest Ri & 0 6 2 0 ۲ an = Unit vector along the line joining the e? two charges. Allo are opinto no, modhemalicety Fe es 10 for <u>91,80</u> - colo F= k. 1191 St. x an Were k= a. To tristerio? pt U origitaddadd (notider) M = tirel

Fonce afon 92 due to SI in Force space is written in the form of $F_{21} = \frac{9_{1} \cdot 9_{2}}{4\pi \epsilon_{d} r_{1}} + \frac{1}{62} + \frac{1}{62}$ 10- itto M $F_{12} = \frac{g_1 \cdot g_2}{1 \cdot g_1 \cdot g_2} \times a_{12}$ origin of a breathrage coordinates system & a second chee Be, and + - 10 miles manipulation the G Coldin. End. The Honce the sall to on the million they are in three spined. I maken in sharen in the spine of the sharen in the sharen i $(\gamma_{i},\gamma_{i},z_{i})$ $(\gamma_{2},\gamma_{i},z_{i})$ $(\gamma_{2},\gamma$ (n_2, y_2, z_2) million mi = ny ân + y ây + ZI âz 2 an + 920ay oft 22 az 101- = 18 1 = $(n_2 - n_1)\hat{a}_1 + (y_2 - y_1)\hat{a}_2 + (z_2 - z_1)\hat{a}_2$ la de la companya de

 $[n_{21}] = \sqrt{(n_2 - n_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$ 939 0 $\vec{n}_{12} = (n_1 - n_2) \hat{a}_n + (y_1 - y_2) \hat{a}_y + (z_1 - z_2) \hat{a}_z$ $\begin{bmatrix} n_{12} & (n_{1} & y_{1}) &$ 0 0 Meth-01 0 -0 5 A charge of SI = -10 Mc 1s placed " at the . Origin OF a rectengulour coordinate system & 0 30 a second charge, 92=-10 mc, is placed on the the manis at a distance of 50 m from the \$ \$ \$ \$ 0 Origin. Find the force on St duc to Sz if 6 they are in Bree space) by Cm 19 2178765 neter 2 ATOZIA 0.5m Z(NT Answer - 360an N 5 91/0.00 02 51 (15, 16 + 16, 124) € 9, = -10 me == +10 x 10-60 + mg st P9 $\hat{\sigma}(\mathfrak{S}_2 \mathfrak{T}_1) + 10 pic(\mathfrak{T}_1 \mathfrak{T}_1) \mathfrak{b}(\mathfrak{x}, \mathfrak{g}^3(\mathfrak{C}_1) \mathfrak{T}_1) = \tilde{\mathfrak{s}}_1$

171 Field, due to iswiftedentity F12 = ? Field due to sube-lace density, we know $F_{12} = \frac{9_1 9_2}{4 \pi \epsilon_0 \eta_2} \times -\hat{\alpha}_{12} + \hat{\alpha}_{12} + \hat{\alpha}$ Constider an infinity charged alles lying in my plane. Assume that the typice of survey $m_2 = 50 \cdot an + 0 \cdot ay + 0 \cdot a_2 = 0 \cdot 19$ $\frac{10}{p_{12}^2} = (0 - 660)a_n + (0 - 0)a_y + (0 - 0)a_z$ The sheet excleredy Fraum for the or in both it is a off - to directions. It is instanting the though [12] 5F Jun (-50) 57 tor = 50 bloth with Component. $\hat{a}_{12} = \frac{m_{12}}{|m_{12}|^2} = \frac{\pi}{50} \hat{a}_{10} = \hat{a}_{10}$ unter loitneres 146 A poxide x 410 x10 x 9x10 x (ân) $x = 11F_{12}$ is the approxide x 40 x 10 x (ân) = -0.036 än Newton

Field due to swiface polensity:-Field due to surface density, $\vec{E} = \frac{p_s}{2\xi_0} \hat{a}_n \hat{f}_n \hat$ Consider an infinity charged sheet lying in x-y plane. Assume that the sheet ois it uniformly charged. Of + child is of and of Consider a strip of a differential width of dr. The sheet extends from - as to a in both n & y directions. It is obvious that the Field does not vary with n or y due to symmetry. Now there is only z component. E (1)

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By definition, Bs = <u>d9</u> <u>d8</u> <u>d8</u> <u>in an infinite</u> <u>AAP</u>, <u>in an infinite</u> <u>swetace</u> charged sheat

 $dg' = (dP_3)ds' + bpoold positions for the first of the set of t$ 1) For al differential ristrip of width dry in the have PL = Pgdindo - y no triby a to The field at a point, A ong z axis is given by, de prices du aloit otte large at alse the costs mormal to the plane of the Herestimold From For a Bin States Here ra= vzr+n COSQ = Z/m $\therefore E_{Z} = \frac{p_{s}}{2\pi\epsilon_{o}} \int \frac{z^{r}}{(z^{r}+n^{v})} dn$ $=\frac{\beta_3}{2\pi\epsilon_0}\left[\frac{-\tan^2}{2\pi}\right]_{-\infty}^{\infty}$ that is, $E_{Z=} = \frac{P_3}{2\epsilon_0}$; $E_{Z=} = \frac{P_3}{2\epsilon_0} = \alpha_Z$

DIF the switcher charged sheet lies in y-2 plane, the Field at a point on n-ands is 5 00 10 10 $\vec{E} = \frac{p_s}{2\epsilon_s} \quad \hat{a}_{n,b} \quad \hat{a}_{n,b} \quad \frac{2b}{\epsilon_b} \quad \hat{c}_{b} \quad \hat{c}_{b}$ 9 Dimitarily if it is loop in not zo plane, the field -at a point on y-anispits, it would T revie ai et de $\frac{1}{2} \frac{p_{go}}{2} \frac{p_{g$ -* -3 In general, the field at a point ion () the axis normal to the plane of the 5 sheet is given by $p_{1,2}$ of Unitform charge $E = \frac{P_s}{2E_0} \cdot \hat{a}_n$ Density, H A. 18. C. A. Cose - M $\frac{1}{2\pi\xi_{0}} = \frac{1}{2\pi\xi_{0}} = \frac{1}{2} =$ HALE, EZ= 195 ; EZ= 193

[fot contract] Meth: An infinite sheet moonly plane entending From - a to d'in both direction has, most auto d'in both direction has, autorit approved density of a to ne mit Find with electric Field at Z = 1.0 cm => twe knows the => $\frac{1}{E} = \frac{p_s}{2c_0} \times \hat{a}_z$ $= 10 \times 10^{-9} \text{Cm}^{-2}$ $\frac{10}{10} = \frac{10}{10} \times 10^{-9} = \frac{10}{10} = \frac{10}{$ = 564.71792 V/m Drob Mour = V Blanis Field due to volume chorage Density Determination of field due to volume charge density simply involves the estimation, OF total charge, & From Pr, E= 9 4x6pr : E= of Pr 4x6pr dr ân (r)

potential at a point due to a fined 6 Ó charge is defined as the work done in bringing one Coulomb of charge From infinity to the point against the Force created 1 by the Fined charge, that is, ۲ 0 -T the potential is work done per unit? -01 2 Chourge 11 -6 G 1 View work done to bring a charge & From ~= g of x12000 x 3 g --0 0 Simply, V = work Done Je1 or, volt service smulor g. wb blaig ٢ 0 History Determination of field due to volume change density simply involves, the estimation at total charaged, & tracent by,

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potential at a point y foury The potential at a point due to a point Charge is given by, de the war in the - 415- 20 2 SJ.ENN potentialio at a point JUP T A WO -0 Notetorree, them will reveal or Donsider a Fined (1) TU. MAI ETT I SPINT charge, 3 and 10 sone out in the IC of charge at an 1 31.10 Mare 18 înfinite distance. K 2 -> There exists a tonce on IC, by S. IF 1C Jan 1 Soffree II all's ------@ IF IC is at point B miter of the charge is moved against the which is at a distance of Some work has to x from g, then Force on 10 be done. due to g is, F= 9 4740.nr · Regan as no S -ch no la 4A Co

proof-9polgartial at 11 4 point 10 In F= 9 47400 policy is the solution of 100 solution of in 0 () 10 Charge , By ... Biven by Here, 0 () novote:-0 W2 FS. J & Charge UT That Force -1 Thits is 1 - 1 C charge a. dw = Fan Cos 180° force this org tavisto (Demoidere à fined -(94 tros = 5. Fdre 19 किला याद्र यात छा एन -1 21 AZ Force 180° angle 1 of charge at an (9) अ काहा कारहा infinite distance, 02 Come to 1 There Jonusta affines JUDE mander I' | DES -0 3) III LC is at point I triog the si DL III (estructor is at a distance of more for in a superior the -10 0 ٩ 1 due to the is him 10 1 0 • $= -\frac{9}{4\pi c_0} \int \pi^2 dr$

