BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF RNGINEERING AND PHYSICS

Bachelor of Science Honours Degree in Electronic Engineering

EEN 5102:   **Integrated Circuits and Microelectronics**

Duration: 3 hours   **Total marks: 100**

INSTRUCTIONS

This paper contains seven questions each carrying 20 marks.

Answer any **FIVE** questions.

Question 1

a) (i) State the three different classes of integrated circuits according to structure. [3]

(ii) Hence list the advantages and disadvantages of each. [9]

b) Highlight the different classes of Integrated circuits according to function. [2]

c) With reference to Integrated circuits, distinguish between passive and active components giving a typical example of each. [4]

d) Distinguish between an Integrated circuit and a discrete circuit. [2]

Question 2

a) Describe how voltage regulation is achieved in the circuit below. [5]
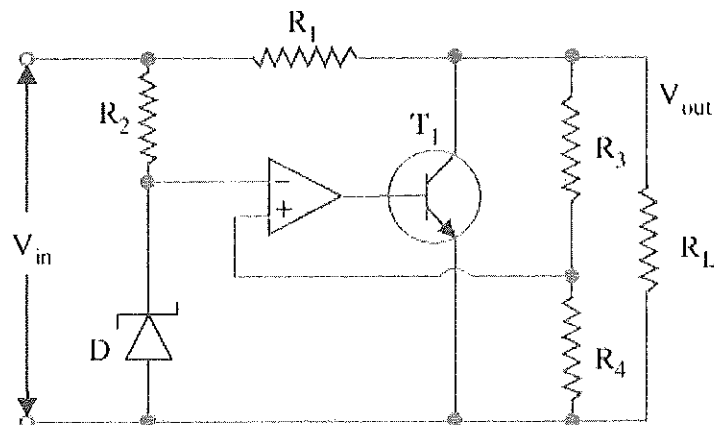
b) The Zener diode in figure below has the following ratings, V_z = 6.8Vat I_z = 50 mA, r_z = 2 Ω at I_z = 50 mA, $I_{z\ (min)}$ = 5 mA, $I_{z(max)}$ = 150mA. What would be the load voltage when the load current I_L varies from 10 mA to 120 mA. Also, calculate voltage regulation of the regulator. [5]
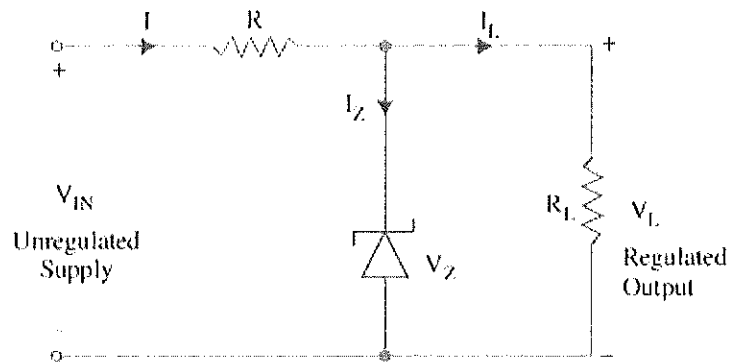
c)   With the aid of a circuit diagram, describe the operation of the step-up switching voltage regulator.   [10]

Question 3

a)   Describe the following terms/sections as used by the computer in the monitoring and controlling of a physical variable (that is assumed to be analog) in process control. Give examples where possible.

(i) Transducer.   [3]
(ii) Analog-to-digital converter (ADC).   [3]
(iii) Computer.   [3]
(iv) Digital-to-analog converter (DAC).   [2]
(v) Actuator.   [2]

b)   Consider the circuit below, and assume that V_{REF} = 10 V for the Digital to Analogue converter (DAC). What are the resolution and full-scale output of this converter?   [4]

$$V_{OUT} = \frac{-V_{REF}}{16} \times B$$
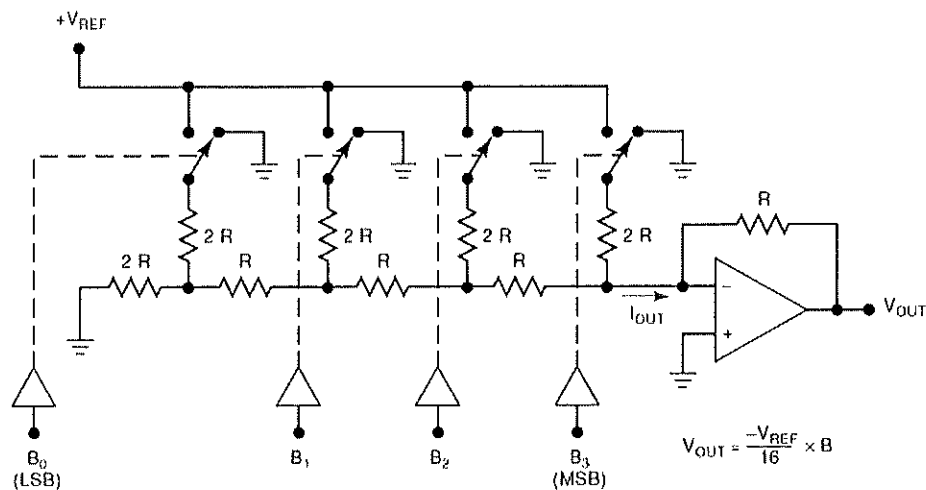
c)   A five-bit DAC has a current output. For a digital input of 10100, an output current of 10 mA is produced. What will I_{out} be for a digital input of 11101?   [3]

