UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2008/2009

SUBJECT	:	FIZIK ASAS II
CODE	:	DSF 1993
COURSE	:	2 / DET, 1 / DEE
DATE	:	APRIL 2009
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER ALL QUESTIONS IN **PART A** AND ANY **THREE (3)** QUESTIONS IN **PART B.**

THIS EXAMINATION PAPER CONSISTS OF SIX (6) PAGES.

PART A

Q1 (a) (i) Name two experimental evidences to indicate waves that can exhibit particle-like characteristics.

(ii) State the Einstein's theory regarding quantization of energy in electromagnetic waves radiation.

(7 marks)

(b) A microwave oven uses electromagnetic radiation at 2.4 GHz. What is the energy of each microwave photon.

(4 marks)

(c) The work function for barium is 2.48 eV. What is the maximum kinetic energy of electrons ejected from barium when it is being illuminated by light with wavelength 400 nm?

(9 marks)

Q2 (a) State Faraday's law of electromagnetic induction.

(3 marks)

(b) A copper square coil with dimension 15 cm on each side, slides horizontally through a region of uniform magnetic field $\boldsymbol{B}$ = 2.0 T, with constant velocity v = 0.02 ms^{-1}. The direction of the magnetic field is perpendicularly downward of the page. The coil is moved from position (P), (Q), (R) and (S) as shown in **Figure Q2(b)**. The region outside the dotted line has zero magnetic field.

(i) Find the magnitude of the induced emf in the coil at positions (P) and (R).

(ii) Determine the direction of the induced current in the coil for each position. (either clockwise or anticlockwise)

(iii) Find the induced current in the coil at position (R) if the coil's resistance is 0.70 ohms.

(17 marks)

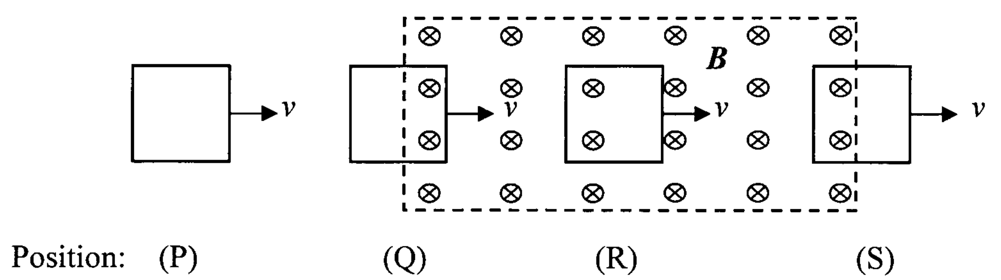

Figure Q2(b)

PART B

Q3 (a) Two very small metal spheres are initially neutral and are separated by a distance of 0.50 m. Suppose that 3.0×10^{13} electrons are removed from one sphere and are placed on the other sphere.

(i) Determine the net charge on each sphere.
(ii) Determine the electrostatic force that acts on each sphere.
(iii) Is the force attractive or repulsive?

(8 marks)

(b) Two isolated charges $q_1 = 8.5\ \mu C$ and $q_2 = -21\ \mu C$ are placed on the *x*-axis as shown in the **Figure Q3(b).** Point P is 6.0 cm from the origin O. Find

(i) The net electric field at points O and P.
(ii) The electric potential difference between point O and point P, V_{OP}.

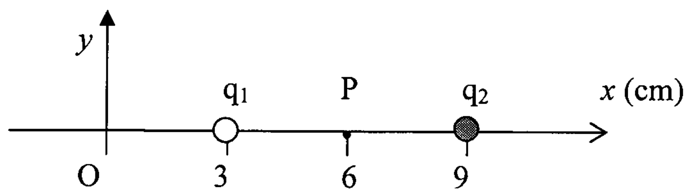

Figure Q3(b)

(12 marks)

Q4 A parallel plate capacitor, each has an area of 0.25 m^2 and 0.01 m apart. The capacitor is connected to a power supply and is charged to a potential difference V_0 = 3000 V. It is then disconnected from the power supply. A sheet of dielectric material is inserted between the plates, completely filling the space between them. It is found that the potential difference decreases to 1000 V, while the charge on each capacitor plate remains constant.