 $=\frac{9}{4\pi 6} \begin{bmatrix} -\frac{1}{1} \\ -\frac{1}{2} \end{bmatrix} \begin{pmatrix} 1 \\ -\frac{1}{2} \\$ george = Find the spotential at a point. $= -\frac{3}{4\pi c_{n}} \left[\frac{1}{2} + \frac{1$ $= \frac{9}{4\pi \epsilon_0} \int_{-1}^{0} \left(-\frac{1}{r}\right)$ $e_{o}W = \frac{9}{4\pi\omega r}$ Hence $N = \frac{9}{4\pi\omega r}$ UNCON X SAN W. S. Cocm : 0.1 m. 10-116124 Cutxe

Math Math A charge OF 10 PCI is at stest in Pree 3 0 0 space. Find the potential at a point, 0 A 10 cm away From the charge $\frac{1}{2} \frac{1}{2} \frac{1}$ 9 4567 2 UJ ° = 47.40 × 9/8P 0 = 10 pc = 10×1012200011 r 210 cm we know, $\frac{1}{4\pi 4_0} = 9\times 10^2$ =0.1m5 10×1012 _ x 9x109 0.1 10 0.91

potential Difference

(तिरुव मार्श्वक) /// The potential Difference between two points A & B is defined as the work done by an applied torice tim movings a quant positive to charge intromitile to Bring electric Field. The work done by W=18-90 Este dbrotzy? $(\nabla \nabla I) (\underline{\nabla} I) (\underline{\nabla} \nabla I) (\underline{\nabla} \nabla I) (\underline{\nabla} I) (\underline{\nabla} \nabla I) (\underline{\nabla} I) (\underline{\nabla} \nabla I) (\underline{\nabla} I) (\underline$ VB+ps. V. J. From A to B De potential différence between ARTB (111) also described the as the difference between the potentials at A & B. VA2 - JE. dL VB = - JE: dL VAB = VA - VB

(potential Orpadient) Potential Guradient = VV Kov=16 Vector, differential popercator & v aviliand timpis a scalar potential. beiliges as 2 =) The potential gradient in different Coordinate system 1837 age given by not sould all (U(VV) contesian = Sr an + SV an + SV ay + SV az (i) b(www) cylindrical = $\frac{SV}{Sp} ap + \frac{1}{p} \frac{SV}{Sq} \cdot ap + \frac{SV}{Sz} az =$ $To of A monthly cal = <math>\frac{SV}{Sp} ap + \frac{1}{p} \frac{SV}{Sq} \cdot ap + \frac{SV}{Sz} az =$ (iii) (IV) spherical = Sirvira, Thill is voider Spherical = Sr apt bodiropp ogla (). En & A Lo aboltrationesq 19 pourted 1 HE. JE. JE. HL 16.7 (= = er $\mathcal{B}_{\Lambda} - \mathcal{U}_{\Lambda} = \mathcal{A} \mathcal{U}_{\Lambda} , \mathcal{A}$

Mathing 1017 Signable

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VE

problem: __ IF the potential Function, Miss given by V= n³y - ny + 32, Find) thet potential gradient. Losskieib unt co bourflob el HIC-Elephia Flight, Sap y=19, Coulomby Mula Solution: - Electric debrinded of the single v= n³y - ny + 3z electric Lorgestriche demonstry, that is, we know, cir ebig f= 4 aut sidset $\nabla v = \frac{SV}{Sn} \hat{a}_n + \frac{SV}{Sy} \hat{a}_y + \frac{SV}{Sz} \hat{a}_z$ [Hisrod: Juli Joint States II] on Electroic Automation (Bertrifter) J's definedens, no = 3 my my my man - 2b = C Subarry the different flunc according by Strangering the grides of the g lemmon . firsten 22 22 y wenter of the to $\frac{\delta V}{\delta yz} = \frac{\delta}{\delta z} \left(\frac{n^3 y}{n^3 y} - \frac{n y^2}{n^3 y} + 3z \right)$ = 3 $V = \left(\frac{3n^3 y}{y} - \frac{n y^2}{y} + 3z \right)$ $+ 3 \hat{a}_z \quad V m^1$ (Amy)

Electrie Flux 1001

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电 multilistalsontknown as Electric Displacement I Fluxit act your - Brit V you > It is defined as the displaced charge, that ۲ e is Electric Flux, & y=9, Coulomb 6 > Electric Flur is defined as the switche 6 2 integral of electric flux density, that is, 2 ۲ (2 1 worx sul C Ċ 0 (e e 1 .-=> Electric Flux (Density, D 15 defined as, 10 10-1 6 $D = \frac{d\psi}{ds}$, an $\mathcal{M}C/m^{2}$ gives = (where p is the electric Flux according Otossing the differential area, d.S. The direction. (OF ds is always outword (anzjas), normal to ds, (38 + MAU - 666) 5 Bornet is de = dean 36 542 + 3 & E Vm 19059

Definition +0211911 100 200 Electric Field diensity of Dall boll colols 1 Flun DE E E Divid mi2 sinting bradio, grous Es = permitivity of Force space; F/m Man and inter showing one when in rules the E = Electric Field Strength, V/m Los Matha (P. P. Sris & delp. (f. ٤ It an electric Field in Free space is mot given by E= an + 2ay + 5az Vim 1 北江 (学 Find the electric Field Idensity d'Hi baA => Electric Field, E = an + 2ay + 5az $\varepsilon_0 = 8.854 \times 10^{-12} \text{ F/m}^{-12}$ $D = \xi \cdot E$ 8:854 ×10 12 (ax+2ay+5az) 1 10 8 Ø D= (8.854an+17.7 ay+44.27az), PC/m It states that the net Flux passing through any closed surface is equal to the charge enclosed by that surface. Hind in the charge (contar and that surface. Hind in the charge - treating and the charge of the charge of the charge

=) It is known as Grauss's, law in integral form.

And it is also applied 1 mill Groussian 11 surfaces.

A spherical switche which encloses a charge 9 at its centre.

D= (18:854 An + 17.7 AN + 44.87 9=) = (

anast The differential area ds, is on the surface of the sphere whose direction is an. Let n But, be the stadius of the sphere. The electric field E, at the spherical stand of the spherical sphere of the sphere o $E = \frac{19}{4\pi\epsilon_0 r^{\alpha}} \cdot \frac{19}{4\pi}$ But, Dit Core = Gright an Eksenteinen Poisson Andre Laplace Billing Taking dot product with ds on both sides, we get, Brank spalgoul orsering (= D. ds = $\frac{9}{4\pi p^{\prime}}$. an . ds. amitsupp Erroring Here, ar & an have the same direction april 9 $\therefore D. ds = \frac{g}{4\pi r^2} ds \qquad 0 = \sqrt[n]{7}$ Jet, $\oint D \cdot ds = \int \frac{g}{4\pi n^{r}} \cdot ds = \frac{g}{4\pi n^{r}} \cdot \frac{g}{g} ds$

The dilforential wither tas in the Contraction of the salt of the stingent where, ding a hor is an to But, S= 4mm, avea of spherical, So, Il loss of the spherical, So, 9 D. ds = 9 Hence proved (2) - 7 poisson's & Haplace's Equations 1. POISSONS And Laplace Equation 12 King doit preduct iter the de on both aides =) poisson zo Laplace ATAG , tog sul polsson's equation, et . no. wints = eb. C. 7. v = - Pro & Laplace the Equation, with event of 2 nd 2) V ~ 20 . ds . ds . oz v V The point form OFB Grauss lew is, Brilling $\nabla \cdot \mathbf{D} = \mathbf{P}_{\mathbf{T}}$ eb: $\mathbf{P}_{\mathbf{T}} = \mathbf{P}_{\mathbf{T}}$ eb: $\mathbf{P}_{\mathbf{T}} = \mathbf{P}_{\mathbf{T}}$