Question 4

a)   Highlight the three main properties of an op amp.   [3]

b)   Determine the common-mode gain of an op amp that has a differential voltage gain of 150×10^3 and a CMRR of 90 dB.   [3]

c)   The op amp shown in Figure below has an input bias current of 100 nA at 20°C. Calculate:
(i) the voltage gain.   [1]
(ii) the output offset voltage due to the input bias current.   [2]
(iii) How can the effect of input bias current be minimized?   [2]
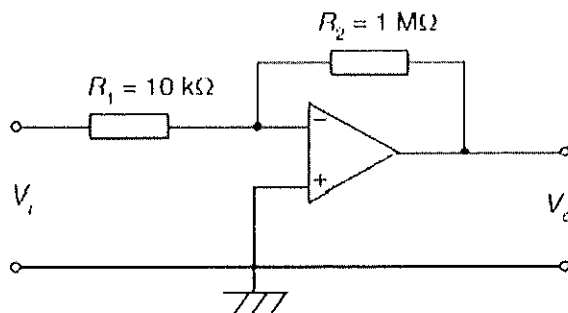
d)   For the summing op amp shown in figure below, determine the output voltage, V_0.   [3]
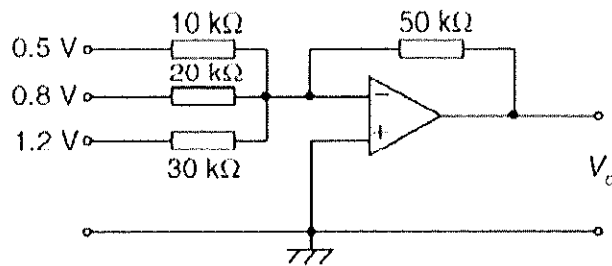

e)   With the aid of a circuit diagram and waveforms, explain the principle of operation of the photodiode.   [6]

Question 5

a)   Define Resolution (Step Size) of a D/A converter with the aid of formula.   [3]

b)   (i) What is a Phase Locked Loop?   [1]

    (ii) With the aid of a block diagram, and typical output signals for every section, briefly explain the operation of the different sections of the Phase Locked Loop.   [12]

c)   State any four typical applications of the photodiode.   [4]

Question 6

a)   With the aid of a circuit diagram of your choice and input/output waveforms, describe how a zero-crossing detector works.   [10]

b)   With the aid of supporting equations, derive the relationship between, V_{out}, V_1, and V_2 in the circuit diagram below.   [6]
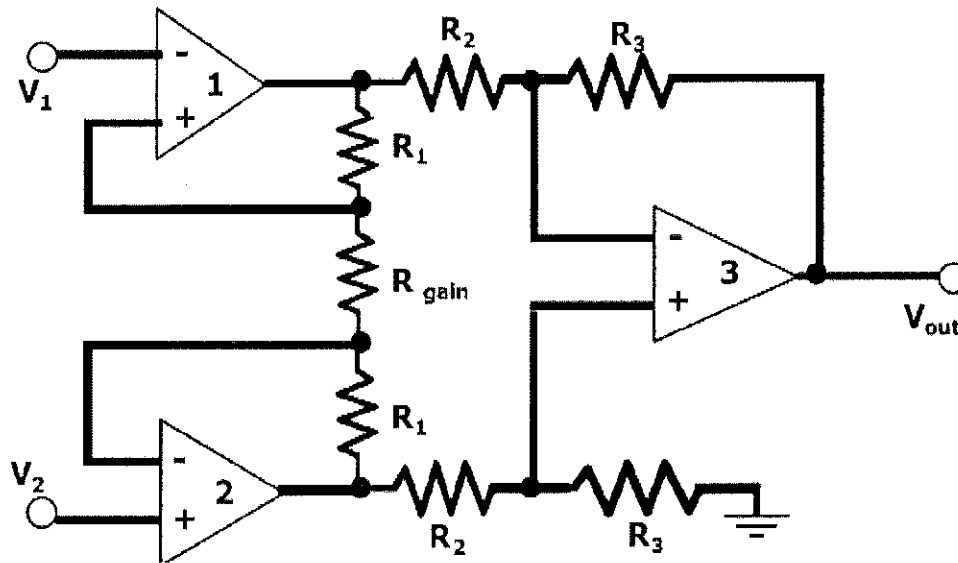
c)   Describe two unique characteristics of the LASER light. [4]

Question 7

a)   Draw the block diagram representing the different stages for an electrical signal measuring system. Give two examples, where applicable of the parameters or equipment involved per stage.   [8]

b)   A resistance strain gage with a gage factor of 2 is fastened to a steel member subjected to a stress of 1,050 kg/cm^2. Calculate the change in resistance, ΔR, of strain-gate element due to the applied stress.   [3]

c)   Describe the principle of operation of the capacitive transducer.   [6]

d)   List 3 advantages of optical fibre systems over metallic transmission system.   [3]