(a) Determine
(i) The original capacitance, C_0 (without dielectric material)
(ii) The magnitude of the charge on each plate
(iii) The capacitance, C after the dielectric is inserted.
(iv) The dielectric constant, K of the dielectric.

(14 marks)

(b) The capacitor is connected again with a power supply and charged to a potential difference V = 3000 V. Calculate the percentage difference in energy stored by comparing to the energy stored by the original capacitor without dielectric.

(6 marks)

Q5 The circuit shown in **Figure Q5** consists of batteries with emf, ε_1 = 16.0 V with internal resistance r_1 = 1.6 Ω and ε_2 = 8.0 V with internal resistance r_2 = 1.4 Ω, and two resistors, R_1 = 5 Ω and R_2 = 9 Ω. Find

(i) The current in the circuit.
(ii) The potential difference V_{ac} of point a with respect to point c.
(iii) The power output of 16.0 V battery.
(iv) The total rate at which electrical energy is being dissipated in the 5 Ω and 9 Ω resistors.
(v) The rate of the electrical energy being converted to other forms in the 8.0 V battery.

(20 marks)

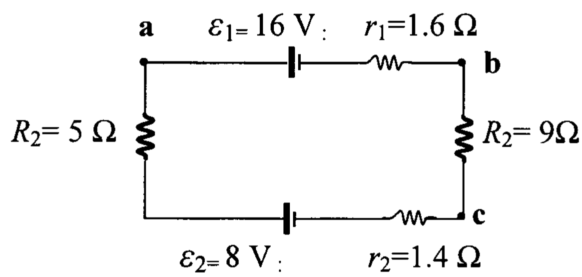

Figure Q5

Q6 (a) Four resistors are connected to form a network as shown in **Figure Q6(a)**. Calculate

(i) The equivalent resistance of the network.
(ii) The current in resistor 3Ω.

(10 marks)

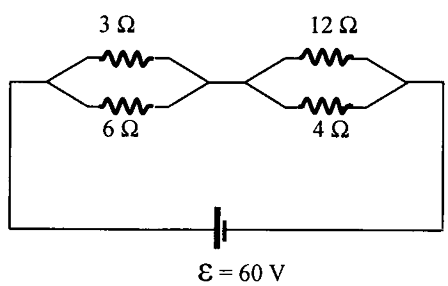

Figure Q6(a)

(b) In the circuit shown in **Figure Q6(b)**, find

(i) The current in 5 Ω resistor.

(ii) The unknown emf, ε_2.

(10 marks)

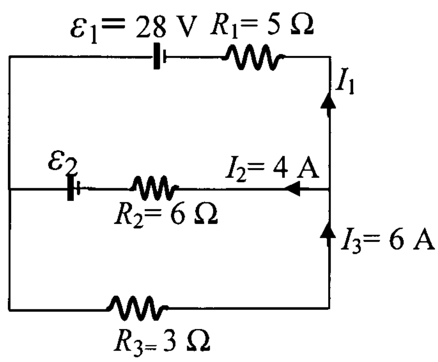

Figure Q6(b)

Q7 (a) A particle with a speed of 50 ms^{-1} enters a uniform magnetic field whose magnitude is 0.20 T. The magnitude of the charge is 1.6 x 10^{-19} C. For each of the cases X, Y and Z as shown in the **Figure Q7(a)**, find the magnitude and the direction of the magnetic force on the particle (particle for case (Z) is negative particle).

(8 marks)

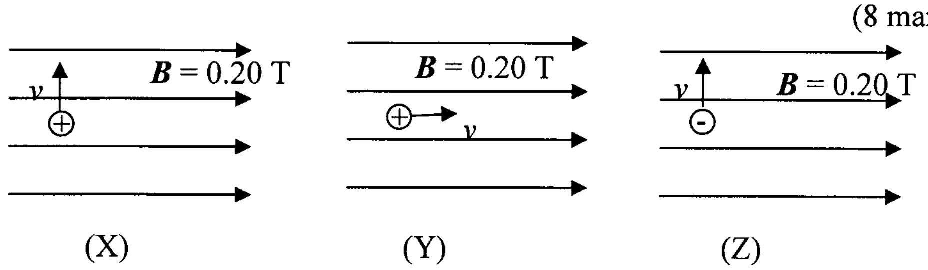

Figure Q7(a)

(b) Two long, straight parallel wires, 10 cm apart carry equal currents I = 20A in the same direction as shown in **Figure Q7(b)**. The direction of currents, I is perpendicularly out of the page. Determine

(i) The net magnetic field strength at point P between the wire 6 cm from one wire and 4 cm from the other.