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But, 1 Drzie Emil auf Dra miliburge eboulgs. 1 mr to and, V.D= V.EE $\nabla \cdot \mathbf{D} = \nabla \cdot \boldsymbol{\varepsilon} \boldsymbol{\varepsilon}$ $\nabla \cdot \mathbf{D} = \nabla \cdot \boldsymbol{\varepsilon} \boldsymbol{\varepsilon}$ $= \nabla \cdot \boldsymbol{\varepsilon} \boldsymbol{\varepsilon} (-\nabla \nabla \cdot \boldsymbol{\varepsilon}) \boldsymbol{\varepsilon} \cdot \boldsymbol{\varepsilon}$ $= \nabla \cdot \boldsymbol{\varepsilon} \boldsymbol{\varepsilon} (-\nabla \nabla \cdot \boldsymbol{\varepsilon}) \boldsymbol{\varepsilon} \cdot \boldsymbol{\varepsilon}$ O = 1 - OPEN 1 1 W B + W W B = W W Multi in in $: \nabla^{v} V = Pv$ 1 Maundanty Condition 200 F & D Here, ∇^{r} is a scalar operator $\left(\frac{1}{m^{r}}\right)$ and is Called as Laplace's operator, Initropprost entry $\overline{V}^{r_2} = \frac{S^{r_1}}{S \chi^r} + \frac{S^{r_1}}{S \chi^r} + \frac{S^{r_2}}{S \chi^r} + \frac{S^{r_1}}{S \chi^r}$ In the stegion where propagion Poisson's equation be comes mi a Ho ball 20 emost all 81 any boundary. V.V = 0 L'aplaces equation in one dimension, et ? a cross acry boundary with at the surrice Untrop Sign mit , material pros with 70 Dry - Dry = 13

Laplace's equation on two dimension, [11] STAV + STY = 0 = VIV IS VED V Laplace's equation on three dimension, Vr = Jrv + Srv + Srv =0 Boundary Condition on E&D co, Visis a scolor operator (mail and is DThe tangential component OF Elis Continuous across any boundary, that 1s, Etans = Etans + 18 Or, The tangential components OF Ering medium 1 as that OF E in medium? 13 the same at any boundary. OF YYA The normal component OF Dis Continuous across any boundary except at the swithice OF the conductor, In general, $D\eta_{\perp} - D\eta_{2} = P_{3}$

Ps = Switace charge density (cm-2) Por any point other than the conductor. bon boundary Dri = Driz UD proof of boundary conditions: Consider "I the riectingular loop on the boundary 07 two media, be sur off 20 - Exit - Experiment Eyil Eyil Eyil Eyil Durdaugu HI 12 muliparir rife 153 straingarian Joil rojant (an) worth En . Rectangular loop on boundary It is well known that electric field is conservative & hence the line integral of E.dl 18 A suborn Zero around a closed path, \$ E.dl = 0 Boundary F TAS nedicing againstruteal San Free - ON 009

According 11, to, 1 Grayss's laver 1, 17

Ming Dids = 01 surface / Migranie

Applying this to cylindrical surface on the boundary spreading over medium 1 F medium2, we get, sh to all'st Smilling 13 - Pone 43 = Brighing Jog notust $Dn_1 - Dn_2 = \frac{g}{48} = P_3$ (61 bord) - Dn1 - Dn2 VEPS = = = blolf - sigterel = DRIVEN O Iniv (Hence proved) all high bight bight bight St = Find point lationing alle Statest point change 1.C. My = 1 Location of frided charge 1/1 At = Location of test charge Then the Force on SE due to Firsed charge in Force space Sp is given by,

A'A , Electric Field / Electric Field on C2 0 Artnength/ Electric Field, intensity Ch-0 ١ Mephyma this to entircled Surface on the 0 Electric field due to a charge is defined 9 3 2 as the coulomb's force per unit charge. 2 0 It is a vector & has the unit of -2 1 Newton per coulomb on volt per metre, 2 2 ٠ that is, $g = \frac{g}{8b} = end - ind$. (T Electric Field, E = F 29, N/21 11 5 1 Electric Field Strength Due to Point Charge !-3 Ø 9F 2 Fined point charge, C 8t = test point charge, C NF= location OF Fined charge "t = Location of test charge Then the Force on St due to Fixed charge in Free space gf is given by,

FtF = 9t. 9Fic hildat pull, ENTRE such Part cleethic field due to grate a distance The electric Field, E at the location of Bt due to SF is defined as the scatio OF Force on ge due to Spri and the test Charge, gt, that is, 16 gr of Fi $E \cong \frac{F_{4F}F_{tF}}{g_t}$ E = QTE . alt, N/e 47607+F . alt, N/e Electroie Field due ta time charge Density:-By definition, line charge density is given by. $P_L = \frac{dg}{dl}$, C/m

dg = R dL $g = \int R \cdot dL$

Here gris the total charge? But electric Field due to g'at a distance The electric Hipted, Eyd and Stored of The scation of OF BI dependents defined 18 defined 18 - He scation an E test 4 Mar of and tonce on st PROLINATION 18, JONNEL 18, JPS JONNE E= 47 6 2 Edie Fit



Steady Magnetic Fields It is Constant. with time, Steady Curvents, produce, steady magnetic Fields. It is also called as magnostatic Magnetie Field intensity, HU berreito si HI Magnetie Field intensity, HU berreito si HI Fields. Magneti en Flux Density, B's pri poplariont. Their stellation, "B'= uff Jog in mort ing Distady Magnetic Fields are governed by Biot-Savart-Law & Ampere's cipcuit law. 4 Fundamentals OF Steady Magnetic Fieldy Magnetici fieldy are also called static magnetic Fields on Magnetostatical Field s. These are Build produced by a magnet or by a current. - element. (-) K The two ropposite ends of a magnet are called its poles. Bis about defined as , B = filt

Dagnetie Lines OF Force/Flux IT is constant with time. Contain the other off Sile ugy Ring a the string the first and the general the Fields, It is a life of magnostatic . Haig It is observed the impon fillings arrange themselves in a set of porallel lines going goi from one pole to another. These lines Choss of unite These are called the magnetic, lines of Force / Flun. Magnetie Flux :- 1 Lines of force produced in the medium surgrounding electrico currents l'on magnets Magnetie Flux T density (B) (wb/m2) (1) produce de by An Force, P = (B, ds), weber elegnent. र्ज (-) 'राख मार्व B is also defined as, B= Mett

H= magnetic Held (AIm) N= permeability of the medium (HIm) Cob/m = No This day here etters a modifie Mo = permitibility of Free space Manuel = HTSUXID-7. Eltiment Econogram My = Relative permeability of the medium. Current Element:-A covorent elementrosis, à conductor Covorying Current. It is scopresented by IL. 1 her mach Hells I= Current trèse reoriductori? siter Bom = Hb (m-A) strendly math 1 list august (A) - math (A) Magnetic field 1 H = 3kin + 2ay . AIm enists at a point of in Force space , what is the magnetic Flux density at the point? -=) Here, H = 13 an + 2ay million trends. $N_{en} = 4\pi \times 10^{-7}$ No = 41-X10-7 ·· B= NoH= (4 xx10-x) (3an+ 92ay)

 (π^{-1}) $(3.76an + 7974 2.513ay) x10^{-6} w6/m^{2}$ = 3.76 an + 2.513 ay recub/m? ... Mo partility of Thee space Amperie's law Hon Guvident element BIOT - SAVART LAW Currolo H Algunant Biot-Savort law, is given by miles institution A dH = <u>IdLxap</u> -4mp I = Cubitant dt= magnetic Field at a point IdL = differential current element (A-m) an = Unit avector, along 11theb line it blining eit sithe point soppor and withe treal of to r = Distance of Philipping the current element. (m) voc + woll - H (sould (-F-aD-A) = wh · B= AcoH= (9 KK10) (30+ 82 ay)

Statement OF Biot-savant Law?-Curro differential current produces a differentials magnetic field, dH. The field magnitude at a point is proportional to the product OF IdL, and sign of the angle between the conductors & the line OF the point to the conductor. It is also inversely proportional to the square distance From the element to the point. IF the current is upward, the direction of M magnetic Field is anti-clockwise and if the Currentries tradownwoord, the direction of Bd magnetic Field is clockwese. pro 9718 = H To Find it out easily we use right hand with the thumb. IF a coverent i element is held in the right hand with the thumb pointing upwords indicating the direction OF Current, then the remaining Fingoy indicate the direction of the magnetic field.

