Help Session Week 13 29/5/18

- EMT only certain number of questions to test on; either too easy or too hard.

- Go through Qs likely to be in exam.

If want to memorise / stream line learning, Questions:

Q7 - really easy, do you know what the unit is
- 7a specifically (can skip b & c)

Q8 & Q9 & Q10 → "Guaranteed to be tested"
— 2015 & 2017 exam

Q12 previous years assignment

Q13 - if can do Q10 then can do Q13

Q16 - Last exam

Q18, Q19, Q20 - tute classes

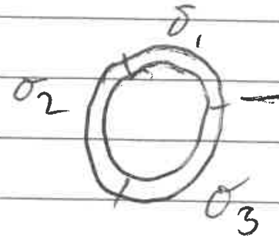
Q24 - em waves, Q37 - recommendation 2016 exam

Q38 - 2015 exam

exam breakdown

70 - em stuff
30 - em waves → Andy's was 60/40

If can do all above questions can easily pass.



→ Connected segments question from tutorials (last sem) was in 2017 exam

Project

-watch lectures or it

to do well work on MatLab code
- do in pairs/partners
- don't submit MatLab code, so can copy/paste

After get over hurdle of MatLab code everything else really easy
- Team of 5, doing it.

Slide 25 ⇒ by end should have similar graph. → Final model should be one (from the board) 79 of 12 pgs
- don't need to know about it for exam

Go into info file, ~~look~~ chart of "Bulk de-coupling"

Make your own experiments.

put some beads, one in corners etc
talk about result
- systematic

- see if says it's dependent or frequency in booklet so then do something dependent or frequency in code

- Can reverse ~~engineer~~ engineer formulas in the booklet e.g. formula 242.
- change things in model see $f \propto \sqrt{\frac{1}{L\rho}}$

Important Slides
from 4 to sides

~~lll~~ pg 4

Moratelli postulates

pg 5 – relates to Q37
& pg 6.

Core of EMT

don't see these interactions at speed of light, some speed slower than speed of light.

pg 21 – 24 – 1/r ones to consider
orthogonal / perpendicular to each other.
E & H

Might have to do curl

(E · H should get 0?
as orthogonal

Question pg 25 Question on quiz

26 – 2017 exam, time average poynting vector.

Q38 ~~should~~ & Q24 should do before exam.

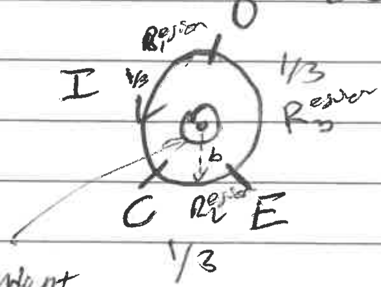
Guided waves important – should understand everything here → pg 54 important
pg 55 – FOR QUIZ

Anything to do ~~for~~ with K in exercises.

Look at past quizzes. What is kappa

Independent Segments Question

$-\varphi_{CD}$
Determine the potential difference $-\varphi_{DE}$
$-\varphi_{EC}$



ndependent Source.

Current in Ring "I" is constant.
Need to induce the current

Just put a wire through it and ramp up the current

The wire through it creates a uniform magnetic field.

given to you

$$B(t) = B(t)\,a_z$$
$$\psi(t) = \oint_{ring} B(t) \cdot dS$$
$$= \psi_0 + kt$$

(1) The potential difference is obtained is from integrating the coulomb field

So ∴ need to get the ~~cole~~ coulomb fied

so find E_c

$$E_C = -\nabla\psi$$

(2) $\psi = -\int E_C \cdot dl$

(What is he asking, what info do I know about that?)

Think about total Electric field.

$$E_T = E_C + E_I$$

$$\int E_T \cdot dl = \int E_C \cdot dl + \int E_I \cdot dl$$

$$\boxed{(3) \quad emf = \frac{-d\varphi}{dt} \longrightarrow emf = \oint E_I \cdot dl}$$

Faraday's Law on induction.

$$emf = \frac{-d\varphi(t)}{dt}$$

$$emf = -K = \oint E_I \cdot dl$$

$$\oint E_T \cdot dl = \overset{0}{\cancel{\oint E_C \cdot dl}} + \oint E_I \cdot dl$$

as from 0 to 0 for example (around the loop) is 0!

