EE2002

TUTORIAL 3 (with answers at the back)

1. The op-amp in Fig 1 has a slew rate of 0.50V/μS. The amplifier must be capable of amplifying the following input signals:

   $v_1 = 0.01\sin(10^6 t)$
   $v_2 = 0.05\sin(350 \times 10^3 t)$
   $v_3 = 0.10\sin(200 \times 10^3 t)$
   $v_4 = 0.20\sin(50 \times 10^3 t)$

   a) Determine whether the output will be distorted due to slew-rate limitations on any input.
   b) If so, find a remedy (other than changing the input signals).

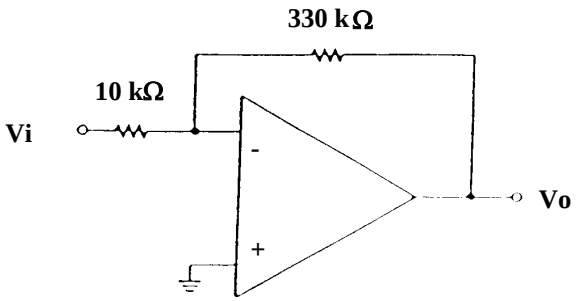

Fig. 1

2.a) What minimum SR is necessary for a unity-gain amplifier that must pass, without distortion, the input waveform shown in Fig 2.

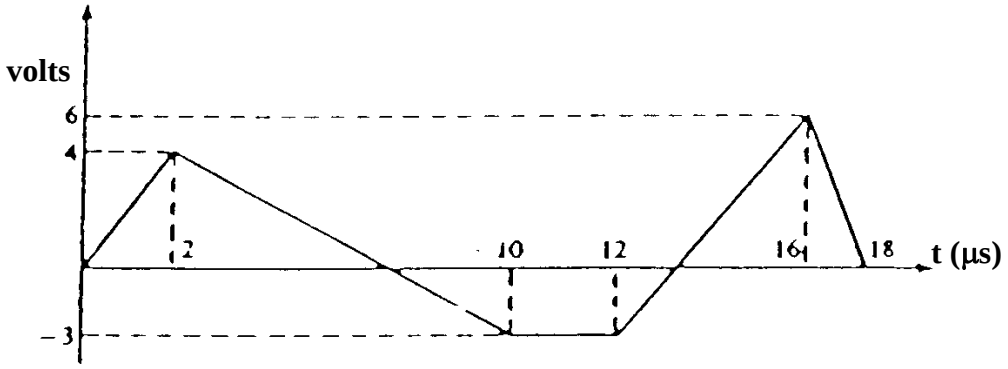

Fig. 2

2.b)Repeat (a), if the amplifier is in a noninverting configuration with R_I=50kΩ and R_f=100kΩ.

3. In a certain application, a signal source having 60kΩ of source resistance produces a 1-V-rms signal. The signal must be amplified to 2.5V rms and drive a 1kΩ load. Assuming that the phase of the load voltage is of no concern, design an op-amp circuit for the application.

4.a) Determine the empirical diode junction equation for a 1N4005 diode given the following voltage and current values:

V_{Dl} = 0.6V @ I_{Dl} = 2.3mA
V_{D2} = 0.8V @ I_{D2} = 245mA

4.b) Use the empirical diode junction equation, obtained in 4(a), to calculate the diode voltage V_D for a 1N4005 diode when the diode currents is

i) I_D = 20 mA
ii) I_D = 300 mA

4.c) A 1N4005 diode is used in the circuit shown in Fig. 3, determine the diode voltage and current by means of successive iteration method.

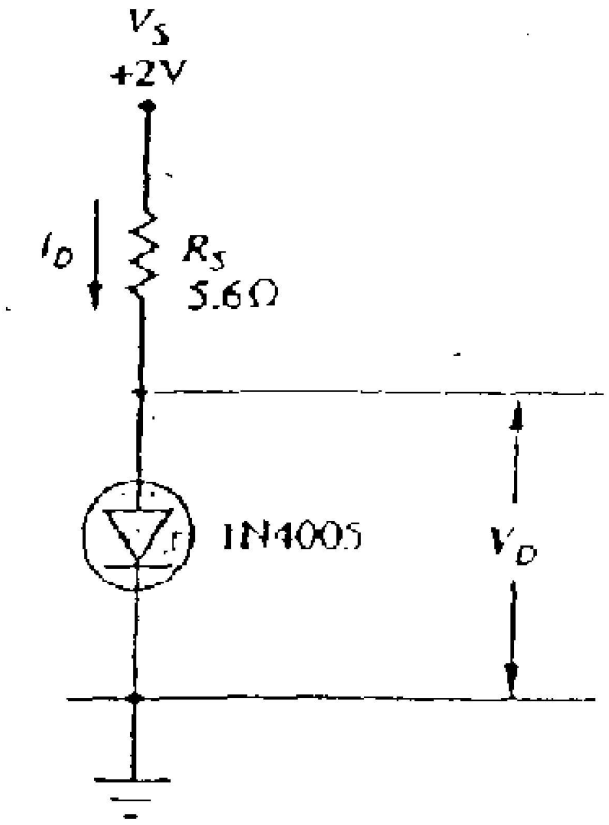

Fig. 3

5. Determine the AC component of the output voltage, v_{OUT}, for the circuit in Fig. 4 when V_{SDC}=5V DC.

The data sheet for the 1N4305 diode has the following voltage and current values:

