

# Summary for Test 1

## Vector Calculus

- draw vector field
- $\vec{A} \times \vec{B}$
- $\vec{\nabla} T$ ,  $\vec{\nabla} \cdot \vec{v}$ ,  $\vec{\nabla} \times \vec{v}$ ,  $\nabla^2 T$
- $\int_B \vec{v} \cdot d\vec{l}$
- $\int_S \vec{v} \cdot d\vec{a}$
- $\int_U T d\tau$
- fundamental theorems  
(check)
- $\delta$ -fct.
- potential

# SUMMARY FOR TEST 2

$\delta$ -function

Electrostatics:

Coulomb's law

$$\vec{F} = \frac{1}{4\pi\epsilon_0} \frac{qQ}{r^2} \hat{r}$$

$$\vec{F} = q\vec{E}$$

Electric Field

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \sum \frac{q_i}{r_i^2} \hat{r}_i$$

$$\vec{E}(\vec{r}) = \frac{1}{4\pi\epsilon_0} \int \frac{dq}{r^2} \hat{r}$$

Gauss's law

$$\oint \vec{E} \cdot d\vec{a} = \frac{Q_{\text{enc}}}{\epsilon_0}$$

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$$

& applications

$$V(\vec{r}) = - \int_{\infty}^{\vec{r}} \vec{E} \cdot d\vec{e}'$$

$$V(\vec{r}) = \frac{1}{4\pi\epsilon_0} \int \frac{dq}{r}$$

$$\text{and } \vec{E} = -\vec{\nabla}V$$

$$W = \frac{1}{2} \int_V \rho(r) V(r) = \frac{\epsilon_0}{2} \int_{\text{all space}} E^2 d\tau$$

---  
next test: conductors &  $C = \frac{Q}{\Delta V}$

# SUMMARY FOR TEST 3

- Conductors:
- $V = \text{const}$ ,  $\vec{E} = 0$  inside, ...
  - apply  $\oint \vec{E} \cdot d\vec{a} = \frac{Q_{\text{encl}}}{\epsilon_0}$
  - $C = \frac{Q}{\Delta V} = \frac{Q}{V_+ - V_-}$

Uniqueness Thms: apply (not proof)  
 ↓  
 show that solution satisfies boundary conditions (bc)

## Method of Images

Sketches: Fig. 1, Fig. 2 (image(s))  
 & show that b.c. satisfied

$V = \dots$

$$\vec{F}_{\text{eng}} \quad \sigma = -\epsilon_0 \left( \frac{\partial V^{\text{above}}}{\partial n} - \frac{\partial V^{\text{below}}}{\partial n} \right) \Big|_{\text{at surface}}$$

$$q_{\text{induced}} = \int \sigma da$$

## Separation of Variables:

Sketch

$$V = X(x) Y(y) Z(z) \quad R(r) \Phi(\phi) \Theta(\theta) \quad \dots$$

$\nabla^2 V = 0$  & separate variables

solve DE (see Eq. sheet for what is provided)

Apply b.c. one by one

plug back into  $V = \dots$

$$\sigma = \dots \Rightarrow \vec{F} = q \vec{E} = -q \vec{\nabla} V$$

(last via direct comparison or Fourier's Trick)

## Summary for Test 4

- Multipole Expansion:

- \* determine  $\vec{p}$ ,  $V_{\text{mono}}$ ,  $V_{\text{dip}}$

- \* NOT: derivation of  $\vec{E}_{\text{dip}}$  (HW 18.1)

- Determine \*  $\vec{E}_{\text{dip}}$  (general & special case) ( $\vec{E}$  due to dipole)

- \*  $\vec{N}$ ,  $\vec{F}$  on dipole (&  $\vec{F}$  on charge)

& combinations

- $\sigma_b$ ,  $\rho_b$  & Gauss's Law

- Dielectric:

- + determine & draw  $\vec{D}$ ,  $\vec{P}$ ,  $\vec{E}$

- for general & for linear dielectric

- includes using Gauss's Law for  $\vec{D}$  &  $\vec{E}$

- \*  $C = \frac{Q}{\Delta V}$

- $\Delta V = -\int_{-}^{+} \vec{E} \cdot d\vec{l}$

- NOT: Boundary Conditions & Separation of Variables

## Summary for Test 5

- $\vec{D}, \vec{E}$  via Gauss's law then  $W = \frac{1}{2} \int \vec{D} \cdot \vec{E} \, d\tau$
- Separation of Variables using bound. cond. for  $V$  and  $\epsilon \frac{\partial V}{\partial n}$
- $\vec{F}_{\text{mag}} = q \vec{v} \times \vec{B}$  simpler case & cycloids
- $\vec{I}, \vec{K}, \vec{j}$  and corresponding  $\vec{F}_{\text{mag}}$
- Biot-Savart  $\vec{B} = \frac{\mu_0}{4\pi r^2} \int \vec{I} \, d\vec{l} \times \hat{r}$  etc. for  $\vec{K}, \vec{j}$   
&  $\vec{F}_{\text{mag}}$
- Ampère's Law  $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{\text{enc}}$