$$\boxed{(4) \quad J = \sigma E}$$

$$\oint E_I \cdot dl = \oint \frac{J}{\sigma} \cdot dl$$

$$\boxed{\begin{aligned} R_1 &\triangleq \int_0^{\pi/3} \frac{L}{\alpha\sigma} \cdot dl \\ R_1 &= \frac{l}{\alpha\sigma} \end{aligned}}$$

$$= \int_{Region_1} \frac{J}{\sigma_1} \cdot dl + \int_{Region_2} \frac{J}{\sigma_2} \cdot dl + \int_{Region_3} \frac{J}{\sigma_3} \cdot dl$$

$$J = \frac{I}{A} \quad (\text{where } A = \alpha)$$

all these things coming together ^

$$= \int_{R_1} \frac{I}{\alpha \sigma_1} \cdot dl + \int_{R_2} \frac{I}{\alpha \sigma_2} \cdot dl + \int_{R_3} \frac{I}{\alpha \sigma_3} \cdot dl$$

Region 1 (I was constant)

$R_1 = 1$, $R_2 = 5$, $R_3 = 15$

$$= I(R_1 + R_2 + R_3)$$

$$\oint E_I \cdot dl = I(R_1 + R_2 + R_3)$$

$$-k = I(R_1 + R_2 + R_3)$$

(in exam will give k, in this case we will say it is 21 or k = 21)

$$-21 = I(1 + 5 + 15)$$

$$I = \frac{-21}{21} = -1A$$

$$\cancel{\int E_T \cdot dl = \int E_c \cdot dl + \int E_I \cdot dl}$$

$$\cancel{\int E_T \cdot dl = \psi + \int E_I \cdot dl}$$

$$\cancel{\psi = \int E_T}$$

$$\boxed{\begin{array}{l} emf = -21 \\ \frac{1}{3} emf = -7 \end{array}}$$

$$E_c = E_T + E_I$$

$$= \frac{J}{\sigma} - E_I$$

$$\psi = -\int E_c \cdot dl$$

$$\psi = -\int \left(\frac{J}{\sigma} - E_T\right) \cdot dl$$

$$\psi = -\int E_c \cdot dl$$

get IR from integral

$$\psi_{CD} = -IR_1 - (-7)$$

$\psi_{DE} =$

$\psi_{EC} =$

sum all of them is 0

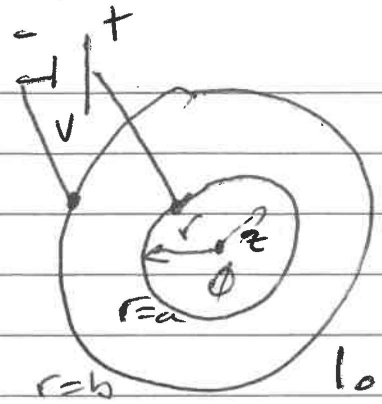
i.e. $\psi_{CD} + \psi_{DE} + \psi_{EC} = 0$

Reason the sum of them is 0.
is from. ①
The potential differences obtained is from integrating the coulomb field.

And $\oint E_c \cdot dl = 0$

$\therefore$ Sum of all potential differences is 0.

Using Cylindrical co-ordinates



1. $\phi(r) = ?$
2. $E(r) = ?$
3. $\rho_s = ?$

(make sure to state assumptions

Cantoni
Asked it in this way so that ~~it~~ it is Systematic.

Q(1) What is φ?
So need to find formula for it.

$$\nabla^2 \varphi = \frac{-\rho}{\varepsilon_0}$$ → not in formula sheet! (Must know this)

~~[illegible]~~ ρ is free charge density.
no free charge in area of interest ∴

$$\nabla^2 \varphi = 0$$

$$\nabla^2 \varphi = \frac{1}{r}\frac{\partial}{\partial r}\left(r \frac{\partial \varphi}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 \varphi}{\partial \phi^2} + \frac{\partial^2 \varphi}{\partial z^2}$$

This equation is explaining differences in voltage.

So look at cylinder, no potential diff all z or ϕ directions ∴

$$\nabla^2 \varphi = \frac{1}{r}\frac{d}{dr}\left(r \frac{d\varphi}{dr}\right) + \cancel{\frac{1}{r^2}\frac{\partial^2 \varphi}{\partial \phi^2}}^{\,0} + \cancel{\frac{\partial^2 \varphi}{\partial z^2}}^{\,0}$$

$$0 = \frac{1}{r}\frac{d}{dr}\left(r \frac{d\varphi}{dr}\right)$$

$$0 = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial\varphi}{\partial r}\right)$$

$$\cancel{\int 0 \cdot r\,dr} = \int \frac{\partial}{\partial r}\left(r\frac{\partial\varphi}{\partial r}\right)$$

$$0 + C_1 = r\frac{\partial\varphi}{\partial r}$$

$$\frac{C_1}{r} = \frac{\partial\varphi}{\partial r}$$

(don't forget the $+C$!)