$V_D = 0.50V$ at $I_D = 250\mu A$
$V_D = 0.70V$ at $I_D = 10mA$

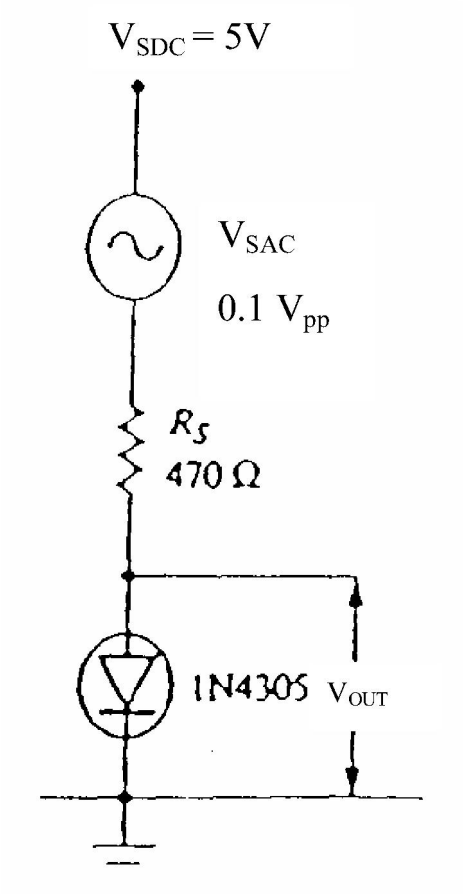

Fig. 4

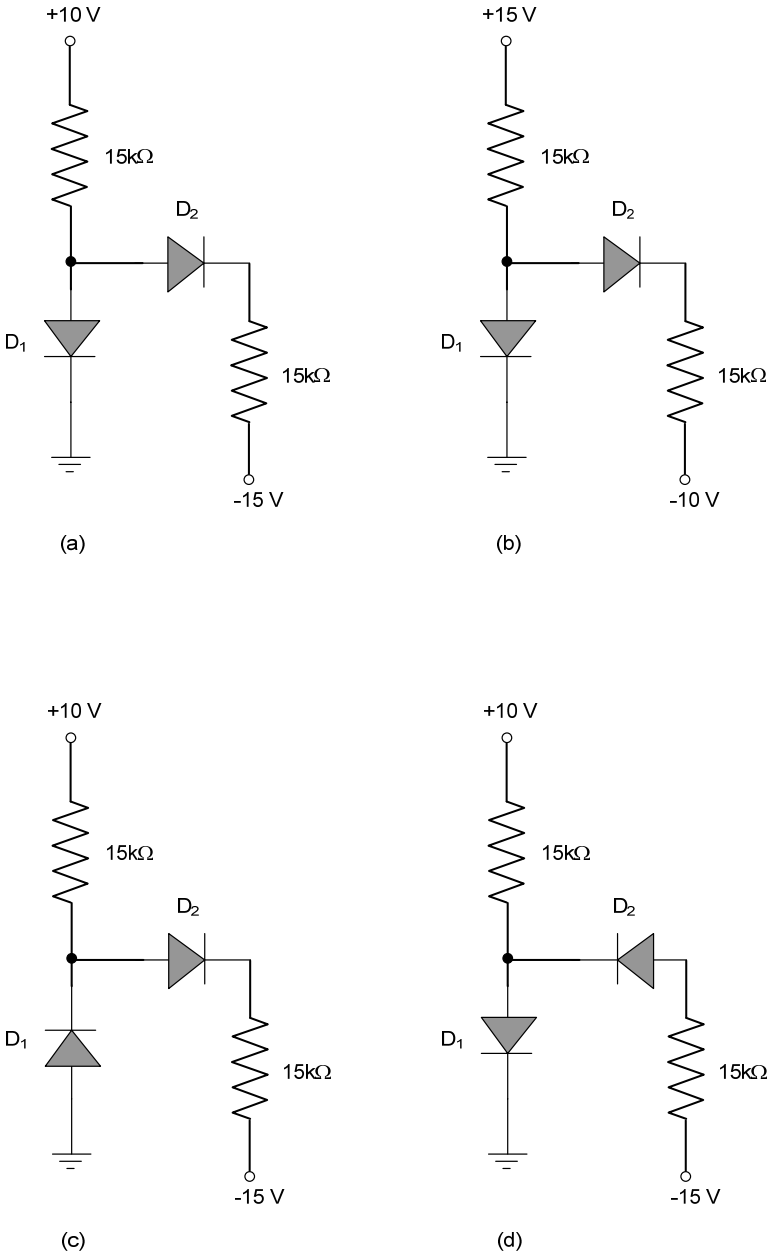

Fig. 5

6. Find the Q points of the diodes in the circuits of Fig. 5. For forward biased diode, the diode voltage is given as 0.75V.

Answers to Tutorial 3

1. (a) The output due to v_2 and v_3 will be distorted.

   (b) There are only two remedies:
   - (i) find an amp with greater SR, a SR of at least 0.66 V/μs
   - (ii) reduce the A_{CL} of the present amplifier to 25 V/V.

2. (a) The minimum SR is 3.0 V/μs
   (b) The $(SR)_{min}$ = 9 V/μs

3. Many right answers.

4. (a) The empirical junction equation for the IN4005 diode is

$$i_D \approx (1.90nA)e^{v_D/42.8mV}$$

$$\text{or} \quad v_D = (42.8mV)\ln\left(\frac{i_D}{1.90nA}\right)$$

   (b)
   - (i) For I_D=20 mA, V_D=0.692 V
   - (ii) For I_D=300 mA, V_D=0.808 V

   (c) V_D=0.794 V
   I_D = 215 mA

5. v_{OUT} = 1.24 mV_{PP}

6.

	D1	D2
(a)	-2.13V, 0A	0.75V, 0.808mA
(b)	0.75V, 0.283mA	0.75V, 0.667mA
(c)	0.75V, 0.183mA	0.75V, 0.9mA
(d)	0.75V, 0.617mA	-15.75V, 0A