-1- Consider the two signals :

$F(t) = 2+3\cos(100\pi t)+4\cos(200\pi t)+6\cos(400\pi t)$

$G(t) = \dfrac{\cos(100\pi t).\sin(300\pi t) - \sin(100\pi t).\cos(300\pi t)}{\sin(200\pi t)}$

Find the period of each of the signals, TF and TG. (p25)

a) TF=1/100 TG=1/100 b) TF=1/200 TG=1/300

c) TF=1/50 TG=1/50 d) TF=7/200 TG=1/200

→ e) None of the above

-2- The signal F(t) given in (1) is an approximation of the real signal f(t) with average power equal to 50Watt.
What is the %average power error in the approximation?(take R=1Ω) (p25)

a) 31% b) 35% c) 65% d) 39% e) None of the above

-3- Consider the trigonometric Fourier series representation of f(t) as given over the interval (-2,2): $f(t) = \begin{cases} t+1 & -1\le t\le 0 \\ -t+1 & 0\le t\le 1 \\ 0 & \text{elsewhere} \end{cases}$

The Fourier series is also a representation of the periodic signal F(t) obtained by repeating f(t) periodically. The period of F(t) is: (p25)

a) 3 b) 2 c) 1 d) 4 e) None of the above

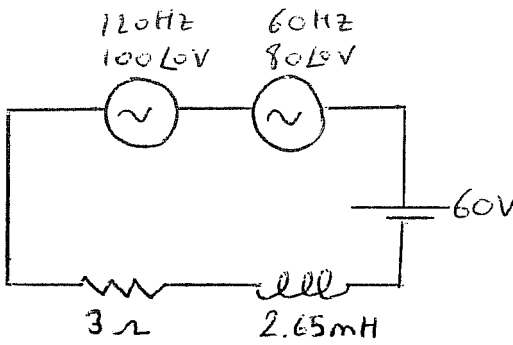
-4- Two periodic functions of period 6 seconds each are given by:

$f(t) = \begin{cases} -t & -3<t\le 0 \\ t & 0\le t<3 \end{cases}$ $\qquad$ $g(t) = \begin{cases} 1 & 0<t<3 \\ -1 & 3<t<6 \end{cases}$

Find the ratio of the amplitude of the 3rd harmonic present in f(t) to that present in g(t). (p25)

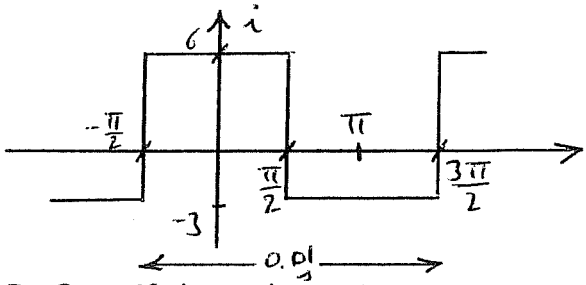
a) $1/\pi$ b) $3/\pi$ c) $\pi/3\pi$ d) π e) None of the above

-5- Calculate the rms value of the current flowing in the circuit shown. (p26)



a) 8.5A b) 54.85A c) 42.58A
d) 25A e)None of the above

-6- For the wave shown, calculate A_0, A_5 and B_5. (p26)



a) $A_0=1.5$, $A_5=1.5$ b) $A_5=1.15$
c) $B_5=1.5$ d) $A_5=1.5$, $B_5=1.15$
e) None of the above

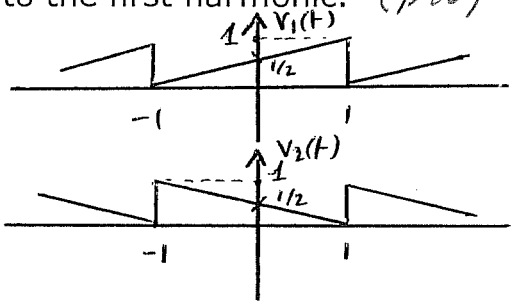
-7- Find the average power in a resistance $R=2\Omega$, if the voltage is $v= 32\text{Sin}(3t)\text{Cos}^2(t/2)$ (p26)

