YTU Physics Department 2024-2025 Spring Semester			
FIZ1002 Physics-2 Final Exam			
Question Sheet	**AAAAAA**	**12.06.2025 09.00-11.40**	**100 m**

Name		The 9th article of Student Disciplinary Regulations of YÖK Law No.2547 states "**Cheating or helping to cheat or attempt to cheat in exams**" de facto perpetrators take **one or two semesters suspension** penalty. Students are NOT permitted to bring **calculators, mobile phones, smart watches** and/or any other unauthorized **electronic devices** into the exam room.
Surname		
Student No		
Group/Saloon		
Signature		

θ	0^0	30^0	37^0	45^0	53^0	60^0	90^0
sin	0	1/2	3/5	$\sqrt{2}/2$	4/5	$\sqrt{3}/2$	1
cos	1	$\sqrt{3}/2$	4/5	$\sqrt{2}/2$	3/5	1/2	0

$$k = \frac{1}{4\pi\varepsilon_0} \cong 9\,10^9 \frac{Nm^2}{C^2};\ \varepsilon_0 \cong 9\frac{10^{-12}F}{m};\ e^{0.69} = 2;\ \mu_0 = 12\frac{10^{-7}Tm}{A}$$

$$q = 1.6\,10^{-19}C;\ ln\left(\frac{1}{2}\right) = -0.69;\ g = 10\frac{m}{s^2}, \pi = 3$$

$\vec{E} = k\int\frac{dq}{r^2}\hat{r};\ V = k\int\frac{dq}{r};\ \Delta U = q\Delta V;\ \lambda = \frac{Q}{L} = \frac{dq}{dl};\ \sigma = \frac{Q}{A} = \frac{dq}{dA};\ \rho = \frac{Q}{V} = \frac{dq}{dV};\ \phi_E = \int\vec{E}.d\vec{A};\ V_B - V_A = -\int_A^B\vec{E}.d\vec{l};\ \oint\vec{E}.d\vec{A} = \frac{Q_{in}}{\varepsilon_0};$

$|\Delta V| = Ed;\ E_y = \frac{\sigma}{2\varepsilon_0};\ \ E_i = \frac{\sigma}{\varepsilon_0};\ p = aq;\ \vec{\tau} = \vec{p}\times\vec{E};\ U = -\vec{p}.\vec{E};\ C = \frac{|Q|}{|\Delta V|};\ C = \frac{\varepsilon_0 A}{d};\ U = \frac{1}{2}CV^2;\ \frac{1}{C_{eq}} = \sum_i\frac{1}{C_i};\ C_{eq} = \sum_i C_i;\ C = \kappa C_0$

$V = \frac{V_0}{\kappa};\ E = \frac{E_0}{\kappa};\ U = \frac{U_0}{\kappa};\ W = \int\vec{F}.d\vec{r};\ W = -\Delta U;\ I = \frac{dq}{dt};\ I = nqv_dA;\ R = \rho\frac{\ell}{A};\ \vec{J} = \sigma\vec{E};\ R = \frac{\Delta V}{I};\ \sigma = \frac{1}{\rho};\ J = \frac{I}{A};\ \tau = RC;\ V = IR;\ I = \frac{dq}{dt}$

$I(t) = I_0\left(1 - e^{-t/\tau}\right);\ q(t) = Q_0\,e^{-t/\tau};\ I(t) = I_0\,e^{-t/\tau};\ q(t) = Q_0\left(1 - e^{-t/\tau}\right);\ P = IV = I^2R;\ \vec{F}_B = q\vec{v}\times\vec{B};\ \vec{F}_B = I\vec{l}\times\vec{B};\ \vec{\tau} = \vec{\mu}\times\vec{B}$

$\vec{F} = q\vec{E} + q\vec{v}\times\vec{B};\ U = -\vec{\mu}.\vec{B};\ d\vec{B} = \frac{\mu_0 I}{4\pi}\frac{d\vec{s}\times\hat{r}}{r^2};\ \Phi_B = \int\vec{B}\cdot d\vec{A};\ B = \mu_0\frac{N}{l}I = \mu_0 nI;\ \oint\vec{B}\cdot d\vec{l} = \mu_0(I + I_d);\ \ I_d = \varepsilon_0\frac{d\phi_E}{dt};\ \vec{\mu} = I\vec{A};\ B = \mu_0 nI$

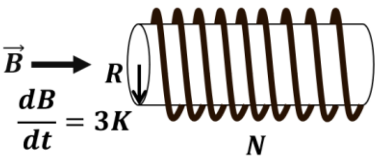
$\varepsilon = \oint\vec{E}\cdot d\vec{l} = -\frac{d\phi_B}{dt};\ \varepsilon_L = -N\frac{d\Phi_B}{dt} = -L\frac{dI}{dt};\ I_{rms} = \frac{I_{max}}{\sqrt{2}};\ \Delta V_{rms} = \frac{\Delta V_{max}}{\sqrt{2}};\ X_L = Lw;\ X_C = \frac{1}{Cw};\ tg\phi = \left(\frac{X_L - X_C}{R}\right);\ I_{max} = \frac{\Delta V_{max}}{Z}$