IF the current is upward, the direction of magnetic Field risson anti-clock wish & if i the covent is downwords, bthe direction 10 Fb magnétic qui field is clockwise to but in porri to the product of Idl, and sign of the angle bothicin the set of the fine OF the point to the Conductorizing 15 also E Field due to infinitely long ewovent Element: The Field produced by an infinitely long courte element at a point is given by, $H = \frac{T}{2\pi\rho} = \frac{1}{2\rho} + \frac{1}{2\rho} +$ proop!- the we we ptrom the delement Lith The Minne, Gi in the sught It a coursent the sught hand with The month of a point in the sught the then then the indicating. the colline of the of a contraining Ainges indicate the the of the ction of the mugnetic field.

By Blot - Savaret, law we have in 1 It wordt in this dement. Id L & no this forment. Id L & Double a growth Human Human Human Human Human A. A Double a Con The This and Human Human Human Human Human Human A. But a de sind = mator o trompils of a ingle moder to to the the showing algorit i - i to « point l'and on other and iction while -i-d.Hromot under An Bind dor à Sind = Prising 475 B. dor à fising : 1/2 - 1/2 So, If due to infinitely long current element is given by anth this tramels $H = \frac{T}{4\pi p} \int \sin \theta \cdot d\theta \cdot \hat{a} p$ $= \frac{I}{4\pi p} \left[-\cos(\pi)^{1/2} A \cos(\phi) \right] \frac{\hat{a}_{p}}{A}$ $= \frac{I}{4\pi\rho} \begin{bmatrix} 1+1 \end{bmatrix} \hat{a} \phi = \frac{I}{2\pi\rho} \hat{a} \phi \phi$

P Field Due TO Finitie Counternt Element $H = \frac{1}{4\pi R} \left[\frac{1}{2} \cos \alpha_2 - \cos \alpha_1 \right] a_p$ where, inthe inthe internet I= Curvent in the element. R = Distance OF the point from the element anisper' = Onis 16 to tul and angle made by the line toining the ~20 > point and one of the element with The pands of the element. b 1 d2 = Angle made by the line joining the point and the other end of the -element with the ands. Movie PA po ob Piz (garp R PR R SIR - GIAIS John Day 1 802 (S) Z ST. CH 9TTC 61112

The differential magnetic field, att. at [] the poin Produe to I Idle Derpatrice and with dH = in Idl Sind grap bacalo gross trodes Coursesst. enclosed. by The Aprilly. H= J Idl sind a q Blusiborregalismi 4thm a q Ibill b & Hidl = I for a. we have, pr= (Z-L) + R -: = 00mg 10 z-LI = Reated Thus, we get -di = - Reosec & dx Low the matrices $\frac{1}{2} = \frac{1}{2} \frac$ 1.3 anticludicuis. C. (a) = 1 [Cosazi cosa Triag, MAIM H P.Ene 2714 CREATER MARINE

Amperie's work law or Amperie's cincuit Law:-Ampion's einewit Law' Of the magnetic Field H about any closed loop is equal to the Current enclosed by the speth. Mathematically, provide the \$ H.dL = Ienc We have, my (3-4) + R (Bu) aq dL=dLaq proof:-Third, we get -de =-Reoseeix dx Consider (19) cinculor loop as in Figure which enclosed a current element. Let the current be in supworld direction. Then the field is anticlockwise. (aq) H at the point And is given by The H = I enc. ap Proved J. Proved J.

Diffictuantial formili of Ampiera's Cincutt 1.8. 501 Law:-The law is given by sont . Ib. H Manwell's 3rd equation in integral 100 Alm¹) and differential form:and differential form :-= _1b.1f (= According to Ampere's Eincuit law, and, $\vec{\nabla} \times \vec{H} = \vec{I} \cdot \vec{D} \cdot \vec{D} \cdot \vec{D} = \vec{I} \cdot \vec{H} \cdot \vec{Q}$ and, $\vec{\nabla} \times \vec{H} = \vec{I} \cdot \vec{P} \cdot \vec{D} \cdot \vec{D} \cdot \vec{D} = \vec{I} \cdot \vec{H} \cdot \vec{\nabla} \cdot \vec{A} \cdot \vec{A}$ From Stokes Theorem, we have, $\oint \vec{H} \cdot d\vec{L}' = \int_{S} (\vec{\nabla} \times \vec{S}) \cdot d\vec{S}$ This is could the insolutegral form of Mappin's cincuit lists . E]= : JXH = 17 This is Manwell's 3rd egn with integred form.

A THE AM HE SHOW AND A Again, D magnielle Fluie, Demity, Definition JH. IL =) \$ (7xH) . Is 11=1 (F. (HxF)) (Districtions, mot scovert law estatement In Find The Field day To Frinch Ling enter This is manwell's 3nd equation with differential Form on point Form. HARRING DE MARSHOLD or, prover that for a field due to infinited the Interest due to initia. Cintrest clement E Ampliancis more law (Anthemitter) Chairs Prove with a literal integral " to To black made . Arel 1 Br in a closed loop H. Himmini Mining K S Fonce, on a moving lield + airs allers maily first and a loss (Bowndary Condition (Barier briefle) CONTROL TI STRAGING PROCH FORTH PORT PORT

parameter OF Transmission The Can be described in terms of its line parcameters. Reade, which are RLGC (Swith) (101:12) R= Resistance per unit length R L= Ro Inductance (amont, per unit length h = Conductance SXI WWYE UF ALL STUDE Cun Cerpa citan ce (iv) velocily, U = U, U 19: PHACLE SLATH Considerat These all are inclusiformly distributed along the entine length of line Real 11-11-1.3 V SHELDIDIE-To contraction Lossless Transmission _ wild reducing count construction 11 R=0, Gr=0 that meany there are no ohmor ohmie and conduction lossess in the line, on, conductors are perifient to and the dielectric Instraget in caste is lossless, retto all'() L'SNELS PTRI 10

UThe propagation constant, Thick to scemember dans alle h In terms of HJBER & 200 A Joseph 20 = $\sqrt{(R+Jw)} (G_1+Jw) (S_1) + S_1 +$ REJUL ="Reajul = VCJWL) (Jwc) time sol cr+jwcish -> croni Jung > boni Jungek Ubril 622 Conter (tone and plur unit longity = J -j ~ w~ Lee) q= Attenudition 2 Ju VLe (Reduction OF signal) B= Phase shif Constant. (IV) velocity, U = w plar roll's signal's are at different difficiented betraining the at a given time). Vu The characteristic impedance, ZON TN GC+ JUC = / L' Ofuicea induce internet creaters. Distortionless Transmission Line Condition of distortionless inorre tout with 1 - A and ano opposed of mile Gille entre the stand of the line box conditioned and sufficient ac 2 do and the () The attenuation constant (a) is Independent of forequency