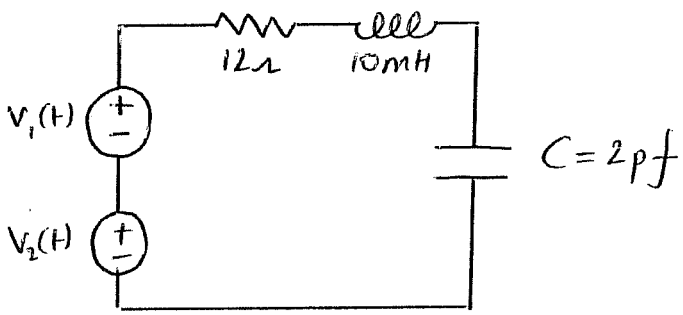
a) 256W b) 512W c) 192 W d) 96 W e) None of the above

-8- In a circuit : $v(t) = 5\text{Sin}(t) +10\text{Sin}(3t)$,
$I(t) = 7\text{Sin}(2t) + 50\ \text{Sin}(8t)$
What is the average power ? (p26)

a) 267.5 W b) 0 W c) 250 W d) 35 W e) None of the above

-9- Two periodic voltages V1(t) and V2(t) of the same period (T=2s)are applied to the circuit. Find the current in this circuit due to the first harmonic. (p26)



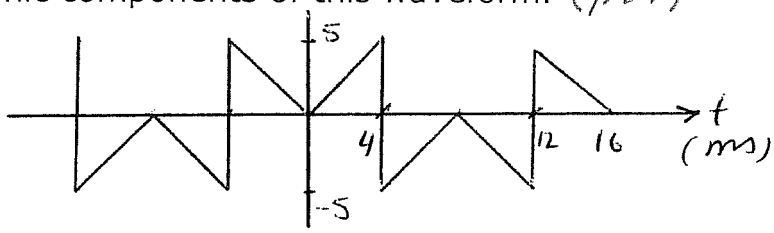


a) 12 Cos(πt) b) 12 Sin(πt) c) 12Cos(πt)+12Sin(πt)
d) 0 e) None of the above

-10- The function e^x $(0<x<1)$ is to be represented by a cosine series, find a_2. (p26)

a)−0.684 b)−0.0827 c)0.0848 d)0.0424 e) None of the above

-11- Consider the wave form f(t). Find the amplitude and phase of the 3rd harmonic components of this waveform. (p27)



a) C_3= 5.1 $\theta_3=\pm 90°$ b) C_3= 2.57 $\theta_3=\pm 90°$
c) C_3= 4.8 $\theta_3=\pm 180°$ d) C_3= 5.1 $\theta_3=\pm 180°$ e) None of the above

-12- A rectifier system with input f(t)and output g(t) is described by: $g(t) = |f(t)|$. For an input of $f(t) = (\pi/4)\mathrm{Sin}(w_0 t)$, the coefficient of the exponential Fourier series of g(t) with n even is: (p27)

a) $1/\ 2(1-n^2)$ b) $1/(1-n^2)$ c) $2/(1-n^2)$ d) $1/(\pi-\pi n^2)$ e)None of the above

-13- Let the signal f(t) be a signal defined between $-\pi$ and π. F(t) is zero outside the following exponential Fourier series: (p27)

$$\sum_{n=-\infty}^{\infty} C_n \cdot e^{\left(\frac{jnt}{2}\right)}$$

The series represents the periodic extension of f(t) with period T. Find T.

