[This question paper contains 4 printed pages.]

1009 *Your Roll No.* .....

B.Sc. (Hons.) / II C

ELECTRONIC SCIENCE – Paper 2.2 (IX)

(Operational Amplifier and Analog Computation)

Time : 3 Hours *Maximum Marks : 38*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt **five** *questions in all, including Question No.* **1** *which is compulsory. Use of Scientific Calculator is allowed.*

1. (a) If CMRR = 10^5 and differential gain $A_D = 10^5$. Determine the common mode gain A_{cm}. (2)

   (b) If PSRR = 70db. What is the numerical value of PSRR. Explain impact of low PSRR on circuit performance. (2)

   (c) Why is constant current bias circuit desired ? (2)

   (d) Define the following terms :–

   (i) input offset voltage

   (ii) unity gain bandwidth (2)

P.T.O.

(e) What are notch filters ? (2)

2. (a) Give the AC analysis of Dual input balanced Output Differential Amplifier. (4)

(b) For given specifications evaluate the (i) operating point (ii) voltage gain and (iii) maximum peak-to-peak output voltage swing without clipping. (3)

Specifications :

R_C = 2.2 KΩ, R_E = 4.7 KΩ, R_{IN1} = 50 Ω, R_{IN2} = 50 Ω.

V_{CC} = +12V, V_{EE} = −12V, $\beta_{d.c.} = \beta_{a.c.}$ = 150, γ_{BE} = 0.7V.

3. For an operational Amplifier in voltage follower configuration following data is given :–

A = 500,000, R_1 = 420Ω, R_i = 45 MΩ ($45\times10^6\Omega$)

R_F = 4.7 KΩ, R_0 = 50Ω, V_{CC} = +15V, V_{EE} = −15V

Maximum output voltage swing = ±12V,

Unity gain bandwidth (UGB) = 0.8 MHz

(a) Draw the circuit diagram for the circuit ? (2)

(b) Evaluate the following for above mentioned circuit.

(i) Voltage gain with feedback (A_F)

(ii) Input resistance with feedback (R_{iF})

(iii) O/P resistance (R_{OF}) (3)

(c) Discuss the impact of circuit on total output offset voltage. (2)

4. (a) Design a triangular wave generator for 6 KHz signal with peak to peak voltage of 8V; Supply voltage = ±13V and saturation voltage = ±11V. (3)

(b) Design a second order band pass filter for frequency range 1 KHz to 8 KHz. (3)

(c) What is the use of all-pass filter? (1)

5. (a) For a practical integrator with input signal as a sine-wave with peak-to-peak amplitude of GV at 1 KHz, draw the output voltage waveform if R_1C_F = 0.2 mS and $R_F = 10R_1$. Assume that $v_{C_F}(0) = 0V$. [Voltage across C_F is initially zero). (4)

(b) Explain, with help of necessary circuit diagram and waveforms, the working of schmitt trigger. (3)

6. (a) For a non-inverting amplifier with $R_1 = 2K\Omega$ and $R_F = 8\ K\Omega$ and input offset voltage = 15 mV input

offset current = 40 nA and input bias current = 200 nA, evaluate total error voltage at the output for compensated and uncompensated circuit operation. (3)

(b) Explain the working of IC 555 with the help of circuit diagram and necessary waveforms for a stable mode of operation. (4)

(a) Why are differentiation circuit not used in design of analog computers for solving differential equations ? (2)

(b) Design a circuit to generate the following integral :-

$$g(\omega) = \int \sin(\omega t)\, e^{-qt}\, dt \qquad (5)$$