(1) The phase shift constant (B) is linearly dependent and to remain the second of On with Frequency The propagation constant, since is constant built bui (Horal Mile and Color Joul) (Horal Color) (Horal) (Hor 是一(唐六正)- $\frac{1}{1000} = \frac{1}{1000} \left[\frac{1}{1000} + \frac{$ F+ FENREX (1+ JWL) sinteres and Fi NRG Tr JWL JRG part of the state $\frac{1}{\sqrt{R}} = \frac{1}{\sqrt{R}} \frac{1}{\sqrt{$ 「(すべう)~~(ちょう) = JRG. t. JWG. t. JW2 . JCh (Hx\$) - --(FXP)·10=(50×7)·17 (5×7)= JR4 + jwJLe 一下: 一下: 二 · RET XRE 0.1.9] B= JWJLC

popriling Theorem & indecating various terms \$Things to scenember, The modified Ampere's cincuital UB: Magnetic Intensity. law op maxwell's 4th law 1st pit of to have on (Magnetic Field $\overrightarrow{\nabla} \times \overrightarrow{H} = \overrightarrow{J} + \frac{\overrightarrow{SD}}{\overrightarrow{J} + }$ strength) Ep. Electric Field Strengh, For vector Calculus topmula > D = Pisple cement Z.(BXI) Mare JA 4th law $=)\vec{E}\cdot(\vec{\nabla}\times\vec{H})=\vec{E}\cdot\vec{J}+\vec{E}\cdot\frac{\delta\vec{D}}{\delta\vec{H}}$ > and electric covert uten and intradational electric flun From vector Calculus, נשתנה שנהוש אולים - ינותה המשועוי Field Cold alla Manual alla $\overrightarrow{\nabla} \cdot (\overrightarrow{F} \times \overrightarrow{G}) = \overrightarrow{G} \cdot (\overrightarrow{\nabla} \times \overrightarrow{F}) - \overrightarrow{F} (\overrightarrow{\nabla} \times \overrightarrow{G})$ KID suchace to talan ale ₹=Ĕ -1 YXH + SD + 7 ₽ = ₹ £ = ∓ D= It is the rector whose magnitude is the electric current density. 毛(らメ児) = 出(ミメら) - ≤(Ē×Ŧ) CERTED -> TXH = 7+ OF ₩(Exマ)-マ(ExF) one of formula of vector = Ē(₹×Ĥ) Calculus 3 1 $\vec{\nabla} \cdot (\vec{F} \times \vec{G}) = \vec{G} \cdot (\vec{\nabla} \times \vec{F}) - \vec{F} \cdot (\vec{\nabla} \times \vec{G})$ = E.J + E. J+ VXE, BY SBY P.T.0 16461

→ 一司(官×雷田)= 戸河北町山50-町(国×司) $\frac{1}{1} = \frac{1}{2} = \frac{1$ $= \vec{E} \cdot \vec{j} + \vec{E} \cdot \vec{S} \cdot \vec{F} + \vec{H} \cdot \vec{S} \cdot \vec{B}$ $= \vec{E} \cdot \vec{j} + \vec{E} \cdot \vec{S} \cdot \vec{E} + \vec{H} \cdot \vec{S} \cdot \vec{H}$ $= \vec{E} \cdot \vec{j} + \vec{E} \cdot \vec{E} \cdot \vec{S} \cdot \vec{E} + \vec{H} \cdot \vec{N} \cdot \vec{S} \cdot \vec{H}$ $= \vec{E} \cdot \vec{D} + \vec{E} \cdot \vec{E} \cdot \vec{S} \cdot \vec{E} + \vec{H} \cdot \vec{N} \cdot \vec{S} \cdot \vec{H}$ $= \vec{E} \cdot \vec{D} + \vec{E} \cdot \vec{E} \cdot \vec{S} \cdot \vec{E} + \vec{H} \cdot \vec{N} \cdot \vec{S} \cdot \vec{H}$ $= \vec{E} \cdot \vec{D} + \vec{E} \cdot \vec{E} \cdot \vec{S} \cdot \vec{E} + \vec{H} \cdot \vec{N} \cdot \vec{S} \cdot \vec{H}$ $= \vec{E} \cdot \vec{D} + \vec{E} \cdot \vec{E} \cdot \vec{S} \cdot \vec{E} + \vec{H} \cdot \vec{N} \cdot \vec{S} \cdot \vec{H}$ $= \vec{E} \cdot \vec{D} \cdot \vec{E} \cdot \vec{S} \cdot \vec{E} + \vec{H} \cdot \vec{N} \cdot \vec{S} \cdot \vec{H}$ NOW, ($\vec{F} \cdot \frac{s}{st} = \frac{s}{st} \left(\vec{E} \cdot \vec{E}\right) + \frac{s}{st} \left(\vec{E} \cdot \vec{E}\right) = \frac{s}{st} \cdot \frac{d}{dt} \left(\vec{v} \cdot \vec{v}\right) = \frac{s}{st} \cdot \frac{d}{st} \left(\vec{v} \cdot \vec{v}\right) = \frac{s}{st} \cdot \frac{s}{st} \cdot \frac{d}{st} \left(\vec{v} \cdot \vec{v}\right) = \frac{s}{st} \cdot \frac{s}{st} \cdot \frac{s}{st} \left(\vec{v} \cdot \vec{v}\right) = \frac{s}{st} \cdot \frac{s}{st} \cdot \frac{s}{st} \cdot \frac{s}{st} \left(\vec{v} \cdot \vec{v}\right) = \frac{s}{st} \cdot \frac{s}{st} \cdot \frac{s}{st} \cdot \frac{s}{st} \cdot \frac{s}{st} \left(\vec{v} \cdot \vec{v}\right) = \frac{s}{st} \cdot \frac{s}{st} \cdot$ Mind stille different SIE (Mind of Fig. S. 18) (Mind of Fig. S. 19) mugnetic fields decreases E. S. (E) = 2E. dE 日からあるし S. E dt Stat Similarly, H. SH = 1/2 SH $\cdot - \overrightarrow{\nabla} \left(\overrightarrow{E} \times \overrightarrow{H} \right) = \overrightarrow{E} \cdot \overrightarrow{J} + \cancel{S} \overrightarrow{E} + \cancel{S} \overrightarrow{E}^{2} + \cancel{S} \overrightarrow{E}^{2}$ =) - $\int_{U} \vec{r} (\vec{E} \times \vec{H}) dt = \int_{U} (\vec{E} \cdot \vec{j}) dt + \int (\frac{S\vec{E}}{2St}) dt$ + J (1/2 St) du

Applying dhiergenes Theonem, Divergence Theorems =) \$ (E × H) · (ds) = fi(E· J) du + J fi(2 E + 4 H) du $= - \frac{1}{2} \left(\frac{1}{2} \times \frac{1}{2} \right) \frac{1}{2} = - \frac{1}{2} \int_{U} \left(\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \right) \frac{1}{2} \int_{U} \left(\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \right) \frac{1}{2} \int_{U} \left(\frac{1}{2} \times \frac{1$ 9s (ExF) is = Total power & having the volume De (1/2 E + 1/2 MH) du =) The state at which energy St du (1/2 E + 1/2 MH) du =) The state at which energy stoned in electric and magnetic fields decreases In the volume. in the volume (1) - Judd E. du =) pourer dissipated in the volume Similardy, H. St. 2. St. Je (Exil) 10 = J. (E. J) dut JUZEE) du + J (HE GF) du

Lossless Dielectric JE vectors whose magnetule JE is electric current G= Surphase 1, density Descive the wave equations in 6 = Swiftice charge density? Θ lossless dielectric. Ans! 11 12= volume charge In lossless dielectric, 6=0, Pr=0 densities D = Electric Displacement diff erential Manwell's equation in B= Magnetic Flux density where Form, E=>Electric Field D=EE vector $\forall . D = P_{v}$ brauss's law B = MIT (#= magnette Field $\vec{\nabla} \cdot \vec{B} = 0$ intensity (-olgon) j= と目 $\vec{\nabla} \times \vec{E} = -\frac{\vec{S} \cdot \vec{B}}{\vec{S} + \vec{S}}$ Craussian Laws $\vec{\nabla} \times \vec{H} = \vec{D} + \frac{\vec{S}(\vec{p} \times \vec{q}) \times \vec{q}}{\vec{S} + \vec{S} +$ The magnetic Fluin B across any closed Q = 1 . (5 Swiftice 13 Zero Substituting, 第30 3.8=0 2. D= 0 - E- Pr fortx Hmagnetic Field = Region where around the magnet シマ・ショー = 0 where the moving charige experience Fonce, シュート 三二 Magnetic Flun, B (=) ALSO, = The quantity on strength J.B Course Revention of magnetre lines Poto Le ced by magnet z) マ·MF=0 三, 中=0 (ii)

and issues 1 Again and har the B 1 VXE THE Strill - Our and and and the second of =) all and all all a sinterior bechard. And, Vxit IP = 147 3 BP 0 TO D Si sicher all in I Taking ean way and Latin an military will be and the ALD. ranot PXIE? ZIM 2118 B De CE using cure an poth sides, V×(V×E) =-V×SE (マ × E) = - マ × SE $= (\overrightarrow{\nabla}, \overrightarrow{E}), \overrightarrow{\nabla} = (\overrightarrow{\nabla}, \overrightarrow{\nabla}), \overrightarrow{E} = \overrightarrow{\nabla} \times \frac{S \overrightarrow{B}}{St} \qquad [A \times (p \land q)] = (A \times c) B \qquad (A \cdot B), c] = (A \cdot B), c]$ => OS TENE X SHAF EN EN E =0 STATOSA (D) 0-5.50 => == == ZI , E, = MUM TOS (= XH) MI J. O = O. =) L- P. TE = M ST (SP) smother and St (SP) D = 5.55 => 2 ~ The Ender M St MEE? And this is call the equation in terms of のこれ、小田にの E. (II) ---- (II) · · · · · (II)