a) 8π b) 2π c) 6π d) 4π e) None of the above

-14- Consider the following signal :
$F(t) = 2\mathrm{Cos}(100\pi t)+3\mathrm{Cos}(300\pi t)+6\mathrm{Cos}(500\pi t)+9\mathrm{Sin}(300\pi t)$
Find the coefficients of the exponential Fourier series of F(t). (p27)

a) $C_1=C_{-1}=1$; $C_3=1.5-4.5j$ $C_{-3}=1.5+4.5j$; $C_5=C_{-5}=3$
b) $C_1=C_{-1}=-1$; $C_3=4.5-1.5j$ $C_{-3}=4.5+1.5j$; $C_5=C_{-5}=-3$
c) $C_1=C_{-1}=2$; $C_3=2.5-4.5j$ $C_{-3}=2.5+4.5j$; $C_5=C_{-5}=3$;
d) $C_1=C_{-1}=2$; $C_3=2.5-4.5j$ $C_{-3}=2.5+4.5j$; $C_5=C_{-5}=3$;
e) None of the above

-15- Consider a resistance $R=1\Omega$ across which the following voltage is induced : $V(t) = e^{j100\pi t}+(2+4j)\ e^{j200\pi t}+(3+9j)e^{j300\pi t}$
Find the % energy contained in this sum when taken as an approximation of the signal f(t) defined over (1/50 s; 2/50 s).
f(t) has an energy E=2.5 joules. (p27)

a) 78.8% b) 82% c) 88.8% d) 98.8% e) None of the above

-16- A voltage $v(t) = \cos(w_1 t)+2\sin(w_2 t)$ with $f_1=4KHz$ and $f_2=8KHz$ is passed through a non-linear system having a transfer function of the form : $V_0(t)=v+0.1v^2$
How many distortion (harmonic and inter-modulation) components are present in the output voltage? (p28)

a) 2 b) 4 c) 6 d) 8 e) None of the above

-17- If two filters of 300Hz passband are used at each frequency, how many distortion components will remain?(referring to -16-) (p28)

a) 2 b) 4 c) 6 d) None e) None of the above

-18- Referring to -16-, what is the amplitude and phase distortion of the output voltage? (p28)

a)A=0.8, $\theta=2.9°$
b) A=1, $\theta=45°$
c)A=1.02, $\theta=11.3°$
d)A=1.2 , $\theta=90°$
e)None of the above

1. Find the rms value of v(t) in Fig. 1 over the time interval (0, 5). (p 70)

A. $v_{rms} = 0.54$
B. $v_{rms} = 0.98$
C. $v_{rms} = 0.86$
D. $v_{rms} = 0.68$
E. None of the above

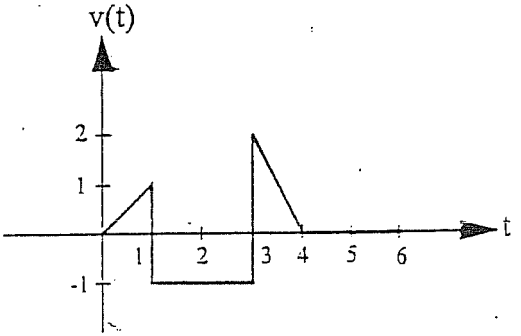


Figure 1.

10. Find the expression for the Fourier coefficients C_n for the periodic function shown in Fig. 9. (p 71)

A. $1/2\pi n$, $n \neq 0$; $1/2$, $n = 0$
B. $j/\pi n$, $n \neq 0$; 0, $n = 0$
C. $j/2\pi n$, $n \neq 0$; $1/2$, $n = 0$
D. $j/3\pi n$, $n \neq 0$; 1, $n = 0$
E. None of the above

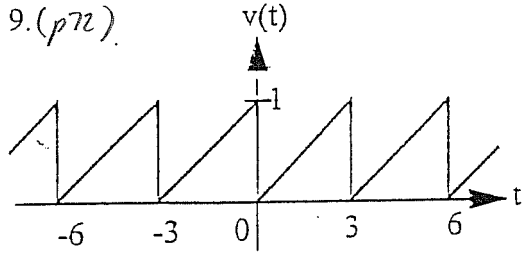


Figure 9.

