This question paper contains 8 printed pages]

HPAS (M)—2015

ELECTRICAL ENGINEERING

Paper I

Time : 3 *Hours* *Maximum Marks* : 150

Note :— Attempt *Five* questions in all, taking at least *one* from each part, but Question No. 1 is compulsory.

Part A

1. (*a*) For the pass-band filter shown in Fig. 1.

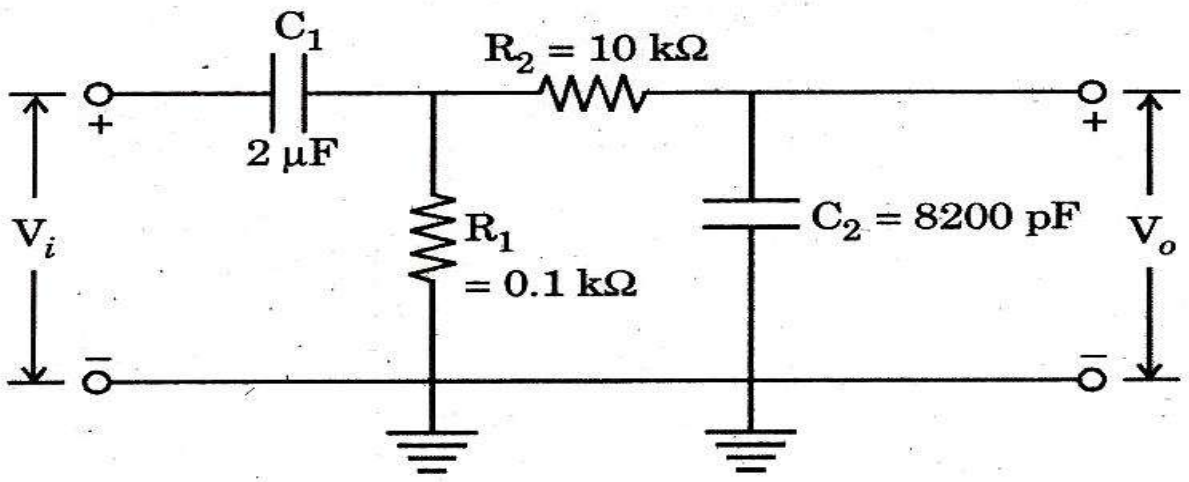

Fig. 1

P.T.O.

(*i*) Sketch the frequency response of $A_V = \frac{V_o}{V_i}$ against a log-scale extending from 10 Hz to 10 kHz.

(*ii*) What are the bandwidth and the center frequency ?

(*b*) Using superposition, find the voltage V_2 for the network in Fig. 2.