NOT:  $\vec{A}$ , bound. cond. for  $\vec{A}, \vec{B}$ ,  
multipole expansion (incl. magnetic dipole)

# Summary For Test 6

(Celebration of :) Ampère's Law  $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{\text{encl}}$  (needs sketch with Amperian loop)

given  $\vec{j}(\vec{r}_b, \vec{r}_f)$ ,  $\vec{K}(\vec{r}_b, \vec{r}_f)$ ,  $I(\vec{r}_f)$   
 $\rightarrow \vec{B}, \vec{H}$

$$\vec{A}(\vec{r}) = \frac{\mu_0}{4\pi} \int \frac{\vec{j}(\vec{r}')}{r} d\tau' \quad \text{etc.}$$

$$\vec{B} = \nabla \times \vec{A} \quad \vec{j} = \frac{1}{\mu_0} (\nabla \times \vec{B})$$

$$\vec{m} = \int I d\vec{a}$$

$$\vec{B}_{\text{dip}}(\vec{r}) = \frac{\mu_0 m}{4\pi r^3} (2 \cos \theta \hat{r} + \sin \theta \hat{\theta})$$

$$\& \vec{B}_{\text{dip}}(\vec{r}) = \frac{\mu_0}{4\pi r^3} [3(\vec{m} \cdot \hat{r})\hat{r} - \vec{m}]$$

$$\vec{N} = \vec{m} \times \vec{B} \quad \text{and} \quad \vec{F} = \nabla(\vec{m} \cdot \vec{B})$$

$$\vec{j}_b = \nabla \times \vec{M} \quad \text{and} \quad \vec{K}_b = \vec{M} \times \hat{n}$$

(Ampère's law & Interpretation)

$$\oint \vec{H} \cdot d\vec{l} = I_{f, \text{encl}} \quad \text{and} \quad \vec{B} = \mu_0 (\vec{H} + \vec{M})$$

boundary conditions: derive & sketches of  $\vec{M}, \vec{B}, \vec{H}$

Electrostatics & Magnetostatics

## Summary for Content after Test 6

- Determine  $\vec{B}$ :

$$\vec{M} \rightarrow \vec{J}_b, \vec{K}_b \xrightarrow{\text{Ampère's Law}} \vec{B}$$

$$\vec{M} \rightarrow \vec{H} = -\vec{\nabla} W \xrightarrow{\text{separ. of variables}} W \rightarrow \vec{H} \rightarrow \vec{B}$$

$$I_f \xrightarrow{\text{Ampère's Law}} \vec{H} \rightarrow \vec{B}$$

- Boundary Conditions  $\xrightarrow{\text{apply}}$  sketch for bar magnet  $\vec{M}, \vec{B}, \vec{H}$

- $\mathcal{E} = -\frac{d\Phi}{dt} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{a}$   $\mathcal{E} = IR$  and from before:  $\Delta V = -\int \vec{E} \cdot d\vec{\ell}$

- in matter  $\vec{J} = \sigma(\vec{E} + \vec{v} \times \vec{B})$   
neglected in examples

$$C = \frac{Q}{\Delta V}$$

- $\Phi = MI$

- $\Phi = LI$

- $W = \frac{1}{2\mu_0} \int_{\text{all space}} B^2 d\tau = \frac{1}{2\mu_0} \left[ \int_V B^2 d\tau + \int_S (\vec{A} \times \vec{B}) \cdot d\vec{a} \right]$

$$W = \frac{1}{2} LI^2$$

- Maxwell Equations

- correction
- interpretation
- differential  $\leftrightarrow$  integral
- derive boundary conditions

Thank you for great semester with you!

C

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This ensures transparency and allows for easy verification of the data.

In addition, it is crucial to review the records regularly to identify any discrepancies or errors. This proactive approach helps in catching mistakes early and prevents them from escalating into larger issues.

Furthermore, the document highlights the need for secure storage of these records. Both physical and digital copies should be kept in a safe and accessible location to protect against loss or theft.

C

The second section of the document focuses on the process of reconciling accounts. It provides a step-by-step guide on how to compare the internal records with the bank statements. This process is essential for ensuring that the books are balanced and that there are no unexplained differences.

It also discusses the importance of understanding the reasons behind any variances. Common causes include timing differences, bank errors, or overlooked transactions. Identifying these causes helps in correcting the records and improving future accuracy.

Finally, the document stresses the importance of keeping a clear audit trail. All adjustments and corrections should be properly documented and justified. This not only aids in the reconciliation process but also provides a clear path for auditors.

C