11. A periodic function is represented by:

$$v(t) = \sum_{n=-\infty}^{+\infty} V_n \, e^{j200\pi \, nt}$$

Fig. 10 shows the plot of the magnitude of the coefficients Vn. Find the average and the fundamental frequency of v(t). (p 72)

A. 2; 1Hz
B. 5; 10 Hz
C. 0; 10 Hz
D. 5; 100 Hz
E. None of the above

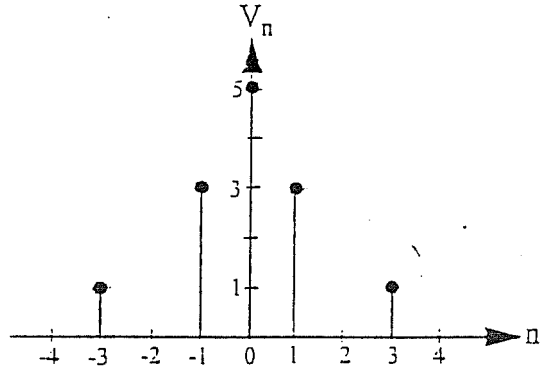


Figure 10.

14. Calculate the power dissipated in the resistor in Fig. 12 if $v_1(t) = 10\cos t$ and $v_2(t) = 10\cos 3t$. (p 73)

A. 12.7 W
— B. 50.7 W
C. 60.8 W
D. 70.5 W
E. None of the above

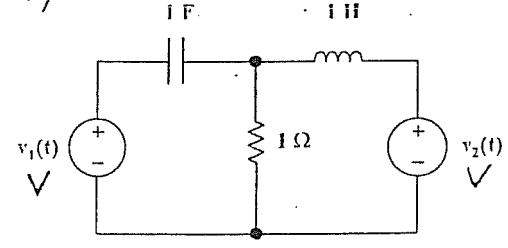


Figure 12

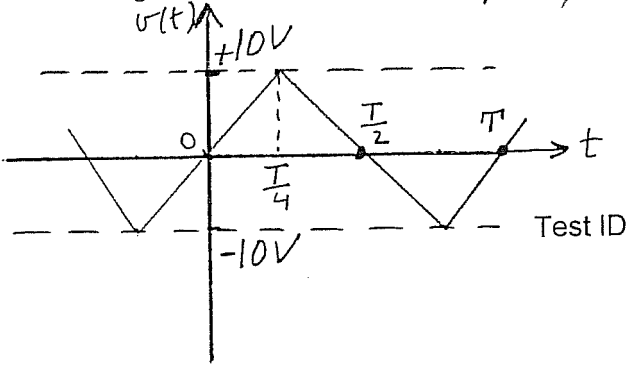
4. A series RL circuit in which R = 5Ω and L= 20 mH has an applied voltage v=100+ 50sin ωt + 25sin 3ωt V, with ω=500 rads/s. Find the instantaneous current. (p 104)

a. i=20+4.47sin(ωt+63.4)+0.822 sin(3ωt+80.54), A
b. i=20+4.47sin(ωt-63.4)+0.822 sin(3ωt-80.54), A
c. i=8.96+4.47sin(ωt-63.4)+0.822 sin(3ωt-80.54), A
d. i=sin(ωt-63.4)+0.822 sin(3ωt-80.54), A
e. None of the above

5. Determine the power dissipated in the resistor of problem 4. p(104)

a. ~50.1 W
b. ~51.79 W
c. ~2000W
d. ~ 2053 W
e. None of the above

11. The figure below shows the triangular waveform of a voltage source operating at frequency f= 1kHz. Find the amplitudes of the fundamental (I_1) and the second order harmonic (I_2) current that flows through an inductor of value L= 1mH when it is supplied by this source.. (Answers are rounded to 2 digits after the decimal point) (p106)



a) $I_1 = 2.31$ A, $I_2 = 1.10$ A
b) $I_1 = 1.34$ A, $I_2 = 0$ A
c) $I_1 = 0$ A, $I_2 = 1.10$ A
d) $I_1 = 1.29$ A, $I_2 = 0$ A
e) None of the above