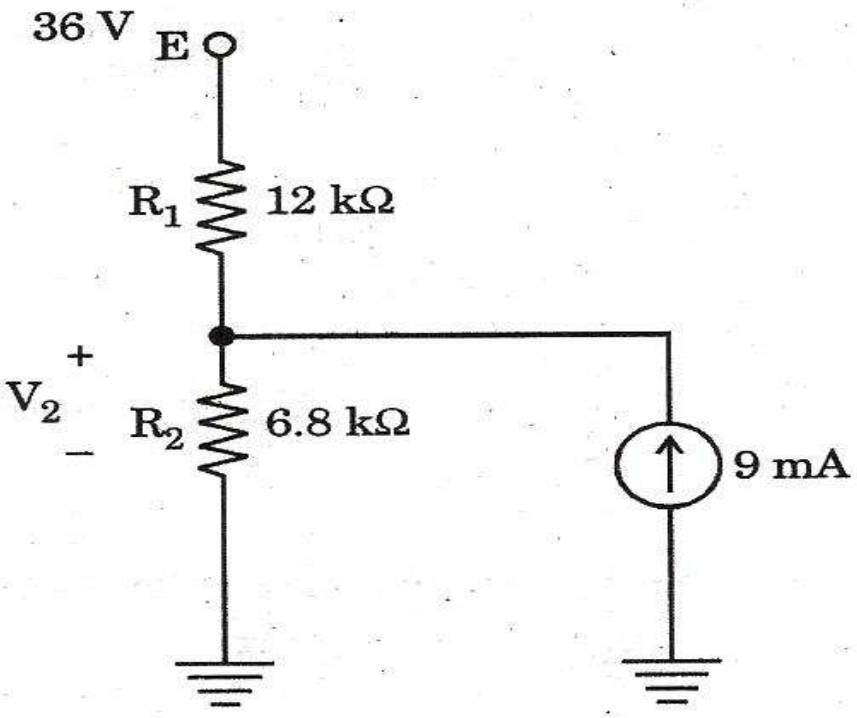

Fig. 2

2. (*a*) Sketch the following Fourier series expansion :

$$v = 2 + 1 \cos \alpha + 2 \sin \alpha.$$

(*b*) (*i*) If

$$y(z) = \frac{0.5\left(1 - 0.5z^{-1}\right)}{\left(1 - 0.25z^{-1}\right)\left(1 - 0.75z^{-1}\right)\left(1 - z^{-1}\right)},$$

find the steady-state value of $y(n)$ if it exists.

(*ii*) Find $x(\infty)$ if $X(z)$ is given by :

$$X(z) = \frac{3z}{(z-1)(z+1)}.$$

Part B

3. (*a*) Given the potential $V = \frac{10}{r^2} \sin\theta \cos\theta$, find the electric flux density D at $\left(2, \frac{\pi}{2}, 0\right)$.

(*b*) Show that a rectangular wave guide does not support TM_{10} and TM_{01} modes.

(*c*) A lossless transmission line with $Z_0 = 50\ \Omega$ is 30 m long and operates at 2 MHz. The line is terminated with a load $Z_L = (60 + j40)\ \Omega$. If $u = 0.6\ C$ on the line, find :

(*i*) The reflection coefficient

(*ii*) The standing wave ratios

(*iii*) The input impedance.

4. (*a*) Draw the circuit that can be used to offset current and offset voltage on inverting amplifier and explain its working.

(*b*) A customer needs an 18 kHz source at 200 V_{rms} for a special lighting application. The waveform should have THD below 5%. The input source is 240 V_{rms} at 60 Hz. Present a design to meet the loads.

Part C

5. (*a*) Assume switches ABCD of Fig. 3 are 0110. Compute output voltage.