$w = \frac{1}{\sqrt{LC}};\ Z = \sqrt{R^2 + (X_L - X_C)^2};\ \langle p\rangle = I_{rms}\Delta V_{rms}cos(\phi);\ \Delta v_R = \Delta V_R\,sin(wt);\ \Delta v_C = \Delta V_C\,sin\left(wt - \frac{\pi}{2}\right);\ \Delta v_L = \Delta V_L\,sin\left(wt + \frac{\pi}{2}\right)$

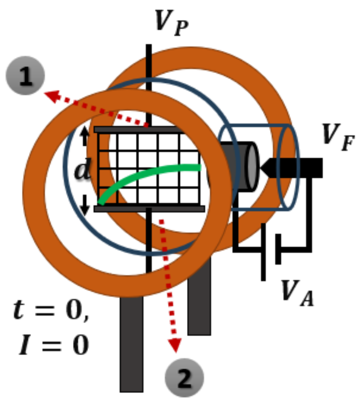
$\Delta V_L = I_{max}X_L;\ \Delta V_C = I_{max}X_C;\ \Delta V_R = I_{max}R;\ \omega_0 = \frac{1}{\sqrt{LC}};\ \tau = \frac{L}{R};\ I = \frac{\varepsilon}{R}\left(1 - e^{-\frac{R}{L}t}\right);\ I = \frac{\varepsilon}{R}e^{-\frac{t}{\tau}};\ U_L = \frac{1}{2}LI^2;\ u_B = \frac{1}{2}\left(\frac{B^2}{\mu_0}\right);\ M_{12} = N_2\frac{\Phi_{12}}{I_1}$

$\varepsilon_1 = -M\frac{dI_2}{dt};\ \varepsilon_2 = -M\frac{dI_1}{dt};\ U_C = \frac{Q^2}{2C};\ Q = Q_{max}cos(\omega t + \varphi);\ I_{max} = \omega Q_{max};\ \varepsilon_{ind} = -Bl\frac{dx}{dt} = -Blv;\ P = F_{app}v;\ \Delta V_2 = \frac{N_2}{N_1}\Delta V_1$

1. A solenoid with radius R and number of turns N lies along its own axis in a time-varying magnetic field with dB/dt=3K, where K is a positive constant. At t=0, B=0. What are the magnitudes of the magnetic flux through one turn of the solenoid and the electromotive force (emf) induced in the solenoid at any time t?



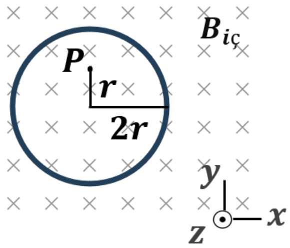
A) $6NK\pi R^2t;\ 9NK\pi R^2$
B) $6K\pi R^2t;\ 6NK\pi R^2$
C) $9K\pi R^2t;\ 9NK\pi R^2$
D) $3K\pi R^2t;\ 3NK\pi R^2$
E) $3NK\pi R^2t;\ 3NK\pi R^2$



2. Laboratory Question The experimental setup used to determine the e/m ratio consists of an evacuated tube, Helmholtz coils, a fluorescent screen placed between parallel conducting plates, and an electron gun. Electrons emitted from the gun by filament voltage V_F are accelerated by a voltage V_A . A uniform current I begins to flow through the Helmholtz coils at time $t > 0$. The distance between the plates is d, and a voltage V_P is applied between them. Which of the following is correct?

A) To determine the e/m ratio using the Lorentz force, the current in the coils must flow counterclockwise.
B) At $t = 0$, plate number 2 is negatively charged.
C) If the current flows counterclockwise through the coils, the beam deflects downward.
D) The magnitude of V_P does not affect the amount of horizontal deflection.
E) The magnitude of V_A is inversely proportional to the kinetic energy of the beam.

Questions 3-4) A circular silver wire with resistance R and radius 2r is placed in a uniform magnetic field perpendicular to its plane. The magnetic field strength increases from $t = 0$ to $t = T$ according to the relation $B = B_0\left(3 + \frac{5t}{T}\right)$, where t is in seconds and B_0 is a positive constant.