6. Consider a periodic function f(t), described by the following sequence during one period of time:

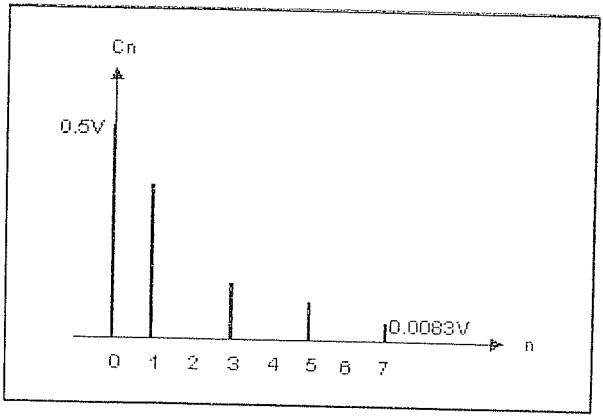
$f(t) = 0$	for	$-4 \le t < -3$
$f(t) = -Vm$	for	$-3 \le t < -1$
$f(t) = 0$	for	$-1 \le t < +1$
$f(t) = +Vm$	for	$+1 \le t < +3$
$f(t) = 0$	for	$+3 \le t \le +4$

where Vm = 20. Find the amplitude "A" of the third order harmonic in the Fourrier series, expressed by $A\cos(3\omega t - \Theta)$. (p123)

a) A=3
b) A=4
c) A=5
d) A=6
e) None of the above

8. The following spectrum is the frequency representation of which Fourier function:

(p124)



a. $f(t) = \frac{4V}{\pi}\sin \omega t + \frac{4V}{3\pi}\sin 3\omega t + \frac{4V}{5\pi}\sin 5\omega t + \ldots$

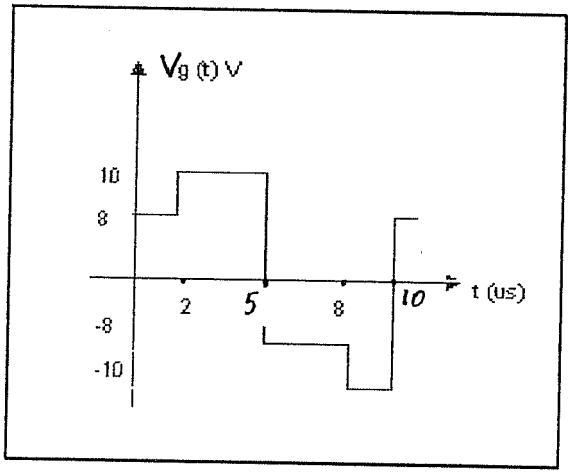
b. $f(t) = \frac{V}{2} + \frac{4V}{\pi}\sin \omega t + \frac{4V}{3\pi}\sin 3\omega t + \frac{4V}{5\pi}\sin 5\omega t + \ldots$

c. $f(t) = \frac{V}{2} + \frac{4V}{\pi^2}\cos \omega t + \frac{4V}{(3\pi)^2}\cos 3\omega t + \frac{4V}{(5\pi)^2}\cos 5\omega t + \ldots$

d. $f(t) = \frac{V}{8} + \frac{4V}{\pi^2}\sin \omega t + \frac{4V}{(3\pi)^2}\sin 3\omega t + \frac{4V}{(5\pi)^2}\sin 5\omega t + \ldots$

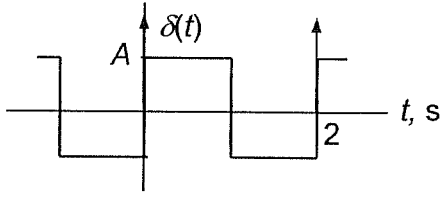
e. None of the above

11. The voltage waveform shown below is applied across a 10 Ω resistor. Determine the power dissipated by that resistor. (p125)



a. 75.6 W
b. 8.2 W
c. 7.56 W
d. 37.8 W
e. None of the above

7. A periodic signal consists of a square wave of a square wave of amplitude $\pm A$, and unit impulse, the period of both signals being 2 s. Determine the magnitude of the third harmonic if $A = 1$. (p126)



A. 0.86
B. 1.21
C. 1.42
D. 1.85
E. None of the above`

4. A complex waveform of RMS value of 240 V has 20% 3-rd harmonic content, 5% 5-th harmonic content and 2% 7-th harmonic content. Find the RMS value of the 3-rd and 7-th harmonics respectively. (p139)