(ii) The net magnetic force per meter (F/l) experienced by the third wire carries a current I_3 = 30 A, placed at P and parallel with both wires.

(12 marks)

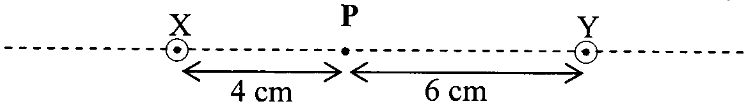

Figure Q7(b)

LIST OF CONSTANTS AND FORMULA

Acceleration due to the gravity $g = 9.8$ ms^{-2}
Speed of light c = 3 x 10^{8} ms^{-1}
Elementary charge e = 1.6 x 10^{-19} C
Electron mass m_e = 9.1 x 10^{-31} kg
Permittivity constant $\varepsilon_\circ$ = 8.85 x 10^{-12} $C^2N^{-1}m^{-2}$
Coulomb constant k = 9.0 x 10^{9} Nm^2C^{-2}
Permeability constant $\mu_\circ$ = 1.26 x 10^{-6} NA^{-2}
Planck's constant h = 6.63 x 10^{-34} Js

$F_{12} = \frac{kq_1q_2}{r^2}$	$V = IR$	$F = qvB\sin\theta$
$E = \frac{F}{q_\circ}$; $E = \frac{kq}{r^2}$	$R_{eq} = R_1 + R_2 + ..$	$F = ilB\sin\theta$
$V = \sum\frac{kq}{r}$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + ..$	$F_{21} = \frac{\mu_\circ I_1 I_2 l_2}{2\pi d}$
$C = \frac{Q}{V}$	$V_{ab} = \varepsilon - Ir = IR$	$B = \frac{\mu_\circ I}{2\pi r}$
$C = \frac{K\varepsilon_\circ A}{d}$	$P = V_{ab}I = I^2R$	$B = \mu_\circ nI$
$K = \frac{C}{C_\circ} = \frac{V_\circ}{V}$	$V_{ab} = V_b - V_a$	$\phi = BA\cos\theta$
$U = \frac{1}{2}CV^2 = \frac{1}{2}QV$	$\sum I = 0$	$\varepsilon = -\frac{\Delta\phi}{\Delta t}$
	$\sum \Delta V = 0$	$\varepsilon = -Blv$
	$\sum\varepsilon = \sum IR$	$E = hf = h\frac{c}{\lambda}$
		$E = \Phi + K_{max}$
		$p = \frac{h}{\lambda}$; $p = \sqrt{2mK}$
		$K_{max} = eV_\circ$

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2008/2009

SUBJECT	:	ENGINEERING MATHEMATICS II
CODE	:	BSM 1933
COURSE	:	1 BEE / 2 BEE / 3 BEE / 4 BEE
DATE	:	APRIL 2009
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS IN **PART A** AND **THREE (3)** QUESTIONS IN **PART B**

THIS EXAMINATION PAPER CONSISTS OF 7 PAGES

PART A

Q1 (a) Obtain the half-range cosine series for

$$f(x)=\pi-x,\ 0<x<\pi.$$

Expand the first three nonzero terms.

(10 marks)

(b) Using the definition of Fourier transform to find the Fourier transform of the following function.

$$f(t)=\begin{cases} t, & 0<t<1 \\ 0, & \text{otherwise.} \end{cases}$$

(5 marks)

(c) By using linearity and time shift, calculate the Fourier transform of

$$f(t)=5e^{-3t}H(t-1)+7e^{-3(t-2)}H(t-2).$$

[Hint:
Time shift for Fourier transform:
If $\mathcal{F}\{f(t)\}=F(\omega)$, then for any constant number a, $\mathcal{F}\{f(t-a)\}=e^{-i\omega a}F(\omega)$.]

(5 marks)

Q2 Given a second order ordinary differential equation

$$y''-y=e^{2x}.$$

Assume that the solution for the differential equation is $y(x)=\sum_{m=0}^{\infty}c_m x^m$.

(a) Find $y'(x)$ and $y''(x)$.