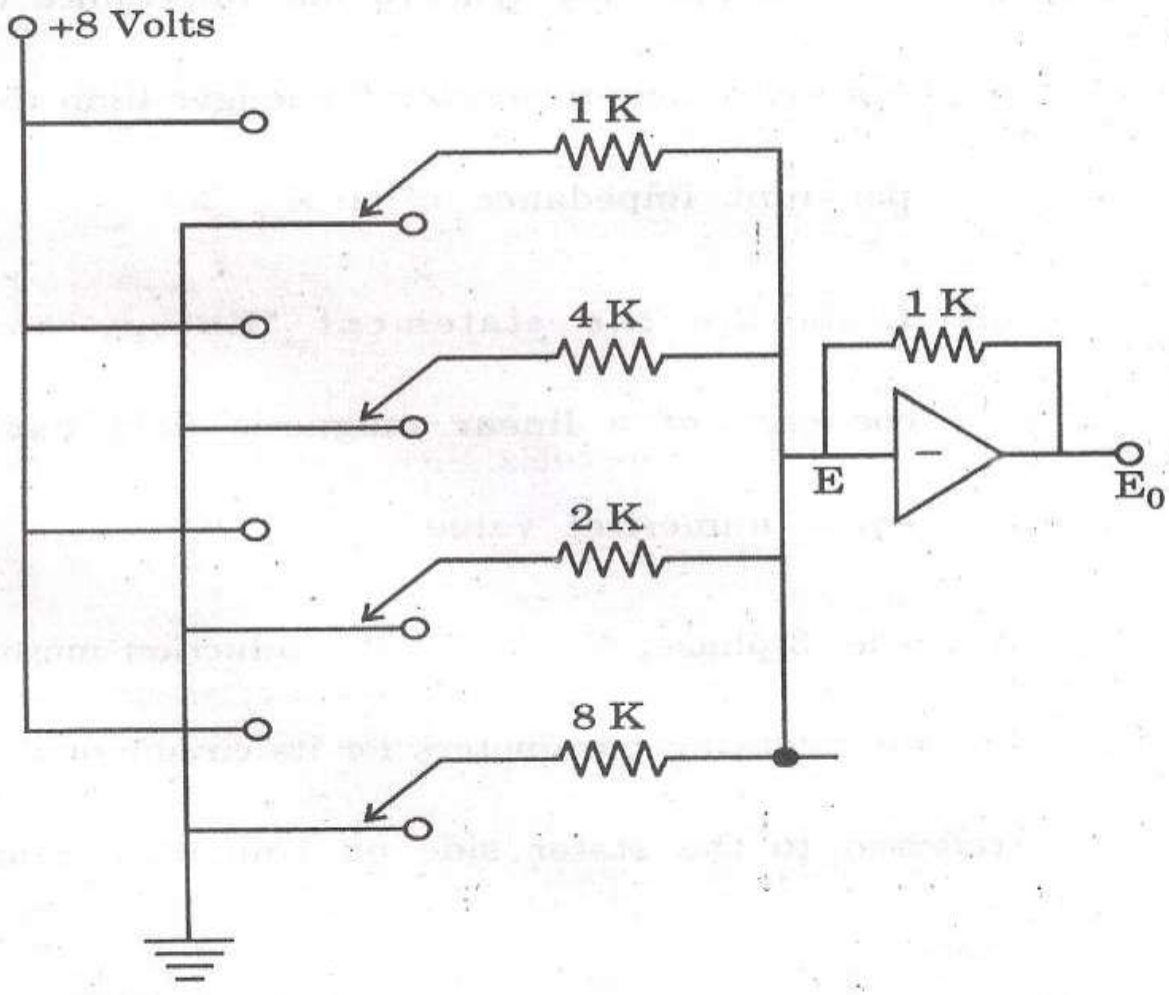

Fig. 3, Summing Network and Amplifier

P.T.O.

(*b*) (*i*) Add 3 and 2 in XS3

(*ii*) Add 4318 and 7677 in 8421

(*iii*) Convert a binary 1011 to gray code.

6. (*a*) (*i*) Why is per unit synchronous impedance of a synchronous generator far longer than the per unit impedance of a X_{er} ?

(*ii*) Elaborate the statement "Energy and coenergy of a linear magnetic field have equal numerical value".

(*b*) A 4-pole, 3-phase, 400 V, 50 Hz induction motor has the following parameters for its circuit model (referred to the stator side on equivalent star basis) :

$r_1 = 1.1\ \Omega, \quad X_1 = 1.15\ \Omega$

$r'_2 = 0.5\ \Omega, \quad X'_2 = 1.1\ \Omega$

X_m = 35 Ω and rotational losses are 800 W. For a speed of 1440 rpm, calculate the input current, power factor net mechanical power and torque and efficiency.

Part D

7. (*a*) Discuss the necessity of equalizing networks when thyristors are operated in series/parallel. Explain the schemes for :

(*i*) Series operation

(*ii*) Parallel operation.

(*b*) Describe the application of a static frequency converter feeding an a.c. motor for starting and acceleration purposes.

8. (*a*) The power in sidebands can have a maximum of one-third of the total AM signal transmitted power for 100% modulation. Calculate the percentage of power in the sidebands for 10% modulation. How does this justify that AM transmitters should be operated with the modulation as close to 100% as possible ?

(*b*) Explain in detail the advantages of FM over AM.