3. What is the magnetic flux in Wb through the wire at $t = \frac{T}{5}$?

A) $32B_0\pi r^2$ B) $16B_0\pi r^2$ C) $12B_0\pi r^2$ D) $8B_0\pi r^2$ E) $36B_0\pi r^2$

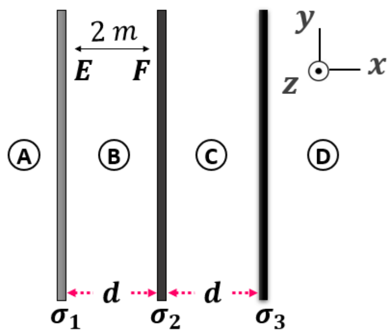
4. Which of the following correctly gives the total induced current in the loop from $t = 0$ to $t = T$?

A) $4B_0\pi r^2/RT$ *counterclockwise*
B) $20B_0\pi r^2/RT$ *clockwise*
C) $4B_0\pi r^2/RT$ *clockwise*
D) $16B_0\pi r^2/RT$ *counterclockwise*
E) $20B_0\pi r^2/RT$ *counterclockwise*

5. What is the induced electric field vector at point P?

A) $5B_0r/2T\ (-\hat{\imath})$ B) $10B_0r/T\ (\hat{\imath})$ C) $5B_0r/2T\ (\hat{\imath})$ D) $2B_0r/T\ (\hat{\imath})$ E) $10B_0r/T\ (-\hat{\imath})$

Questions 6-7) Three infinitely large insulating plates are placed parallel to each other with equal spacing d. The surface charge densities of the plates are $\sigma_1 = 10\ \mu C/m^2, \sigma_2 = -20\ \mu C/m^2$ and $\sigma_3 = 5\ \mu C/m^2$, respectively.



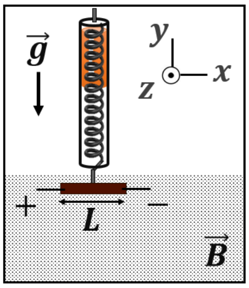
6. What is the electric field vector in region A, in units of V/m?

A) $\frac{5}{18}10^6(-\hat{\imath})$ B) $\frac{35}{18}10^6(\hat{\imath})$ C) $\frac{5}{18}10^6(\hat{\imath})$ D) $\frac{45}{18}10^6(-\hat{\imath})$ E) $\frac{25}{18}10^6(\hat{\imath})$

7. What is the potential difference $|E_E - E_F|$ between points E and F in region B?

A) $\frac{45}{9}10^6$ B) $\frac{5}{9}10^6$ C) $\frac{15}{18}10^6$ D) $\frac{25}{9}10^6$ E) $\frac{50}{18}10^6$

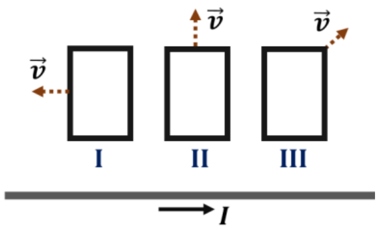
8. Laboratory Question A conducting rod of length *L=2.5 cm* is placed perpendicular to a uniform magnetic field (*B=0.5 T*), located in the shaded region of the xy-plane. The conducting rod is vertically attached to the end of a dynamometer and connected horizontally via weightless wires to a battery and an ammeter. The conducting rod, which has negligible mass, carries a steady current *I*. According to the analysis of a researcher using this experimental setup, which of the following statements is incorrect?



A) If $\vec{B} = B\hat{k}$ the conducting rod moves downward.
B) As the current through the conducting rod increases, the conducting rod continues to move downward.
C) If the current through the rod is 8 A and the dynamometer points 104 mN, the absolute error is 4 mN.
D) If the current through the rod is 4 A and the dynamometer points 52 mN, the relative error is 0.01.
E) If the current through the rod is 2 A, the dynamometer points 25 mN.

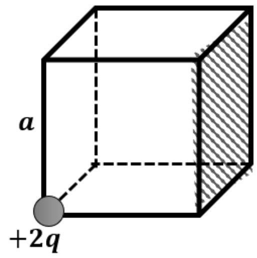
9. A long straight wire carries a <u>constant</u> current I in the direction shown. Three identical rectangular metal loops move in the same plane with constant velocity $\vec{v}$. In which case(s) is a current induced in the loop?

A) I and III B) None of them C) I and II D) All of them E) II and III



10. A point charge of +2q is located at one corner of a cube with edge length a. What is the electric flux through the painted face of the cube?

A) $q/24\varepsilon_0$ B) $q/8\varepsilon_0$ C) $q/4\varepsilon_0$ D) q/ε_0 E) $q/12\varepsilon_0$

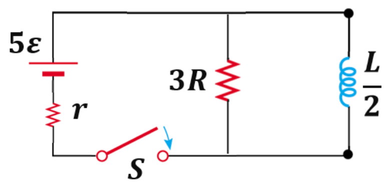


11. Which of the following is the correct SI unit equivalent of the magnetic field unit Tesla?

A) $\frac{Nm}{A}$ B) $\frac{kg}{Cs}$ C) $\frac{kg}{Am}$ D) $\frac{N}{As}$ E) $\frac{Wb}{m^3}$

Questions 12-14) A circuit consists of a battery with internal resistance r, a resistor, an inductor, and a switch, with the values of $R = 10\ \Omega, r = 2\ \Omega$, $\varepsilon = 12\ V, L = 200\ mH$.