(2 marks)

(b) Expand the series up to x^3 in each summation, and by comparing coefficients of x^0, x^1, x^2 and x^3, show that the solution is

$$y(x)=c_0\left[1+\frac{x^2}{2}+\frac{x^4}{4!}+\cdots\right]+c_1\left[x+\frac{x^3}{3!}+\frac{x^5}{5!}+\cdots\right]+\left[\frac{x^2}{2}+\frac{x^3}{3}+\frac{5x^4}{24}+\frac{x^5}{12}+\cdots\right].$$

$$\left[\text{Hint: } e^{2x}=\sum_{m=0}^{\infty}\frac{(2x)^m}{m!}\right]$$

(13 marks)

(c) Given the initial conditions for the differential equation are $y(0)=2$ and $y'(0)=6$. Find the particular series solution.

(5 marks)

PART B

Q3 (a) Using the substitutions $x = X + 3$ and $y = Y - 1$, show that the equation

$$\frac{dy}{dx} = \frac{2x - 3y - 9}{3x + 5y - 4}$$

can be reduced to a homogeneous equation. Hence, find the solution of the original equation.

(13 marks)

(b) Given the *R-L* circuit with source of emf, $E(t)$ as in **Figure Q3 (b)** below.

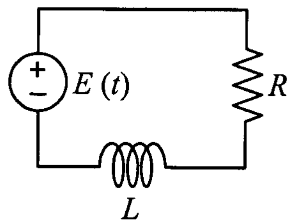

Figure Q3 (b)

The circuit has inductance $L = 5$ H, resistance $R = 15\,\Omega$, electromotive force $E(t) = 10$ V and $i(t)$ A is the current flowing in the circuit. The initial current is i_0.

(i) Show that the mathematical model for the *R-L* circuit is given by

$$\frac{di(t)}{dt} + 3i(t) = 2.$$

(ii) Find the current, $i(t)$, flowing in the circuit at time t.

(7 marks)

Q4 Given a *LC*-circuit in **Figure Q4** with $L = 4$ H, $C = 0.01$ F, which is connected to a source of voltage $E(t) = 400 \sin 5t$ V.

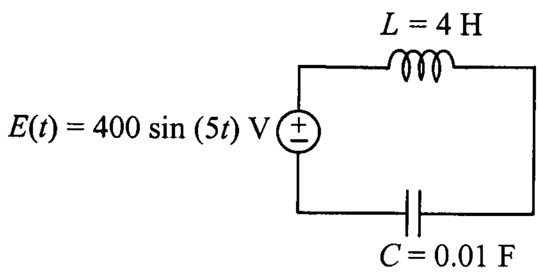

Figure Q4

(a) Show that the *LC*-circuit can be modelled by $i'' + 25\,i = 500 \cos 5t$.

(3 marks)

(b) Find the general solution to the second-order differential equation in (a).

(10 marks)

(c) Given when $t = 0$, the charge, $q(0) = -1$, show that $i'(0) = 25$.

(2 marks)

(d) Find the particular solution to the second-order differential equation in (a) if the current is zero when $t = 0$.

(5 marks)

Q5 Given the network circuit in **Figure Q5** below.

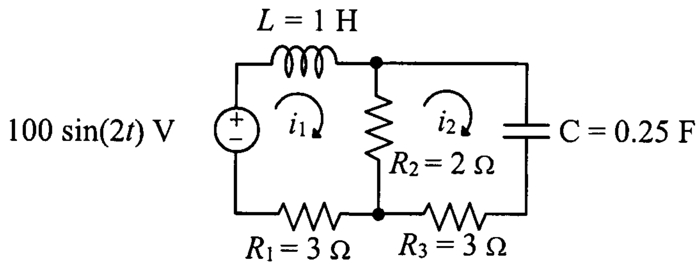

Figure Q5

(a) Show that the network circuit can be modeled by the following system of first-order differential equation

$$\begin{pmatrix} i_1' \\ i_2' \end{pmatrix} = \begin{pmatrix} -5 & 2 \\ -2 & 0 \end{pmatrix} \begin{pmatrix} i_1 \\ i_2 \end{pmatrix} + \begin{pmatrix} 100\sin(2t) \\ 40\sin(2t) \end{pmatrix}.$$

(4 marks)

(b) Find the general solution to the above system of first-order differential equation by using method of undetermined coefficients.

