M. Sc. Physics Examination, 2023

(1st Year, 2nd Semester)

Paper – Core 108

[Electronics]

Time : Two hours   Full Marks : 40

**Answer four questions taking at least one
and at most two from each CO.**

[CO1: Physics of semiconductor device & Regulated power supply]

1. Draw the band diagram of a metal and n-type semiconductor junction and show the barrier potential. Deduce the expression for the junction capacitance. How does it vary with the applied external voltage?

    2+1+5+2

2. a) Write down the working principle of photo detector? What is the IPCE of a photo detector? Why an intrinsic layer is used in PIN photo diode?

    b) Write down the working principle of a solar cell? What do you mean by power conversion efficiency and Fill Factor (FF) of a solar cell?   2+2+2+2+2

3. a) An adjustable voltage regulator working between voltage range 5 to 15 V delivering maximum current of 500 mA has been resigned by using IC 7805.

[2]

Draw the circuit diagram and deduce the expression for output this voltage regulator. Explain how the output voltage can be set at desired values and find the value of minimum input voltage to be applied if the dropout voltage of 7805 is 1.5 V.

b) Draw the simplified circuit diagram, determine the output voltage and explain operating principle of a buck SMPS.   5+5

[CO2: Operational amplifier and its application]

4. a) Calculate the impedance of the circuit given below at terminal X and show that it acts as a basic electrical circuit element. Obtain the value of the circuit element if $R_1=R_2=R_3=R_4=1$ KΩ and C=1 μF.
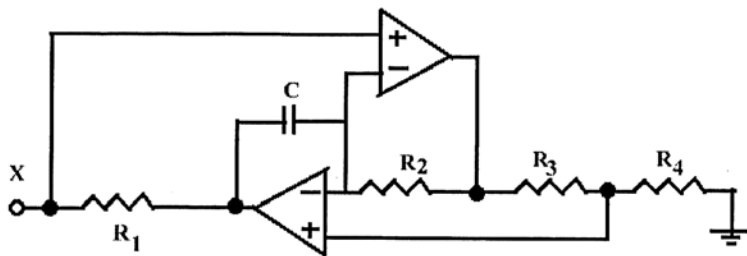

b) In the op-amp circuit shown in Figure below, the input voltage $V_i = \sin 20\pi t$ volt and V_0 is the output. Determine the magnitude of gain and phase shift.

[5]
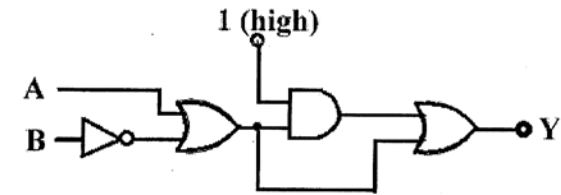
c) The digital electronic circuit shown below (left side) has some problem and is not performing as intended. The voltage at each pin as a function of time is shown in the adjacent figures. Detect the problem and write down the probable reason behind it
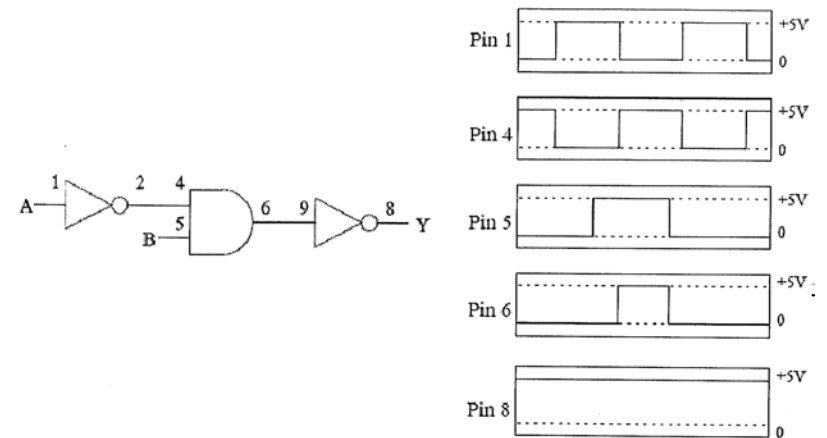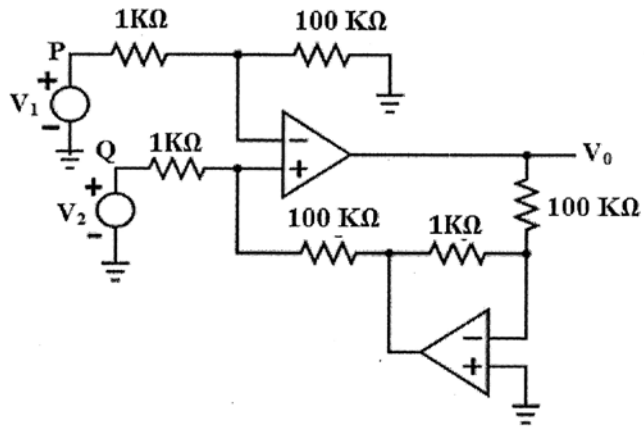