Sinospidal time voucation. on time harmonic Form, mail Lebiscould mil $\frac{\delta}{\delta t} = \frac{1}{2} \omega$ L. C. Milder U. 6. - 142 $\vec{r} = -\vec{r}^2 \cdot \vec{E} = n \frac{s}{st} \cdot \frac{s}{st} \vec{E}$ $= \Lambda(\overline{J}\omega)(\overline{J}\omega)\cdot \overline{\zeta}\overline{E}$ Now, taking $Q_q^m - (Y)$ hour (yrod) $\overrightarrow{\nabla} X \overrightarrow{H}^2 = \overrightarrow{7} + \frac{2}{3} \overrightarrow{D}^2$ Taking curd on both. Side, $\overrightarrow{\nabla} x (\overrightarrow{\nabla} x \overrightarrow{H}^2 - - -) = -2 first a state of the state of$ $\nabla_x(\nabla x H) = iot \nabla_x(\frac{1}{2s} \frac{s}{st})^{ih}$ (if (1)) $=)(\overrightarrow{\Box},\overrightarrow{H}),\overrightarrow{\neg}-\overrightarrow{\Box},\overrightarrow{\neg}),\overrightarrow{H}=\overrightarrow{P}\cdot\overrightarrow{S_{t}}(\overrightarrow{\neg}\times\overrightarrow{D}),\overrightarrow{\neg}$ N-19= 0 = 9 . T $=) 0 - \overrightarrow{\forall} \overrightarrow{H} = \frac{S}{St} (\overrightarrow{\forall} \times (\overrightarrow{E}))$ 12 - = 518 $=) - \overrightarrow{P}^{*} \overrightarrow{H} = \left\{ \frac{S}{S+} \left(\overrightarrow{\nabla} \times \overrightarrow{E} \right) \right\}$ 12 +6 = "HX 7 $=) - \vec{\nabla}^{\gamma} \vec{H} = \xi \frac{s}{st} \left(- \frac{s}{st} \vec{B} \right)$ mpu produstitadia $=) - \vec{\nabla} \cdot \vec{H} = - \xi \frac{S^{\prime}}{SF^{\prime}} (M\vec{H})$ $= - \vec{\nabla} \cdot \vec{H} - A_{4\xi} \frac{S^{\prime\prime}}{SF} (M\vec{H})$

This ear is called wave ear in terms of H . monto In sinosoidal form, 51 - VU We know, St = Jw => マン· 市= ME (ゴル) (ゴル) 市 Ar (wis) (wis) in = - W ME H =- + Le 201 - 2 1 => 1 Wave ean For conducting medum Lossy medium A + 5. = 17 × 7 The conducting medium 670, Pv 20 bord Brinkert 你常你你你 manuell's can in diff form, $\overrightarrow{\nabla} \cdot \overrightarrow{D} = P_{2} \left(-\frac{1}{2} \left(\overrightarrow{D} \cdot \overrightarrow{D} \right) + \frac{1}{2} \left(\overrightarrow{D} - \overrightarrow{D} \cdot (\overrightarrow{D} \cdot \overrightarrow{D}) \right) = \overrightarrow{D} = \left(\overrightarrow{D} - \overrightarrow{D} \cdot (\overrightarrow{D} \cdot \overrightarrow{D}) \right) \left(\overrightarrow{D} - \overrightarrow{D} \cdot (\overrightarrow{D} \cdot \overrightarrow{D}) \right)$ - 0 $\overline{\nabla} \cdot \overline{B} = 0 - \Theta$ $\overline{\nabla} \times \overline{E} = -\frac{S}{St} - \Theta$ $\overline{J} = \delta - C$ $\overline{J} = \delta - C$ Substituting san, $\left(\frac{5}{12}, -\right) = \frac{3}{12} = \frac{7}{12} = -(=$ $\overrightarrow{\nabla} \cdot \overrightarrow{D} = \overrightarrow{P}_{\gamma} \qquad (\overrightarrow{\Pi} \cdot \overrightarrow{V}) = \overrightarrow{2} \cdot \overrightarrow$ =) マ・ア=0 =) マ・ミビ=0 =) マ・ビ=0

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Then, $\overrightarrow{\nabla}.\overrightarrow{B}=0$ $\overrightarrow{\nabla}.\overrightarrow{B}=0$ $\overrightarrow{\nabla}.\overrightarrow{H}=0$ $\overrightarrow{\nabla}.\overrightarrow{H}=0$ $\overrightarrow{\nabla}.\overrightarrow{H}=0$ $\overrightarrow{\nabla}.\overrightarrow{H}=0$
Again, $\forall z \neq z = -\frac{SB}{St}$ $\Rightarrow \overline{B} = -\frac{SB}{St}$ $\Rightarrow \overline{B} = -\frac{SB}{St}$ $\forall z \neq z = -\frac{SB}{St}$ $\Rightarrow \overline{B} = -\frac{SB}{St}$ $\Rightarrow \overline{B} = -\frac{SB}{St}$ $\Rightarrow \overline{B} = -\frac{SB}{St}$ $\Rightarrow z \neq z \neq -\frac{SB}{St}$ $\Rightarrow \overline{S} = -\frac{SB}{St}$
$Taking ean ③,$ $\nabla \times \vec{E}^{2} = -\frac{S \cdot \vec{B}_{eq}}{St}$ $Variance Since $
Adding curl on both side, $\overrightarrow{\nabla} \times (\overrightarrow{\nabla} \times \overrightarrow{E}) = \overrightarrow{\nabla} \times (- \frac{S}{ST})^{-1}$
$=) (\overrightarrow{\nabla} \times \overrightarrow{E}) \cdot \overrightarrow{\nabla} (\overrightarrow{\nabla} \times \overrightarrow{R}) \cdot \overrightarrow{E}_{i} = -\overrightarrow{\nabla} \frac{S}{(S + i)} (\overrightarrow{\nabla} \times \overrightarrow{R})$ $=) O - \overrightarrow{\nabla}^{2} \overrightarrow{E} = -\frac{S}{S + (\overrightarrow{\nabla} \times \overrightarrow{M} \overrightarrow{R})}$ $=S - \overrightarrow{\nabla}^{2} \overrightarrow{E}_{i} = -\frac{S}{S + (\overrightarrow{\nabla} \times \overrightarrow{M} \overrightarrow{R})}$ $=S - \overrightarrow{\nabla}^{2} \overrightarrow{E}_{i} = -\frac{S}{S + (\overrightarrow{\nabla} \times \overrightarrow{M} \overrightarrow{R})}$ $=S - \overrightarrow{\nabla}^{2} \overrightarrow{E}_{i} = -\frac{S}{S + (\overrightarrow{\nabla} \times \overrightarrow{H}_{i})} \cdot \overrightarrow{N} - \frac{1}{S + (\overrightarrow{\nabla} \times \overrightarrow{H}_{i})}$ $=S - \overrightarrow{\nabla}^{2} \overrightarrow{E}_{i} = -\frac{S}{S + (\overrightarrow{\nabla} \times \overrightarrow{H}_{i})} \cdot \overrightarrow{N} - \frac{1}{S + (\overrightarrow{\nabla} \times \overrightarrow{H}_{i})}$
$=) - \overline{\forall}^{n} \cdot \overline{E}^{n} = -M \frac{(s)}{st} \left(\overline{\partial}^{n} + \frac{s}{st} \right) + \frac{s}{st} \left(\overline{\partial}^{n} + \frac{s}{st} \right)$ $=) \overline{\forall}^{n} \cdot \overline{E}^{n} = M \frac{s}{st} \left(\overline{\partial}^{n} \overline{E}^{n} + \frac{s}{st} \overline{D}^{n} \right) \qquad \text{additions}$