(16 marks)

Q6 (a) Prove that

$$\mathcal{L}^{-1}\left[\frac{1-e^{-10s}}{(3s+1)(s+1)}\right] = \left[\frac{1}{2}e^{-\frac{1}{3}t} - \frac{1}{2}e^{-t}\right] - \left[\frac{1}{2}e^{-\frac{1}{3}(t-10)} - \frac{1}{2}e^{-(t-10)}\right]H(t-10).$$

(10 marks)

(b) **Figure Q6 (b)** below shows an RLC circuit with $L = 3$ H, $R = 4\,\Omega$, and $C = 1$ F which is initially at rest. A power source of 5V is applied to the circuit for the first 10 seconds. After 10 seconds, the power source is removed.

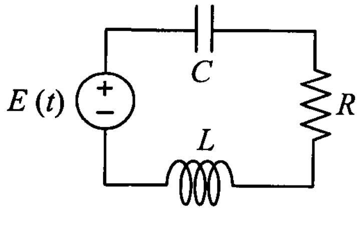

Figure Q6 (b)

(i) Show the *RLC* circuit can be governed by

$$3\frac{di}{dt}+4i+\int_0^t i(\tau)\,d\tau=5\left[1-H(t-10)\right].$$

(ii) Using the answer in **Q6** (a), find the current $i(t)$ in the circuit at any time t.

(10 marks)

FINAL EXAMINATION

SEMESTER / SESSION: SEM II / 2008/2009 COURSE : 1 BEE / 2 BEE / 3 BEE / 4 BEE

SUBJECT : ENGINERRING MATHEMATICS II CODE : BSM 1933

Formulae

Second-order Differential Equation

The roots of characteristic equation and the general solution for differential equation $ay'' + by' + cy = 0$.

Characteristic equation: $am^2 + bm + c = 0$.		
Case	The roots of characteristic equation	General solution
1.	Real and different roots: m_1 and m_2	$y = Ae^{m_1 x} + Be^{m_2 x}$
2.	Real and equal roots: $m = m_1 = m_2$	$y = (A + Bx)e^{mx}$
3.	Complex roots: $m_1 = \alpha + \beta i$, $m_2 = \alpha - \beta i$	$y = e^{\alpha x}(A\cos\beta x + B\sin\beta x)$

The method of undetermined coefficients for system of first order linear differential equations

For non-homogeneous for system of first order linear differential equations $\mathbf{Y}'(x) = A\,\mathbf{Y}(x) + \mathbf{G}(x)$, the particular solution $\mathbf{Y}_p(x)$ is given by:

$\mathbf{G}(x)$	$\mathbf{Y}_p(x)$	$\mathbf{G}(x)$	$\mathbf{Y}_p(x)$
$\mathbf{u}$	$\mathbf{a}$	$\mathbf{u}e^{\lambda x}$	$\mathbf{a}e^{\lambda x}$
$\mathbf{u}x + \mathbf{v}$	$\mathbf{a}x + \mathbf{b}$	$\mathbf{u}\cos\alpha x$ or $\mathbf{u}\sin\alpha x$	$\mathbf{a}\sin\alpha x + \mathbf{b}\cos\alpha x$

Laplace Transform

$$\mathcal{L}\{f(t)\} = \int_0^\infty f(t)e^{-st}\,dt = F(s)$$

$f(t)$	$F(s)$	$f(t)$	$F(s)$
a	$\frac{a}{s}$	$\int_0^t f(\tau)\,d\tau$	$\frac{F(s)}{s}$
e^{at}	$\frac{1}{s-a}$	$H(t-a)$	$\frac{e^{-as}}{s}$
$\sin at$	$\frac{a}{s^2+a^2}$	$f(t-a)H(t-a)$	$e^{-as}F(s)$
$\cos at$	$\frac{s}{s^2+a^2}$	$\delta(t-a)$	e^{-as}
$\sinh at$	$\frac{a}{s^2-a^2}$	$f(t)\delta(t-a)$	$e^{-as}f(a)$
$\cosh at$	$\frac{s}{s^2-a^2}$	$\int_0^t f(u)g(t-u)\,du$	$F(s)\cdot G(s)$
t^n, $n = 1,2,3,\ldots$	$\frac{n!}{s^{n+1}}$	$y(t)$	$Y(s)$
$e^{at}f(t)$	$F(s-a)$	$y'(t)$	$sY(s) - y(0)$
$t^n f(t)$, $n = 1,2,3,\ldots$	$(-1)^n \frac{d^n}{ds^n}F(s)$	$y''(t)$	$s^2Y(s) - sy(0) - y'(0)$

