

$$1. V_{out} = -5 + \frac{10 R_2}{R_1 + R_2}$$

$$V_{out} \Big|_{R_{smin}} = -5 + \frac{10(500)}{1000 + 500} = -1.67V = V_{outmin}$$

$$V_{out} \Big|_{R_{smid}} = -5 + \frac{10(1000)}{1000 + 1000} = 0V = V_{outmid}$$

$$V_{out} \Big|_{R_{smax}} = -5 + \frac{10(1500)}{1000 + 1500} = 1V = V_{outmax}$$

$$2. V_{out} = \frac{10 R_2}{R_1 + R_2}$$

$$V_{out} \Big|_{min} : R_{2min} \text{ and } R_{1max}$$

$$R_{2min} = 1000 - 100 = 900\Omega$$

$$R_{1max} = 1000 + 100 = 1100\Omega$$

$$\therefore V_{out} \Big|_{min} = \frac{10(900)}{900 + 1100} = 4.5V$$

$$V_{out} \Big|_{max} : R_{2max} \text{ and } R_{1min}$$

$$R_{2max} = 1000\Omega$$

$$R_{1min} = 1000\Omega$$

$$\therefore V_{out} \Big|_{max} = \frac{10(1000)}{1000 + 1000} = 5V$$

$$3. \text{ At } 0^\circ\text{C} \rightarrow \rho = 5 \times 10^{-6} \Omega\text{-cm}$$

$$R = \rho \frac{L}{S}$$

$$\frac{L}{S} = \frac{5 \times 10^{-3}}{(50 \times 10^{-6})(1 \times 10^{-6})} = 1 \times 10^8 \text{ m}^{-1} = 1 \times 10^6 \text{ cm}^{-1}$$

$$\therefore R \Big|_{T=0^\circ\text{C}} = (5 \times 10^{-6})(1 \times 10^6) = 5\Omega$$

$$At 100^{\circ}C \rightarrow \rho = 5 \times 10^{-6} (1 + 100(5 \times 10^{-3})) = 7.5 \times 10^{-6} \Omega \cdot cm$$

$$R|_{T=100^{\circ}C} = (7.5 \times 10^{-6})(1 \times 10^6) = 7.5 \Omega$$

$$4. \quad \epsilon_1 = 1\% = 0.01$$

$$GF = \frac{\Delta R/R}{\epsilon_1} \rightarrow \Delta R = R \epsilon_1 GF = (10,000)(0.01)(1.8) = 180 \Omega$$

$$R_{new} = R + \Delta R = 10,000 + 180 = 10,180 \Omega$$

$$5. \quad \epsilon_1 = -1\% = -0.01$$

$$\Delta R = R \epsilon_1 GF = (10,000)(-0.01)(1.8) = -180 \Omega$$

$$R_{new} = R + \Delta R = 10,000 - 180 = 9820 \Omega$$

$$6. \quad V_{out}|_{no \text{ strain}} = \frac{10 R_p}{R_n + R_p} = \frac{10(1000)}{1000 + 1000} = 5V$$

$$R_{n_{new}} = R_n + R_n \epsilon_1 GF_n = 1000 + 1000(0.002)(-30) = 940 \Omega$$

$$R_{p_{new}} = R_p + R_p \epsilon_1 GF_p = 1000 + 1000(0.002)(30) = 1060 \Omega$$

$$V_{out}|_{strain} = \frac{10(1060)}{940 + 1060} = 5.3V$$

$$7. \quad R_{n_{new}} = 1000 + 1000(0.001)(-30) = 970 \Omega$$

$$R_{p_{new}} = 1000 + 1000(0.001)(30) = 1030 \Omega$$

$$V_0 = V_2 - V_1 = \frac{10(1030)}{970 + 1030} - \frac{10(970)}{970 + 1030} = 0.3V$$