$$\frac{C_1}{r}dr = d\varphi$$

$$\varphi(r) = C_1\ln(r) + C_2$$

eqn ① $C_1\ln(a) + C_2 = V_0$

eqn ② $C_1\ln(b) + C_2 = 0$

from ② $C_2 = -C_1\ln(b)$

$$C_1\ln(a) - C_1\ln(b) = V_0$$

$$\cancel{C_1\ln(a)} \quad C_1\ln\left(\frac{a}{b}\right) = V_0$$

$$C_1 = \frac{V_0}{\ln(\frac{a}{b})}$$

$$C_2 = -\frac{V_0}{\ln(\frac{a}{b})}\ln(b)$$

$$\varphi = C_1\ln(r) + C_2$$

$$\varphi(r) = \frac{V_0}{\ln(\frac{a}{b})}\ln(r) - \frac{V_0}{\ln(\frac{a}{b})}\ln(b)$$

$$= \frac{V_0}{\ln(\frac{a}{b})}\left(\ln\left(\frac{r}{b}\right)\right)$$

$$\varphi(r) = \frac{V_0}{\ln(\frac{a}{b})}\ln\left(\frac{r}{b}\right)(\hat{a}_r) \checkmark$$ for part 1

(2) Need to find coulomb field now

$$E = -\nabla\psi$$

$$E = -\nabla\left(\frac{V_0}{\ln(\frac{a}{b})}\ln\left(\frac{r}{b}\right)\right)\cdot a_r$$

$$= \frac{-d}{dr}\left(\frac{V_0}{\ln(\frac{a}{b})}\ln\left(\frac{r}{b}\right)\right)\cdot a_r$$

$$E = -\frac{\partial}{\partial r}\left(\frac{V_0}{\ln(\frac{a}{b})}\ln(r) - \frac{V_0}{\ln\frac{a}{b}}\ln(b)\right)\cdot a_r$$

just constants so cancels out.

$$E = \frac{-V_0}{\ln(\frac{a}{b})}\frac{1}{r}\cdot a_r$$

$$= \frac{-V_0}{r\ln(\frac{a}{b})}$$

$$E(r) = \frac{V_0}{r\ln(\frac{b}{a})}\cdot a_r$$

remove neg sign

added this in, but keep in whole way.

these swap $\left(\frac{a}{b} \Rightarrow \frac{b}{a}\right)$

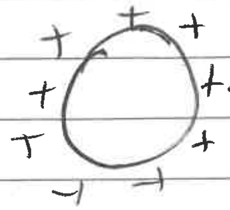
So have part 2 done.

(for vector go $\vec{E}$)

(if forget a_r can state it is a vector and $\therefore$ needs direction)

Part 3 ρ_s?

$$\oint E_c \cdot dS = \frac{1}{\varepsilon_0} \oint_V \rho_v \cdot dv$$ → *Remember this*



→ all charges (if something charged) should be at the surface

$$\oint E_c \cdot ds = \frac{1}{\varepsilon_0} \oint_S \rho_s \cdot ds$$ ← Since all charge at surface

$$E_c = \frac{1}{\varepsilon} \rho_s$$

$$\rho_s = E_c \varepsilon_0$$

$$\therefore \rho_s(r) = \frac{\varepsilon_0 V_0}{r \ln(\frac{b}{a})}$$ ← not a vector

$$\rho_s(a) = \frac{\varepsilon_0 V_0}{a \ln(\frac{b}{a})}$$ ⟸ Question actually asks for inside surface.

3rd part done

Last part of it Q4!

Q4 capacitance between cylinders

Q4 Capacitance ^per length between cylinders (F/m)

$$C = \frac{Q}{\varphi_{ab}}$$

~~ρ_s 7~~

total charge → ~~$Q \times \rho_s \times 2\pi a l$~~ → $Q = \rho_s \times 2\pi a l$

$$C = \frac{\rho_s \times 2\pi a l}{\varphi_{ab}} \quad , \quad \varphi_{ab} = V_0$$

$$\therefore C = \frac{\rho_s \times 2\pi a l}{V_0}$$

QED $\frac{C}{l} = \frac{\rho_s 2\pi a}{V_0}$

^This question (cylinders Q) most likely to be tested.

Order of hierarchy of study
- exams
- tutes
- exercises any said.

Listen to what Cannon (Chris) says will be on ~~exam~~ exam