FINAL EXAMINATION

SEMESTER / SESSION: SEM II / 2008/2009 COURSE : 1 BEE / 2 BEE / 3 BEE / 4 BEE

SUBJECT : ENGINERRING MATHEMATICS II CODE : BSM 1933

Electrical Formula

1. Voltage drop across resistor, R (Ohm's Law): $v_R = iR$
2. Voltage drop across inductor , L (Faraday's Law): $v_L = L\dfrac{di}{dt}$
3. Voltage drop across capacitor , C (Coulomb's Law): $v_C = \dfrac{q}{C}$ or $i = C\dfrac{dv_C}{dt}$
4. The relation between current, i and charge, q: $i = \dfrac{dq}{dt}$.

Fourier Series

Fourier series expansion of periodic function with period $2L/2\pi$	Half Range series
$a_0 = \frac{1}{L}\int_{-L}^{L} f(x)\,dx$	$a_0 = \frac{2}{L}\int_{0}^{L} f(x)\,dx$
$a_n = \frac{1}{L}\int_{-L}^{L} f(x)\cos\frac{n\pi x}{L}\,dx$	$a_n = \frac{2}{L}\int_{0}^{L} f(x)\cos\frac{n\pi x}{L}\,dx$
$b_n = \frac{1}{L}\int_{-L}^{L} f(x)\sin\frac{n\pi x}{L}\,dx$	$b_n = \frac{2}{L}\int_{0}^{L} f(x)\sin\frac{n\pi x}{L}\,dx$
$f(x) = \frac{1}{2}a_0 + \sum_{n=1}^{\infty} a_n\cos\frac{n\pi x}{L} + \sum_{n=1}^{\infty} b_n\sin\frac{n\pi x}{L}$	$f(x) = \frac{1}{2}a_0 + \sum_{n=1}^{\infty} a_n\cos\frac{n\pi x}{L} + \sum_{n=1}^{\infty} b_n\sin\frac{n\pi x}{L}$

Table of Fourier Transform $\mathcal{F}\{f(t)\} = \int_{-\infty}^{\infty} f(t)\,e^{-i\omega t}\,dt$

$f(t)$	$F(\omega)$	$f(t)$	$F(\omega)$
$\delta(t)$	1	$\text{sgn}(t)$	$\frac{2}{i\omega}$
$\delta(t-\omega_0)$	$e^{-i\omega_0\omega}$	$H(t)$	$\pi\delta(\omega) + \frac{1}{i\omega}$
1	$2\pi\delta(\omega)$	$e^{-\omega_0 t}H(t)$ for $\omega_0 > 0$	$\frac{1}{\omega_0 + i\omega}$
$e^{i\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$	$t^n e^{-\omega_0 t}H(t)$ for $\omega_0 > 0$	$\frac{n!}{(\omega_0 + i\omega)^{n+1}}$
$\sin(\omega_0 t)$	$i\pi[\delta(\omega+\omega_0) - \delta(\omega-\omega_0)]$	$e^{-at}\sin(\omega_0 t)H(t)$ for $a > 0$	$\frac{\omega_0}{(a+i\omega)^2 + \omega_0^2}$
$\cos(\omega_0 t)$	$\pi[\delta(\omega+\omega_0) + \delta(\omega-\omega_0)]$	$e^{-at}\cos(\omega_0 t)H(t)$ for $a > 0$	$\frac{a+i\omega}{(a+i\omega)^2 + \omega_0^2}$
$\sin(\omega_0 t)H(t)$	$\frac{\pi}{2}i[\delta(\omega+\omega_0) - \delta(\omega-\omega_0)] + \frac{\omega_0}{\omega_0^2 - \omega^2}$		
$\cos(\omega_0 t)H(t)$	$\frac{\pi}{2}[\delta(\omega+\omega_0) + \delta(\omega-\omega_0)] + \frac{i\omega}{\omega_0^2 - \omega^2}$		