7.8 Questions

1. A periodic waveform is the sum of three sinusoidal waveforms of period T, $0.5T$ and $0.2T$ respectively. Will this periodic waveform preserve its waveshape when differentiated and integrated?
2. What is the amplitude of $v(t)$=5sinωt–3cosωt and what is its phase in degrees with respect to $v_1(t)$=4sin(ωt - π/5)?
3. Is the composite waveform $v(t)$ = 2sinωt + 3cos$\sqrt{2}\omega t$ is periodic? If yes, what is its period?
4. Is the composite waveform $v(t)$ = 2 sin200πt + 4 cos(200.0001πt – 45^0) periodic? If yes, what is its period and cyclic frequency?
5. The voltage across a linear load is $v(t)$ = 100 sin(100πt-25^0) volts. If the load current $i(t)$ is found to lag $v(t)$ by 36^0 and $i(0)$ is 2 amps find $i(t)$ as a function of time.
6. What is the phase of the first derivative of a sinusoidal waveform with respect to the original waveform?
7. What is the phase of the indefinite integral of a sinusoidal waveform with respect to the original waveform?
8. If $v_1(t) = V_1 \sin \omega t$ and $v_2(t) = V_2 \sin(\omega t + \theta)$ what is the value of θ such that (i) $v_1(t) + v_2(t)$ has a minimum amplitude (ii) $v_1(t) + v_2(t)$ has a maximum amplitude (iii) $v_1(t) + v_2(t)$ has an amplitude of $(V_1 + V_2)/2$.
9. If $v_1(t) = V_1 \sin \omega t$, $v_2(t) = V_2 \sin(\omega t + \theta)$ and $v_3(t) = v_1(t) + v_2(t) = V_3 \sin(\omega t + \phi)$, find θ such that (V_1, V_2, V_3) is a Pythagorean triplet and find ϕ under this condition in terms of V_1 and V_2.
10. Derive an expression for phase angle of $v_2(t)$ with respect to $v_1(t)$ if $v_1(t) = a \sin \omega t + b \cos \omega t$ and $v_2(t) = c \sin \omega t + d \cos \omega t$.
11. Show that average power in an isolated circuit is a conserved quantity.
12. Show that cyclic average power in an isolated circuit is a conserved quantity.
13. An active circuit delivers $i(t)$ = 10 sin300πt amps into the positive terminal of a 12 V battery. The battery has an internal resistance of 0.2 Ω. (i) What is the average power delivered to the 12 V source inside the battery? (ii) What is the average power loss in the internal resistance of the battery?
14. The voltage across a linear load is $v(t)$ = 325 sin(100πt-25^0) volts. If the load current $i(t)$ is found to lead $v(t)$ by 36^0 and the average power delivered to the load is 250 watts, find $i(t)$ as a function of time.
15. Derive an expression for average power if $v(t) = a \sin \omega t + b \cos \omega t$ and $i(t) = c \sin \omega t + d \cos \omega t$ in terms of a, b, c and d.
16. A sinusoidal voltage source of 230 V rms delivers 1 kW of average power to a load. What is the minimum possible amplitude of load current?
17. What is the ratio between rms values of a symmetric square wave and a sinusoidal waveform with same amplitude?
18. What are the ratios between rms values and half-cycle average values of a symmetric triangle waveform and a sinusoidal waveform with same amplitude?
19. The rms value of a periodic waveform $v(t)$ with a frequency of 1kHz is found to be 10 volts. What is the rms value of $v_1(t)$ which has same amplitude and waveshape as that of $v(t)$, but has a frequency of 10 Hz?
20. The rms value of $V_m \sin\omega t$ is $V_m/\sqrt{2}$ for any value of ω. Explain why ω value does not affect the rms value.
21. If the average power delivered by a 50 Hz sinusoidal voltage to a resistor of 10Ω is 2 watts, what is the average power delivered to the same resistor by another sinusoidal voltage source with same amplitude and 5 kHz frequency?
22. Show that if V_{rms} is the rms value of a periodic waveform $v(t)$, the rms value of $av(t)$ is aV_{rms} where a is a real constant.
23. A sinusoidal voltage source $v(t)$ = 100 sin20πt is applied across a 10Ω resistor for 0.42 sec from $t = 0$. (i) Find the cyclic average power (ii) Find the average power delivered during the connection duration (iii) Why are the two values different?
24. A non-sinusoidal periodic voltage waveform with rms value of 100 volts is applied to a 10Ω resistor. What is the average power delivered to the resistor?
25. If $v(t) = V_m \sin\omega t + 0.5V_m \cos 3\omega t$ volts and $i(t) = I_m \sin(\omega t - 45^0) - 2I_m \cos(3\omega t - 45^0)$ amps are the terminal variables of a load, find the average power delivered to the load.
26. (a) If $v_1(t)$ = 5 sin 100πt and $v_2(t)$ = 5 sin 100πt , find the rms value of $v_1(t) + v_2(t)$, average power that will be delivered to a 10Ω resistor by $v_1(t) + v_2(t)$, and the energy that will be delivered to 10Ω resistor in 0.5 sec . (b) If $v_1(t)$ = 5 sin 100πt and $v_2(t)$ = 5 sin 100.000001πt, repeat part (a). Can the energy delivered in 0.5 sec be found from average power in this case? Why are the rms values so different in (a) and (b) for such a small change in frequency of one component?
27. A current $i(t)$ = 10 sin 200πt flows through a resistor of 5 Ω from $t = 0$ to $t = 32$ ms. Explain why energy delivered to the resistor is *not equal* to average power multiplied by duration of connection. Calculate the actual value of energy dissipated in the resistor.
28. A sinusoidal voltage source $v(t) = V_m \sin\omega t$ volts delivers a fixed amount of average power P through its internal resistance of R to a load. The load current has a general form of $i(t) = \sum_{n=1}^{\infty} a_n \sin n\omega t + b_n \cos n\omega t$ amps.

   Show that the fixed amount of average power delivered by the source reaches the load with maximum efficiency and minimum loss, when $i(t)$ is a pure sinusoidal waveform at ω rad/sec with zero phase difference from $v(t)$, *i.e.*, all a's and b's are zero-valued except a_1.
29. Show that the rms value of a periodic waveform $x(t)$ and its absolute value $|x(t)|$ are equal.