 $\Rightarrow \forall \vec{E} = M \frac{\delta}{\delta t} \left(\vec{e} = \frac{\delta e \vec{e}}{\delta t} \right)$ (really 0 < 8.5 = MG SHE + ME SHE = 1104 . 170 (Lossy medium) in terms of E , ring A Conducting Equation in terms of E For sinusoidal form ;- $(1) = -\frac{1}{2^{+1}} \frac{5}{8} \frac{1}{1} - (1)$ we know St = jw The Million and the second Carting car (D). ٤٥, FrE = MG(JW) E = ME Jrw E $2\overline{\nabla}^{n}\overline{E} = \Im M \left(6 + (2\overline{i}\overline{j}w)\overline{E} \times (\overline{j}) \times (\overline{j}\times\overline{v}) \times \overline{v} \right)$ $:.\overline{\nabla}^{n}\overline{E} = D^{n}\overline{E} \left(6 + (2\overline{i}\overline{j}w)\overline{E} \times (\overline{v}) \times (\overline{j}\times\overline{v}) \times \overline{v} \right)$:) = J Juipe (2 + Juire) : =) priopagation delay (I. 4 4) -This is the ware equation & is called propagation Constant of in terms of E. For sinuspided of the medium time vary ation for conducting mediuma E) Pr. F = M St (GE+ St)

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Now taking egn (4) in 2 million 19/14 $\vec{z} \times \vec{H} = \vec{z} + \frac{s}{st} \vec{D}$ not entry of the the terms in terms Taking curl on both sides, material definite such that $\overrightarrow{\nabla} \times (\overrightarrow{\nabla} \times \overrightarrow{H}) = \overrightarrow{\nabla} \times (\overrightarrow{\partial} + \frac{S \overrightarrow{D}}{St})$ => $(\overline{\forall} \times \overline{H})$ $(\overline{\forall} \cdot \overline{\forall})$ $\overline{\forall} \cdot \overline{\forall})$ $\overline{H} = [\overline{\forall} \times \overline{\forall} \cdot \overline{\forall} + \frac{S_1}{S_1}] (\overline{\forall} \times \overline{Ba}) (\overline{E}))$ (= $=) - \overrightarrow{\nabla} \overrightarrow{H} = G(\overrightarrow{\nabla} \times \overrightarrow{E}) + \underbrace{G(\overrightarrow{\nabla} \times \overrightarrow{E})}_{SF} + \underbrace{G(\overrightarrow{\nabla} \times$ $=) - \vec{\nabla}^{n} \cdot \vec{H} = \left\{ \left(-\frac{s}{st} \cdot \vec{B} \right) + \left\{ \frac{s}{st} \cdot \left(-\frac{s}{st} \cdot \vec{B} \right) + \left(-\frac{s}{st} \cdot \vec{B} \right) \right\} \right\}$ $=) - \overline{\zeta}^{n} \cdot \overline{H}^{n} = - \frac{\partial}{\partial t} \left(\frac{S M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N}{\delta t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{H}}{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \left(\frac{M \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta \omega} \right) + \frac{S N \overline{S t \eta$ $= \vec{\nabla} \vec{H} = (\vec{v}) (\vec{s}) + A (\vec{s}) (\vec{v}) + A (\vec{s}) (\vec{v}) (\vec{s})$ This is the week to the in term OF #? . thoug load TOTAL In terms of I sinusoidal Form: -B= SLAS JW A (i) willby DR (i) The Balling $= \overline{\psi}^{2} \overline{H}^{2} = \frac{1}{2} \sqrt{2} \overline{\psi}^{2} + \overline{\psi}^{2} \overline{\psi}^{2} + \frac{1}{2} \sqrt{2} \overline{\psi}^{2} + \frac{1}{2} \overline{\psi}^{2} \overline{\psi}^{2} \overline{\psi}^{2} + \frac{1}{2} \overline{\psi}^{2} \overline$ ·· ¬~H= P~F

Attenuation & phase Shift Constant Docive the enpression for the attenuation & phase shift constants milia lossy dielectric $\frac{S}{Et}$ medium. "(j~z-1) => For lossy dielectric, 6=0,11 x= Attenuetton The propagation constant, $\dot{\gamma} = \dot{q} + j\beta$ Constant B= phase Shift Constant. or, $(q+ip)^{n} = j\omega\mu(b+i\omega\epsilon)$ Or, 2 +2 JP. 2 + Br = Jurib = - Write Or, ~ - B + white - Jwhig - 25Bd Real port, TH TO minut 1 Imaginary part, 2"-B"= -write Lobi Dinie II 123 B.d. - Jwh. 2 or, B = JUMB 2) Hartong of (1) 23 value (1) 2 WM6 JHT2 $d^{n} = \left(\frac{\omega \mu b}{2d} \right)^{n} \left(\frac{\omega c}{2d} \right)^{$

or, $d^{4} = \left(\frac{\omega M \delta}{2}\right)^{4} = -\omega^{7} \mu \epsilon d^{7}$ $O_{2}(2)^{r} + \omega med^{-2} (\frac{\omega me}{2})^{2}$ or. (2m) B or, $(d^{n})^{r} + 2 \cdot d^{r} \cdot \frac{1}{2} \omega^{r} \mu \epsilon + (\omega^{r} \mu \epsilon)^{r} (\omega^{r} \mu \epsilon)^{r}$ $\frac{1}{2} \omega^{r} \omega^{r} + (1 - \omega^{r} \mu \epsilon)^{r} (\omega^{r} \mu \epsilon)^{r}$ $= (2 - 2)^{r}$ or, at which is which will have the $Or, \left(a^{2} + \frac{\omega^{r} \mu \epsilon}{2}\right)^{r} = \frac{\omega^{2} \mu^{r} \epsilon^{r}}{4} \left(1 + \frac{\omega^{2} \epsilon^{r}}{\omega^{2} \epsilon^{r}}\right)$ $On_{\mathcal{A}}\left(\frac{\mathcal{A}+\frac{\omega\gamma_{L}}{2}}{2}\right) = \frac{\omega\gamma_{L}}{2}\left(1+\frac{2}{\omega^{2}}\right)$ or, Itans - 1 winde with and with a spirit of the spirit o

Object = 9. Attenuation Constant = $\omega \sqrt{\frac{2}{2} \left(\sqrt{1+\frac{2^{\omega}}{\omega^{\kappa}}} - \frac{1}{2}\right)}$ or, $q^{\kappa} = \frac{\omega^{\kappa}\mu\epsilon}{2} \left(\sqrt{1+\frac{2^{\omega}}{\omega^{\kappa}}} - 1\right)$ Attenuation Constant, $q = \omega \sqrt{\frac{\omega}{2} \left(\sqrt{1+\frac{2^{\omega}}{\omega^{\kappa}}} - 1\right)}$

in the property of the start of the store NOW, $x^{-\beta^{1}} = -\omega^{-}\mu\epsilon$ =) $p^{n} = d^{n} + \omega p_{1} e^{-\frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} + \frac{1$ $\frac{\omega nec}{2220} \left(\sqrt{1+\frac{c^{n}}{\omega re^{n}}} - 1 \right) + \omega nec} \right)$ z write with any with the the the $= \frac{\omega \eta_{LE}}{2} \sqrt{1 + \frac{\delta^{m}}{\omega \pi e^{\gamma}}} + \frac{\omega \eta_{LE}}{2} (1 + \frac{\delta^{m}}{\omega \pi e^{\gamma}}) + \frac{\omega \eta_{LE}}{2} (1 + \frac{\delta^{m}}{\omega \pi e^{\gamma}}) + \frac{1}{2} (1 + \frac{\delta^{m}}{2}) + \frac{1}{2}$ = white 1+ 2 - 1 + 2 - (2 - 1 - 1 - 2 - (2 - 1 - 2 -° Phase shift constant, B= w Juliz (11+ 22 (11+ 22) (1) ". Attenucation constant = w. J. 2 (JA and) - 2. Currice (VItes -1) Pllemention Constant, & - w w 2 (In 2" - 1)