A. 11.5V, 4.6V
B. 7.6V, 1.3V
C. 47 V, 4.7V
D. 30V, 3.2V
E. None of the above

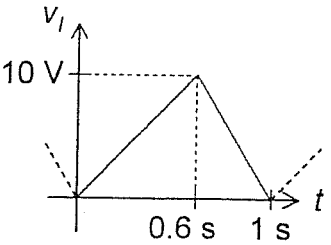
11. A voltage v(t) is applied to a 5Ω resistor. v(t) can be written as:

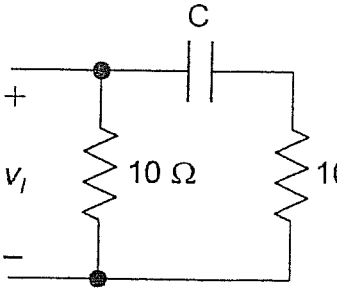
$$v(t) = 1 - \Sigma^{\infty}_{n=1} (1/n^2) \cos (500nt)$$

Estimate the Power dissipated in the resistor using the first four non-zero terms of v(t). (p 141)

a. 2.36 W
b. 0.31W
c. 1.25W
d. 0.95W
e. None of the above

18. The periodic voltage v_I is applied to the circuit shown, the reactance of C at the frequency of the fundamental being much smaller than 10 Ω. Determine the power dissipated in the circuit. (p144)





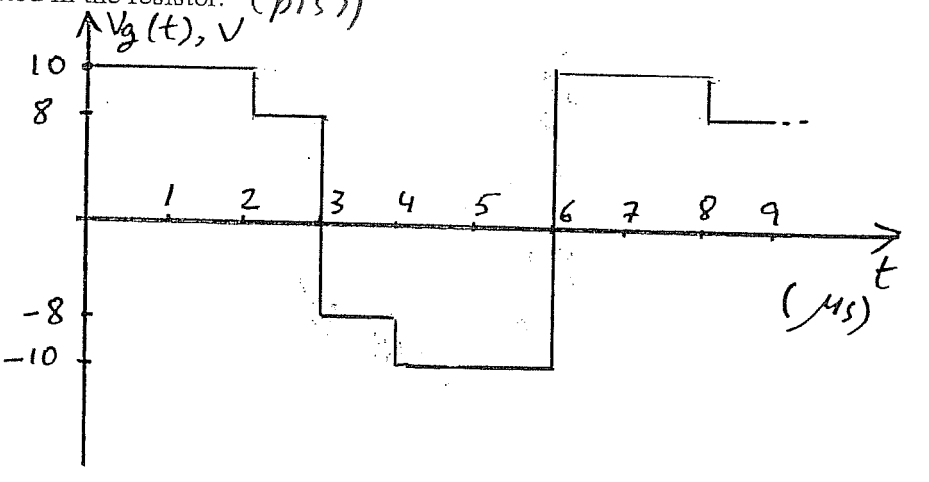
A. 13.33 W
B. 8.33 W
C. 6.67 W
D. 4.17 W
E. None of the above

20. The current through a 1 μF capacitor is $2\cos^2 100\pi t$ mA, where t is in s. Determine the period of the voltage across the capacitor.

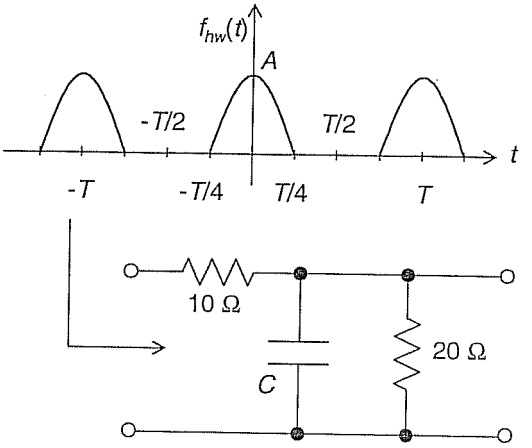
A. 25 ms
B. 50 ms
C. 100 ms
D. 200 ms
E. None of the above

