2014

PHYSICS

(Major)

Paper : 5.4

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Answer the following questions very briefly : 1×7=7

(a) Draw the Norton equivalent circuit from Thevenin equivalent circuit of an electric network containing impedances and voltage source.

(b) How does the value of emitter current of a common-base configuration transistor change due to early effect with change in reverse collector voltage?

(c) What is dark current of a photodiode?

(d) When β and V_{BE} are constants, the change of collector current with respect to reverse saturation current in common-base configuration of a transistor is equal to one. What is your comment regarding the stability of *Q*-point of this mode of operation of the transistor?

(e) In a two-port device, there are four variables—input voltage V_i, input current I_i, output voltage V_o and output current I_o. In h-parameter, which of these are taken as independent and which are taken as dependent variables?

(f) The basic principle of a power amplifier does not violate the law of conservation of energy. Explain.

(g) Mention one important merit and one important demerit of direct-coupled amplifier.

2. Answer the following questions : 2×4=8

(a) Under reverse biased condition, the saturation current through a silicon diode is 2 μA at a temperature T for which

$$\frac{q}{\eta kT} = 20 \text{ volt}^{-1}$$

where the symbols have their usual meanings. Find the current through the diode for a forward bias of 0·50 volt. (Given, $e^{10} \approx 22 \times 10^3$)

(b) What type of feedback is necessary for the working of an astable multivibrator and how is it achieved?

(c) Why is the use of SSB transmission limited?

(d) Give the graphical representations of ASK and PSK.

3. A PN diode having forward resistance of 100 Ω is used in a half-wave rectifier with a 1 kΩ resistive load. The rectifier is fed from the secondary of a step-down transformer having negligible resistance. If the output of the transformer secondary is 24 volt peak-to-peak alternating voltage of frequency 50 Hz then calculate *(i)* average and r.m.s. value of output current through the load, *(ii)* efficiency of the rectifier and *(iii)* frequency of the pulsating output voltage. 5

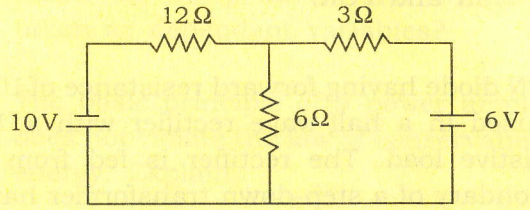
Or

Derive an expression for ripple factor of a full-wave rectifier with π-section filter.

4. Give the statement of maximum power transfer theorem. A source having internal impedance $(10 + j10)$ Ω generates an e.m.f. of $100 \angle 0°$ volt. It is connected across a load consisting of a fixed capacitive reactance 15 Ω and a variable resistor in series. Calculate the value of the resistor for which power delivered to the load by the source is maximum and the value of the maximum power delivered. 5

Or

Give the statement of Millman theorem. Use it to calculate the current through the 6 Ω resistor of the following network :



5. What is a universal gate? Draw a circuit diagram to build a universal gate and discuss its logic operations giving truth table and symbol. Realise basic gates from it. 5

Or

What is the need of preset and clear inputs in a flip-flop and how are they used? Draw the circuit diagram of a *J-K* flip-flop using NAND gate, where preset and clear inputs are incorporated. Explain its operation giving truth table and symbol.

6. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] of the following questions : 5+5=10

(a) What is a bias curve of a CE configuration transistor amplifier with self-bias and voltage divider arrangement? Explain the selection process of *Q*-point in above arrangement of a transistor using bias curve.

(b) Derive the expressions for overall current gain and overall voltage gain of a small-signal low-frequency CE configuration basic transistor amplifier using *h*-parameter equivalent circuit.

Or

(c) What are the 3 dB points in the frequency-response curve of a particular stage of an RC coupled CE configuration multistage transistor amplifier? In such an amplifier, the ratio of lower cut-off frequency and a particular low frequency is $\frac{1}{\sqrt{3}}$ and the ratio of higher cut-off frequency and a particular high frequency is $\sqrt{3}$. What are the total phase differences between input and output signals for the particular frequencies?

(d) What is harmonic distortion in case of a large signal transistor amplifier? Define distortion factor. Give the mathematical analysis of a commonly used circuit connection of a large signal amplifier, where harmonic distortion is minimised.

7. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] of the following questions : 5+5=10

(a) What is feedback in case of an amplifier? Draw the block diagrams of voltage shunt feedback and current series feedback. Discuss the effect of negative feedback on gain and distortion of a feedback amplifier.

(b) What is a differential amplifier? Draw the block diagram of an OP-AMP and describe the functions of different stages.

Or

(c) Why is the bridge of the Wien bridge oscillator made slightly unbalanced? Draw the circuit diagram of the Wien bridge oscillator and discuss how the above condition is achieved. What is the frequency of oscillation of this type of oscillator?

(d) An OP-AMP can be operated in inverting or non-inverting mode. Which one is preferred and why? An OP-AMP is operated in inverting mode with input resistance 100 Ω, feedback resistance 10 kΩ and power supply voltages ±12 volt. Calculate—

(i) output voltage and input current for an input voltage of 10 mvolt;

(ii) output voltage for an input voltage of 150 mvolt.

8. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] of the following questions : 5+5=10

(a) Give the graphical representation of the modulation suitable for mobile communication and emergency services. Establish the relation for modulated wave for the same and compare its bandwidth requirement with other type of modulation.

(Continued)

(b) In a cathode-ray oscilloscope, electrostatic deflection plates are 2 cm long and 5 mm apart, across which a potential difference of 50 volt is applied. If the screen is at a distance 30 cm from the midpoint of the deflection plates and final anode voltage is 1000 volt, calculate *(i)* electrostatic deflection sensitivity, *(ii)* displacement of the spot produced on the screen and *(iii)* the angle of deflection.

Or

(c) For what type of modulated signal superheterodyne receiver is suitable? What is heterodying process of incoming signal in this type of receiver and what is the main advantage of this process? Discuss the functions of the *(i)* RF stage, *(ii)* mixer and *(iii)* IF amplifier of a superheterodyne receiver.

(d) Derive an expression for the effective permittivity of ionosphere taking into account the presence of free electrons only and hence discuss the reflection of radio waves from ionospheric layers.

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