**(3 Hours)** **(Total Marks : 100)**

**N.B :** (1) **All** questions are **compulsory**.
(2) **Figures** to the **right** indicate **maximum marks**.
(3) **Use** of non-programmable **calculators** is **permitted**.
(4) **Symbols** used have their **usual meaning**.

**1. A) Select correct answer.** **(12)**

**1** The scale factors of cylindrical co-ordinates $(\rho, \theta, z)$ are
a) $(1, \theta, \rho)$ b) $(1, 1, \rho)$ c) $(1, \rho, z)$ d) $(1, \rho, 1)$.

**2** The work done in respective units by the force $\vec{F} = 2x\,\hat{\imath} + y\,\hat{\jmath}$ in moving a particle from origin to point P (2, 2)
a) 4 b) 8 c) 6 d) 2.

**3** When a decibel value is computed by comparing a power value to 1 mW it is called as _____
a) dBm b) dBc c) dB d) DB.

**4** The value of stability factor for a base-resistor bias is
a) $R_B(\beta + 1)$ b) $(\beta + 1) R_C$ c) $(\beta + 1)$ d) $1 - \beta$.

**5** An ideal op-amp has
a) infinite input and output resistance
b) infinite CMRR and zero temperature drift
c) zero input resistance and zero slew rate
d)zero output resistance and large offset voltage.

**6** For sustained sinusoidal oscillations , total loop gain should be
a) 0 b) ∞ c) 1 d) -1.

**B)** Answer in one sentence. **(03)**

**1** Give the necessary and sufficient condition that the line integral of $\int_C \vec{A} \cdot d\vec{r} = 0$ for every close curve C.

**2** What should be an ideal value of input resistance of an amplifier?

**3** What is bandwidth of an op-amp?

**C)** Fill in the Blanks. **(5)**

**1** If the work done by a force in moving a particle in closed path is zero, the force field is said to be --------.

**2** Volume element in cylindrical co-ordinate system is ----------.

**3** Halving the power of an amplifier corresponds to a decrease of -------- dB.

**4** The operating point is also called the ------- point.

**5** The op-amp integrator circuit will convert a square wave into a -----wave.

**2. A)** Attempt **any one**. **(8)**

**1** Check the Fundamental theorem for Gradient using $\varphi = x^2 + 4xy + 2yz^3$ and end points A(0,0,0) and B(1,1,1) considering two paths
i) $(0,0,0) \rightarrow (0,0,1) \rightarrow (0,1,1) \rightarrow (1,1,1)$
ii) The parabolic path $= x^2, y = x$ .

**2** Verify Stoke's theorem for $\vec{F} = (2x - y)\hat{\imath} - yz^2\,\hat{\jmath} - y^2z\,\hat{k}$ taking a surface S, upper half of the sphere $x^2 + y^2 + z^2 = 1$ and C is its boundary.

**B)** Attempt **any one**. **(8)**

**1** Determine the scale factors for spherical coordinate system.

**2** If $\vec{F} = 2xz\,\hat{\imath} + 3xy\,\hat{\jmath} + 3yz\,\hat{k}$ evaluate $\oint \vec{F}.d\vec{s}$ over a closed surface S bounded by *x=0, x=1; y=0, y=1; z=0, z=1.*

**C)** Attempt **any one**. **(4)**

**1** If $\vec{F} = \nabla V$, where V(x, y, z) is a single valued continuous function, show that $\int_P^Q \vec{F}.d\vec{r}$ is independent of path.

**2** Calculate $I = \int (3x^2dx - xy\,dy)$ over

a) Straight line $y = x$ from (0,0) to (1,1)

b) Parabola $y = x^2$ from (0,0) to (1,1).

**3. A)** Attempt **any one**. **(8)**

**1** Draw the circuit diagram of CE amplifier using fixed bias method. Derive expression for $I_B$ and $V_{CE}$. Hence obtain the expression for stability factor. Give one advantage and disadvantage of this method.

**2** Obtain the expression for the input $R_i$ and output $R_o$ resistance of a general amplifier. What should be their ideal values? Explain with proper reasoning.

**B)** Attempt **any one**. **(8)**

**1** Draw the circuit diagram for voltage divider CE amplifier. Show that the stability factor is unity. Give one advantage and disadvantage of voltage divider bias.

**2** With the help of a block diagram derive the relation between gain without feedback and gain with feedback when negative feedback is introduced. Explain, What is the effect of negative feedback on bandwidth?

**C)** Attempt **any one**. **(4)**

**1** In a negative feedback amplifier A = 100, β = 0.02 and input signal voltage is 40 mV. Determine (i) voltage gain with feedback (ii) Feedback voltage (iii) output voltage.

**2** What is meant by faithful amplification? Give three conditions to achieve faithful amplification.

**4. A)** Attempt **any one**.

**1** Draw the circuit diagram of Colpitt's oscillator. Explain its working. What is the frequency of oscillation of the circuit? **(8)**

**2** What is a differentiator? Explain its working. Derive the relation between input and output voltage.

**B)** Attempt **any one**.

**1** What is an oscillator? Draw the circuit diagram of phase shift oscillator. Discuss its working. **(8)**

**2** What is a non-inverting amplifier? Draw the circuit diagram of non-inverting amplifier using op-amp. Derive the expression for gain of the circuit.

**C)** Attempt **any one**.

**1** Define comparator circuit. Draw the circuit diagram and sketch the input-output characteristic. **(4)**

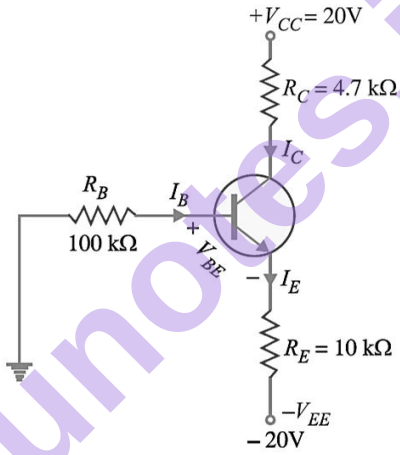
**2** A typical op-amp inverting adder circuit has, $V_1 = 2V$ , $V_2 = 3V$ and $V_3 = 4V$. The three input resistors are $R_1 = 4K\Omega$ , $R_2 = 4K\Omega$ and $R_3 = 4K\Omega$. A resistance of $5K\Omega$ is used in the feedback path. What will be the output voltage? What should be the value of feedback resistor if the circuit has to work as inverting averager?

**5.** Attempt **any Four** : **(20)**

**1** State and explain the Fundamental theorem for Curl.

**2** Considering scale factors for cylindrical co-ordinates derive expressions for arc, area and volume elements.

**3** For the emitter bias circuit shown below, find $I_E$, $I_C$, $V_C$ and $V_{CE}$ for $\beta = 85$ and $V_{BE} = 0.7V$.




**4** An amplifier has a signal input voltage $V_i$, of 0.25 V and draws 1 mA current from the source. The amplifier delivers 8 V to a load at 10 mA. Determine the voltage gain, current gain and power gain in decibels.

**5** A Wien bridge oscillator using op-amp has $R_1 = 2K\Omega$ , $R_2 = 2.5K\Omega$ , $C_1 = 0.2\mu F$ and $C_2 = 0.4\mu F$. Calculate the frequency of oscillation. If a capacitance of $0.4\mu F$ is connected parallel to $C_2$, what will be the output frequency?

**6** In a typical op-amp integrator circuit, $R = 10K\Omega$ and $C = 2.2\mu F$ and Vi = 50 mV. What will be output voltage 1ms after input is applied? How much time is required for the output to become -5V?