Conductors & Insulations (3) Historia M To Conduction Current Density, Je = 21 E S Displacement ", ", $\overline{J}_0 = \frac{\partial D}{\partial t} = \overline{J}_{cod} =$ $\frac{\overline{J}_{c}}{\overline{J}_{o}} = \frac{2\overline{E}}{\overline{J}_{w}} \frac{2}{\overline{E}} \frac{\overline{\delta}}{\omega \varepsilon} \frac{2}{\overline{\omega} \varepsilon} \frac{\overline{\delta}}{\overline{\omega} \varepsilon} \frac{1}{\overline{\omega} \varepsilon$ we cci or, 222 we lin lin good insulator. Derivation of d, B, u & n; For good dielectric, & 221 or, 222 we The attenuation constant, $q' = con \int \frac{he}{2} \left(\sqrt{1 + \frac{2n}{cr_{2}r}} - 1 \right) dr = 1 + nr + \frac{n(n-1)}{2!} n^{r} + \frac{n(n-1)}{2!} n^$ (1+ man) 2 = 1+ 2 comen [Neglecting Higher Order Forms] $\alpha = \omega \sqrt{\frac{ne}{2}} \left(1 + \frac{2}{2\omega re} \right)^{1/2} \left(1 + \frac{2}{2\omega re} \right)^{1/2} \left(\frac{2\omega re}{2\omega re} \right)^{1/2}$ $= \omega \frac{\sqrt{m}\sqrt{g}}{2\omega_{\xi}} = \frac{\sqrt{m}}{2\sqrt{\xi}} : d^{2} \sqrt{\chi}$

The phaseshift constant, $\beta = \omega \int \frac{M_{E}}{2} \left(\sqrt{1 + \frac{2}{\omega r_{E}r}} + L \right)$ $(1+n)^{n} = 1 + n + \frac{n(n-1)}{2!} \cdot n + \frac{n(n-1)}{2!} \cdot n + \frac{n(n-1)}{18005} = 1$ $\frac{\left(1+\frac{2m}{\omega r_{er}}\right)^{1}}{\left(1+\frac{2m}{\omega r_{er}}\right)^{2}} = \frac{1+\frac{1}{2}}{\frac{6}{12}} + \frac{6}{12} + \frac{6}{12} + \frac{1}{2} + \frac{1}{2} + \frac{6}{12} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{6}{12} + \frac{1}{2} + \frac{1}$ $\mathcal{B}^{\text{min}} = \mathcal{C}_{\text{opt}} \left[\frac{\mu \mathcal{E}}{2} \left(1 + \frac{1}{2} \frac{\mathcal{E}_{\text{opt}}}{\omega^{\text{m}} \mathcal{E}^{\text{max}}} + 1 \right)^{1/2} \right]$ Percivation = $\omega \sqrt{\frac{n\alpha}{2}} \left(\frac{2}{2} + \frac{pm}{2\omega rem} \right) = \frac{1}{2} \left(\frac{2}{2} + \frac{pm}{2\omega rem} \right)$ $\frac{2}{2} \frac{\omega}{2} \sqrt{\frac{\omega}{2}} \frac{\omega}{2} \frac{\omega}{2} \frac{1}{2} \frac{2^{n}}{2} \frac{1}{2} \frac{2^{n}}{4} \frac{1}{2} \frac$ · (-B=) why ture (1+ 200 -) +1) 5 = a fre de 6 True かんちょう: 2 5

Intrinsie Empedance Mon 2 Jour (188-11/2.0) NS 1- $= \sqrt{\frac{4}{2}} - \left(1 + \binom{4}{2}\right) = \sqrt{\frac{4}{2}} = \sqrt{\frac{2}{3}} \left(1 - \frac{2}{3}\right) = \sqrt{\frac{4}{3}} \left(1 - \frac{2}{3}\right)$ $=\sqrt{\frac{4}{2}}\left(14\frac{2}{2}\omega\epsilon\right)$ I IF Ep = & M = Mo For the medium in which a wave with a forequency of 0.3 Gitter is propugating. Determine the propagation constant & intrinsic impedance of the medium when 3=0. ⇒ 2= d+ jB Jammu sigma kintu = ~ J JW/ (2+JWE) Jamma silent Ju = J Jupe (Jwk) WR Know VM & = 103 103×103 = JJ2 W2 ME = JW JME V ~ = 377 = j 2 TF / MoE = [] . F=21

à = j 2 x (0.3 x 10²) x J 3x10 & 1/3x108 J 1/3x108 J 1/3x108 = 2 2TT (0.3 × 10.3) x 1 9 3 1 3× 108 \$ × 3 = 56 TUP =) J×6× 3.1416 = $= \frac{1}{2} 18.85 \text{ m}^{-1}$ NOW_{0} $\int \frac{1}{2} \frac{\omega \mu}{G + j \omega \epsilon} = \sqrt{\frac{1}{2} \frac{\omega \mu}{J \omega \epsilon}} = \sqrt{\frac{$ avour a dointin in white on the mainten in which a wave with a triaguiancy of jagartit is propedating. Disnighting trailing control of 2725. (27-97mpedance of the medium when s= 0. (+) Sime (+) 1 June (? + June) JUSTICE STUMMEDE des 1 (Jurke (Sund) We Know 1 to to = 1 + 8×108 Jun we : : 300 min. V 10- 877 NE 2 N F J ME SPA J T. Fassin

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port -A OF Manwell's Equation to Integral form The I.Integnal, Form Diff Pomm $\widehat{\nabla} \preceq x \underbrace{A} = \underbrace{D} + \underbrace{A}$ $(\overline{D} + \overline{D}) = (\overline{D} + \overline{D}$ $\overrightarrow{B} \overrightarrow{A} \times \overrightarrow{F} = -\overrightarrow{B}$ $(\underline{3}, \overline{p}, \overline{p}) = f_{V}$ >vb vg Bids: =bo C. F. J. (= $\overrightarrow{\Theta} \quad \overrightarrow{\nabla} \cdot \overrightarrow{B}^2 = 0$ proop This gental and the formal going (1) 1st Equation 8-= & B? 45 = She R. dv マ×テ = Ď+テ 0= 5.5 0 Ju F. BAWED $= \int_{S} (\overline{\nabla} \times \overline{F}) dS = \int_{S} (\overline{D} + \overline{J}) dS$ え レント(町、戸)、し $=) \int_{\mathcal{S}} (\overrightarrow{\forall} \times \overrightarrow{H}) ds = \oint_{L} \overrightarrow{H} \cdot d\overrightarrow{L}$ · - 13 8. d3 + 0 $=) \oint_{L} H^{2} d\vec{L} = \int_{S} (\vec{D} + \vec{r}) d\vec{s}$

1 11: 12 11 Conversion of Billicentice From Tx English of noipong similar 10 2) J = X E J = - B . B. J mast Tria 日日日日本 =) $\int_{S} \overline{P}(\overline{\nabla} \times \overline{P}) ds = \oint \overline{P} \cdot d\overline{P}$ =) & E. dl > - 1 3 B' dJ O THERE I WITH C () = T = J. $=) \int_{V} \nabla \cdot \vec{D} \, dv = \int_{V} P_{V} \, dv$ 01前一个门 =) Jy = (=. D) dv = \$ D. d3 10000 1.St Equicition 2 =) \$5. D. do = Julydr F+G=FixF Q 7.B 20 Jv F.Bdv=0 SP (E+3) - F (E+3) 25 $\int_{V} (\vec{r} \cdot \vec{B}) \mathbf{I} v = \oint_{J} \vec{B} \cdot d\vec{J}'$ TE.A J = 26(F x F) J (= :. \$, B. d3 =0 => \$, E. dZ = J. (D+3) d. ?