4. The periodic voltage waveform shown below is applied across a 10 Ω resistor. Determine the average power dissipated in the resistor. (p157)

a. 8.8 W
b. 88W
c. 77.4W
d. 4.4W
e. None of the above



9. A half-wave rectified waveform $f_{hw}(t)$ of frequency 50 Hz and having $A = 10$ V is applied to the circuit shown, where the reactance of C is negligible at 50 Hz. Determine the total power dissipated in the circuit. (p158)



A. 0.83 W
B. 1.49 W
C. 1.82 W
D. 2.5 W
E. None of the above

17. The time domain representation of a certain periodic signal is:
$f(t) = 2\delta(t+3T/8) - 2\,\delta(t+T/8) + 2\,\delta(t-T/8) - 2\,\delta(t-3T/8)$

The correct truncated Fourier series for T=1 is (p 161)

a. $8\sqrt{2}\cos(2\pi t) - 8\sqrt{2}\cos(6\pi t) - 8\sqrt{2}\cos(10\pi t) + 8\sqrt{2}\cos(14\pi t)$

b. $-8\sqrt{2}\sin(2\pi t) - 8\sqrt{2}\sin(6\pi t) + 8\sqrt{2}\sin(10\pi t) + 8\sqrt{2}\sin(14\pi t)$

c. $16\sin(4\pi t) - 16\sin(12\pi t)$

d. $-16\cos(8\pi t) + 16\cos(16\pi t) + 8$

e. None of the above

8%

4. A voltage having the waveform of the figure of Problem 9 below, with $A = 8$ V and $T = 1$ s is applied to a coil having a resistance of 4 Ω and an extremely large inductance. Determine the average power dissipated in the coil. (p170)

   A. 1.56 W

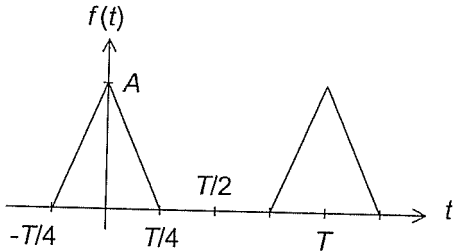
   B. 1 W

   C. 3.28 W

   D. 4 W

   E. None of the above

9. Derive the FSE of the waveform shown, expressing it in trigonometric form. (p 173)



Solution: The function is even, and $a_0 = C_0 =$

$$\frac{1}{T}\times A\times\frac{T}{4}=\frac{A}{4};\ C_n=\frac{2A}{T}\int_0^{T/4}\left(-\frac{4}{T}t+1\right)\cos n\omega_0 t dt =$$

$$\mathrm{Re}\left\{\frac{2A}{T}\int_0^{T/4}\left(-\frac{4}{T}t+1\right)e^{-jn\omega_0 t}dt\right\} =$$

$$\mathrm{Re}\left\{\frac{2A}{T}\left[\frac{4te^{-jn\omega_0 t}}{jn\omega_0 T}-\frac{4e^{-jn\omega_0 t}}{n^2\omega_0^2 T}-\frac{e^{-jn\omega_0 t}}{jn\omega_0}\right]_0^{T/4}\right\}=\frac{2A}{T}\times\frac{4}{n^2\omega_0^2 T}=\frac{2A}{\pi^2 n^2}.\ \text{Hence, } a_n=\frac{4A}{\pi^2 n^2},$$

$$\text{and } f(t)=\frac{A}{4}+\frac{4A}{\pi^2}\left(\cos\omega_0 t+\frac{1}{4}\cos 2\omega_0 t+\frac{1}{9}\cos 3\omega_0 t+\frac{1}{16}\cos 4\omega_0 t+\ldots\right).$$

