2013

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) Explain how the reverse saturation current depends on temperature.

(b) How does a shunt capacitor work as a filter?

(c) What are the basic units of a regulated power supply system?

(d) What types of biasing are necessary for 'transistor' action?

(e) Give the statement of maximum power transfer theorem when an energy source delivers power to a load impedance.

(f) Give examples of AF and RF oscillators.

(g) Express common-mode rejection ratio in dB.

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

(a) Draw the d.c. and a.c. load lines along with the CE mode output characteristics of a transistor and locate the *Q*-point on them.

(b) Draw the block diagrams of voltage series feedback and current shunt feedback.

(c) Compare amplitude modulation with frequency modulation.

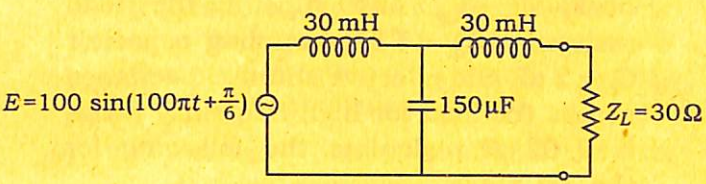
(d) Draw the logic symbol diagram to convert *J-K* flip-flop to *D* and *T* flip-flops.

3. Draw the schematic energy-band diagram of an unbiased and a forward biased *P-N* junction diode. A small portion of the peak of the negative half cycle of an a.c. signal voltage is to be removed. Draw a circuit diagram for this purpose and explain its working giving the waveform of the input and output signals. 5

Or

Draw the circuit diagram of a *P-N* junction diode full-wave rectifier. Derive the expressions for its efficiency and ripple factor.

4. Calculate Thevenin voltage, Thevenin impedance and load current in case of the following circuit : 5



5. Draw the circuit diagram of a tuned collector transistor oscillator. Derive an expression for condition of sustained oscillation in terms of circuit elements using its *h*-parameter equivalent circuit. 5

Or

Draw the circuit diagram of an astable multivibrator and explain its working giving waveform of the output signal across the two transistors.

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

(a) What is the need of stabilisation of *Q*-point of a transistor in operation? Define different stability factors. Draw the circuit diagram of self-bias with potential divider arrangement for an *N-P-N* transistor amplifier and explain qualitatively how the biasing and stability conditions are achieved.

(b) A two-stage R-C coupled amplifier uses two identical transistors having h-parameters $h_{ie} = 1\ k\Omega$, $h_{fe} = 100$ and negligible h_{oe} and h_{re}. If the load resistance $R_L = 3\ k\Omega$, coupling capacitor $C_c = 2\ \mu F$ and effective shunt capacitance across the load for high frequency range is $0 \cdot 02\ \mu F$, calculate the following for the 1st stage :

(i) Mid-frequency voltage gain

(ii) Coordinates of lower and upper 3 dB points in the frequency response curve

(iii) Bandwidth

Or

(c) How can a transistor be considered as a two-port of four-terminal device? What are the variables related to input and output ports in case of a transistor? Establish the relations of h-parameters with these variables for small input a.c. signal and hence draw the h-parameter a.c. equivalent circuit.

(d) What is the basic principle of power amplifier? Draw the circuit diagram of a class-B push-pull power amplifier using power transistors and derive an expression for its efficiency. What is the percentage of maximum efficiency?

(Continued)

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

(a) Draw the circuit diagram of a two-stage direct coupled amplifier using transistors. Derive expressions for voltage gain for different frequency range using *h*-parameter equivalent circuit.

(b) *(i)* Convert binary 110·111 to its decimal equivalent.

(ii) Convert decimal 4021·25 to its binary equivalent.

(iii) Add :

$$(101)_2 + (111)_2 + (100)_2$$

(iv) Subtract :

$$(11011)_2 - (100101)_2$$

Or

(c) Write down the characteristics of an ideal OP-AMP. Draw the circuit diagram of an OP-AMP in inverting mode and derive the expression for its closed-loop gain. Explain briefly the operation of an OP-AMP as integrator with circuit diagram.

(d) What is a clock pulse used in synchronous sequential circuits? Draw a simple circuit diagram which can convert a clock pulse to a spike. What is the basic difference between a latch and a flip-flop from the viewpoint of triggering mechanism? What is race-around condition? Draw circuit diagram of a flip-flop where this condition is eliminated and briefly describe its working.

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

(a) A sinusoidal carrier wave of frequency 10 MHz and power 500 watt is amplitude modulated by a modulating signal of frequency 100 kHz to a depth of 80%. Calculate *(i)* modulation index, *(ii)* power in each sideband, *(iii)* total power of the modulated signal and *(iv)* frequencies of LSB and USB.

(b) Draw the circuit diagram of a square law amplitude modulator and give the mathematical analysis of generation of different sidebands.

Or

(c) What is the frequency range of radio waves? Discuss different ways of radio wave propagation giving appropriate frequency range and nature of modulation and approximate distance between the transmitting and receiving antenna.

(d) What is a time base of a CRO? Explain how the phase difference between two voltages can be measured using Lissajous figure produced in a CRO. What is a bus of a microprocessor? Discuss briefly about major buses of a microprocessor. Which bus is bidirectional?

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