4+4+2

7. Describe the working principle of a 4-bit ripple counter with suitable diagram? Modify this circuit to MOD-10 counter? What is propagation delay in ripple counter?

5+2+3

b) Draw the circuit diagram of a square wave generator and explain its operating principle. Show that a triangular wave generator can be designed using square wave generator. 5+5

[CO3: Digital electronics and its application]

6. a) Implement F = Σm(0,2,4,5,6) using 4-1 MUX.

b) Assume that the propagation delay time of each logic gate in the circuit shown in the figure below is t_g. Determine cases when the propagation delay time will be maximum and minimum if the logic inputs A and B make transition (a) from (0, 1) to (1, 1) (b) from (1, 1) to (0, 1) (c) from (0, 0) to (0, 1) (d) from (1, 1) to (1, 0) and (e) from (0, 0) to (1, 1).
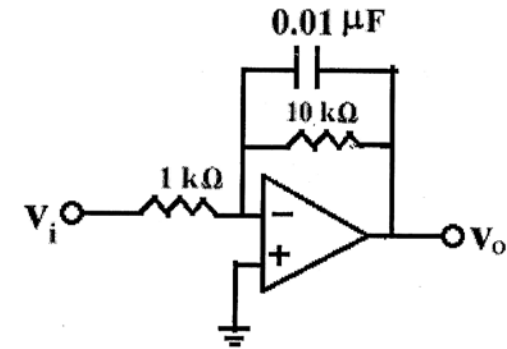
c) Plot the waveform to be obtained at the output (V₀) of the circuit shown in figure below (b) for the given input voltage V_i as shown in figure (a). You should provide explanation. Plot both input and output waveforms in sane time scale.

(a)   (b)
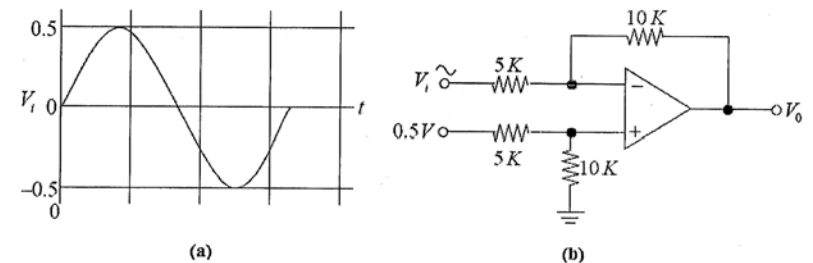
4+4+2

5. a) Calculate the gain of the ciruit given below. Explain why the circuit is not suitable to be used as instrumentation amplifier. Suitably modify the circuit to convert it into an instrumentation amplifier.

[Turn over