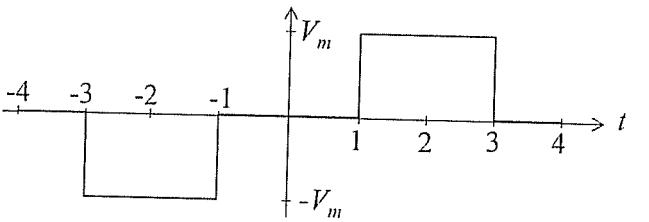
6. Consider a periodic function f(t), described by the following sequence during one period of time:

$f(t) = 0$	for	$-4 \le t < -3$
$f(t) = -Vm$	for	$-3 \le t < -1$
$f(t) = 0$	for	$-1 \le t < +1$
$f(t) = +Vm$	for	$+1 \le t < +3$
$f(t) = 0$	for	$+3 \le t \le +4$

where Vm = 20. Find the amplitude "A" of the third order harmonic in the Fourrier series, expressed by $A\cos(3\omega t - \Theta)$. (p176)

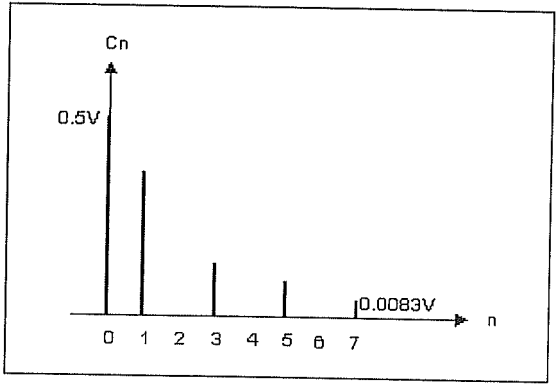
A. A=3
B. A=4
C. A=5
D. A=6
E. None of the above

Solution: The function is as shown. It is odd and quarter-wave symmetric. Hence, $a_0 = 0$ and $b_3 = \frac{8}{T}\int^{2} V_m \sin 3\omega_0 t dt$,



where $T = 8$ and $\omega_0 = \frac{2\pi}{8} = \frac{\pi}{4}$. Hence, $b_3 = \frac{8V_m}{3\omega_0 T}\left[-\cos 3\omega_0 t\right]_1^2 = \frac{160}{6\pi}\left[-\cos\frac{3\pi}{4} + \cos\frac{\pi}{2}\right] = \frac{80}{3\pi\sqrt{2}} = 6.0$

10. The following spectrum is the frequency representation of which Fourier function: (p178)



A. $f(t) = \frac{4V}{\pi}\sin\omega t + \frac{4V}{3\pi}\sin 3\omega t + \frac{4V}{5\pi}\sin 5\omega t + \ldots$

B. $f(t) = \frac{V}{2} + \frac{4V}{\pi}\sin\omega t + \frac{4V}{3\pi}\sin 3\omega t + \frac{4V}{5\pi}\sin 5\omega t + \ldots$

C. $f(t) = \frac{V}{2} + \frac{4V}{\pi^2}\cos\omega t + \frac{4V}{(3\pi)^2}\cos 3\omega t + \frac{4V}{(5\pi)^2}\cos 5\omega t + \ldots$

D. $f(t) = \frac{V}{8} + \frac{4V}{\pi^2}\sin\omega t + \frac{4V}{(3\pi)^2}\sin 3\omega t + \frac{4V}{(5\pi)^2}\sin 5\omega t + \ldots$

E. None of the above

11. A voltage $5\sin\omega_0 t$ V applied to a given resistor dissipates 5 W. What is the power dissipated by a voltage $5|\sin\omega_0 t|$ V applied to the same resistor? (P179)

A. 5 W

B. $5\sqrt{2}$ W

C. $5/\sqrt{2}$ W

D. 10 W

E. None on the above

Solution: The two waveforms have the same rms value and would therefore dissipate the same power in a given resistor.

14. The voltage waveform shown below is applied across a 10 Ω resistor. Determine the power dissipated by that resistor. (p179)

75.6 W

A. 8.2 W

B. 7.56 W

C. 37.8 W

D. None of the above

Solution: Mean square is

$$\frac{64\times 2+100\times 3+64\times 3+100\times 2}{10}=82.$$

$$P=\frac{82}{10}=8.2\text{ W}$$