12. What is the current through the resistor immediately after the switch is closed at $t = 0$?



A) 32 A B) 3/8 A C)15/8 A D) 0 E) 20 A

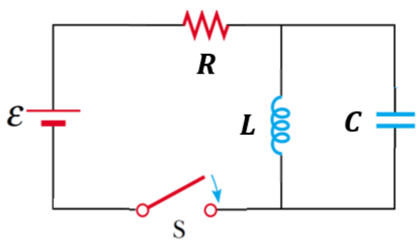
13. What is the current through the inductor immediately after the switch is closed at $t = 0$?

A) 15/8 A B) 32 A C) 20 A D) 3/8 A E) 0

14. What is the current through the inductor after the switch has been closed for a long time ($t \to \infty$)?

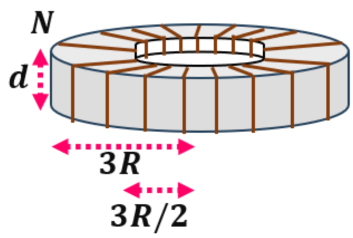
A) 0 B) 32 A C) 2 A D) 10 A E) 30 A

15. In the circuit shown, $R = 500\ \Omega$, $\varepsilon = 100\ V$, and $C = 0.2\ \mu F$. The switch S is kept closed for a long time and the potential difference across the capacitor is measured to be zero. After opening the switch and waiting long enough, the maximum potential difference across the capacitor is found to be 150 V. What is the inductance of the inductor?



A) 225 mH B) 75 mH C) 112.5 mH D) 150 mH E) 562.5 mH

Questions 16-17) A toroid with rectangular cross-section has N turns, an outer radius of 3R, an inner radius of 3R/2, and a height d.



16. What is the self-inductance of the toroid?

A) $\frac{N\mu_0 d}{2\pi} ln(2)$
B) $\frac{N^2\mu_0}{4\pi} ln\left(\frac{2}{3}\right)$
C) $\frac{N^2\mu_0}{2\pi} ln\left(\frac{3}{2}\right)$
D) $\frac{N^2\mu_0 d}{2\pi} ln(2)$
E) $\frac{N\mu_0}{2\pi} ln\left(\frac{2}{3}\right)$

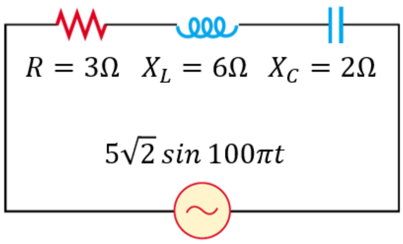
17. If a constant current I flows through the toroid, which of the following correctly gives the energy stored in the toroid?

A) $\frac{N^2\mu_0 dI^2}{8\pi} ln\left(\frac{2}{3}\right)$ B) $\frac{N\mu_0 dI^2}{2\pi} ln(2)$ C) $\frac{N\mu_0 I^2}{2\pi} ln\left(\frac{2}{3}\right)$ D) $\frac{N^2\mu_0 I^2}{4\pi} ln\left(\frac{2}{3}\right)$ E) $\frac{N^2\mu_0 dI^2}{4\pi} ln(2)$

18. An ideal transformer has 200 primary turns and 100 secondary turns. If a current of 1.2 A and a potential difference of 80 V is applied across the primary circuit, what is the current in the secondary circuit?

A) 2.4 A B) 0.6 A C) 4.8 A D) 8/3 A E) 3 A

Questions 19-20) In the given circuit, a resistor, inductor, and capacitor are connected in series to an alternating voltage source.



19. Which of the following correctly gives the circuit's impedance and effective current?

A) $5\,\Omega\,;2\,A$
B) $11\,\Omega\,;\sqrt{2}\,A$
C) $11\,\Omega\,;\sqrt{2}\,A$
D) $5\sqrt{2}\,\Omega\,;\ 1\,A$
E) $5\,\Omega\,;1\,A$

20. Which of the following correctly gives the phase difference in the circuit shown?

A) 53^0
B) 37^0
C) 0^0
D) 45^0
E) 90^0

1-D	**11-B**
2-A	**12-C**
3-B	**13-E**
4-E	**14-E**
5-A	**15-C**
6-C	**16-D**
7-D, E	**17-E**
8-D	**18-A**
9-E	**19-E**
10-E	**20-A**