West Bengal State University

B.A./B.Sc./B. Com. (Honours, Major, General) Examinations, 2015

PART - III

PHYSICS — HONOURS

PAPER – VII-A

Duration : 2 Hours] [Maximum Marks : 50

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Answer Question No. *1* and any *four* from the rest.

Answer any *five* questions : $5 \times 2 = 10$

1. a) How is a FET used as a voltage variable resistance ?

   b) Design a 4 to 1 multiplexer using basic gates.

   c) What is a multivibrator ?

   d) Explain why negative feedback in amplifier is used widely though it reduces the gain.

   e) Show that current flowing through the feedback resistance of ideal non-inverting amplifier is independent of its value.

   f) Draw the output waveform of a modulo four ripple counter.

   g) Draw the block diagram of an amplifier with negative feedback. Find an expression for its closed loop gain.

   h) If the applied a.c. power to a system is 5μW at 100 mV and the output power is 48 W, show that power gain in decibels is 69·83.

2. a) Draw the static drain characteristics of a common source *n*-channel FET and give corresponding circuit diagram. 2

b) What is pinch-off voltage ? Draw the nature of depletion region in an *n*-channel FET (common source) at pinch-off voltage . 1 + 2

c) For a JFET write down the relationship between I_D and V_{GS} (in common source configuration). Who discovered it ? 1 + 1

d) An *n*-channel FET has I_{DSS} = 8 mA, V_p = – 4 volt. Find V_{GS} that will result in a drain current of 4·5 mA. 3

3. a) How is linear oscillator different from multivibrator ? 2

b) State Barkhausen criterion. 2

c) Draw the circuit diagram of a Wien-bridge oscillator. Determine its oscillation frequency. 1 + 3

d) How is amplitude stabilized in Wien-bridge oscillator ? 2

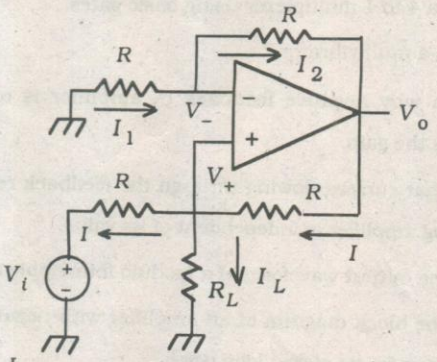
4. a) What is digital comparator ? 2

b) Design a 1 bit comparator that has two inputs A and B and three outputs, one each for equality, $A = B$, greater than, $A > B$ and less than $A < B$. 4

c) What is a shift register ? 1

d) Draw a block diagram of 3-bit serial in serial out shift register. Draw the output weveform if the input word is 101. 3

5. Assuming ideal Op-Amp charasteristics answer the following :



a) If $I_1 = I_2$

show that $V_- = \frac{V_0}{2}$. 2

b) If $I = I_L + I'$

show that $V_+ = \dfrac{(V_o + V_i)\ R_L}{(R + 2R_L)}$. 3

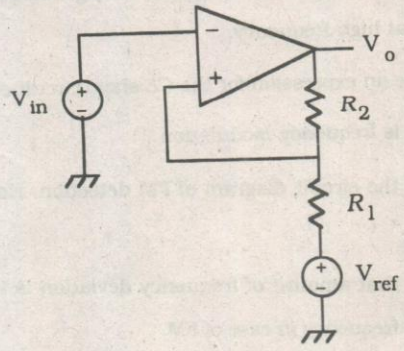
c) State the principle of virtual ground. Use it to show that

$$\frac{V_o}{V_i} = \frac{2R_L}{R}.$$ 3

d) Draw the circuit diagram of a half-wave rectifier, where the peak value of input sinusoid is 0·1 mV. 2

6. a) What is the difference between basic comparator and Schmitt trigger ? 2

b) Assuming ideal Op-Amp characteristics answer the following :



Show that $V_{TU} = V_C + V_H \dfrac{R_1}{R_1 + R_2}$

$$V_{TL} = V_C + V_L \frac{R_1}{R_1 + R_2}$$

where $V_C = V_{ref} \dfrac{R_2}{R_1 + R_2}$

$V_H = +V_{supply}$

$V_L = -V_{supply}$

V_C = Centre voltage, V_{TU} and V_{TL} are upper and lower threshold voltages respectively. 3

c) Explain why a quartz crystal is widely used in the design of sinusoidal oscillators ? 1

d) Draw the electrical model of a quartz crystal.

Sketch the reactance *vs* frequency function.

If the crystal has the following parameters :

$L = 0{\cdot}33$ H, $C = 0{\cdot}065$ pF, $C' = 1{\cdot}0$ pF,

$R = 5{\cdot}5$ K, find series resonance frequency and Q of the crystal. 1 + 1 + 2

7. a) Draw the equivalent circuit for a single stage *CE* amplifier with resistive load at high frequency. 2

b) Derive an expression for the *CE* short circuit current gain. 3

c) What is frequency modulation ? 1

d) Draw the circuit diagram of FM detection. How is bandwidth defined in FM ? 2

e) Show that amount of frequency deviation is independent of modulating signal frequency in case of FM. 2