Sample admittance test

MSc in Electronic Engineering, University of Pavia

Pavia, 2nd August 2023

Question 1

The energy stored in an inductor is:

1. Inversely proportional to the inductance
2. Proportional to the square of the current flowing in the inductor
3. Proportional to the current flowing in the inductor

Question 2

Let us consider a linear circuit including a single independent voltage generator. If the voltage of the generator is doubled, what happens to the power dissipated by any resistor in the circuit:

1. Also doubles up
2. Becomes one quarter of the initial one
3. Becomes four times the initial one

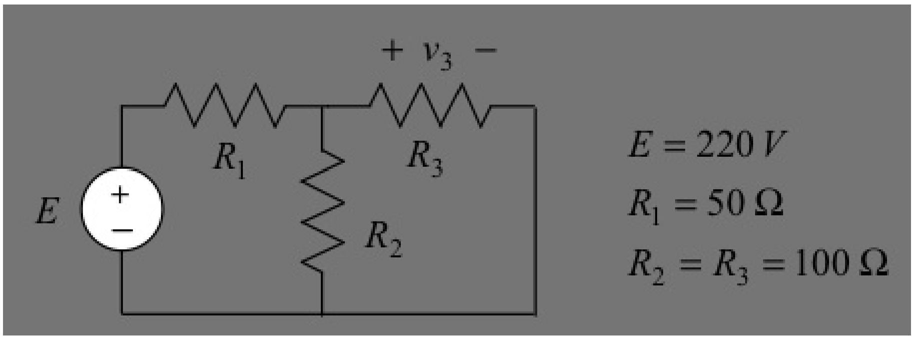
Question 3

The characteristic impedance of a lossy transmission line is:

1. A purely real number
2. A purely imaginary number
3. A complex number

Question 4

In the circuit shown in figure, the voltage v_3 equals:



1. 73.3 V
2. 0 V
3. 110 V

Question 5

In a uniform plane wave, the Poynting vector is oriented in a direction, which is:

1. Parallel to the electric field vector
2. Orthogonal to the electric field vector
3. Parallel to the magnetic field vector

Question 6

In isotropic materials, vectors D and E:

1. Are parallel to each other
2. Are orthogonal to each other
3. Form an arbitrary angle

Question 7

The electromagnetic wave radiated in the far-field region by any antenna has the following property:

1. Its electrical field always points towards the antenna
2. The ratio between the electric field and the magnetic field is 50 ohm
3. It is a spherical wave

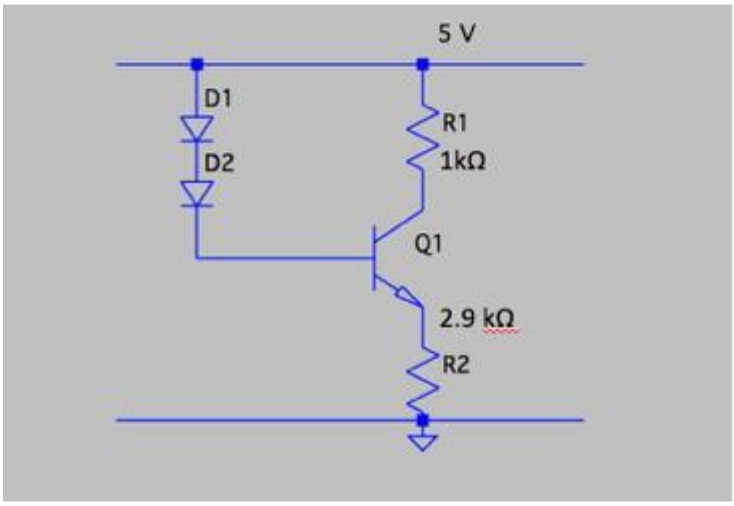
Question 8

Consider two identical, ideal capacitors, each with capacity C. The first one is initially charged at a voltage V, while the second one is initially discharged. At a given instant, an ideal switch connects them in parallel through ideal electrical lines. Which statement is correct?

1. The final voltage across the two capacitors is V/2
2. In the final state, a constant current flow from the first to the second capacitor remains indefinitely
3. In the initial state, the energy of the first capacitor is zero.

Question 9

In this circuit,

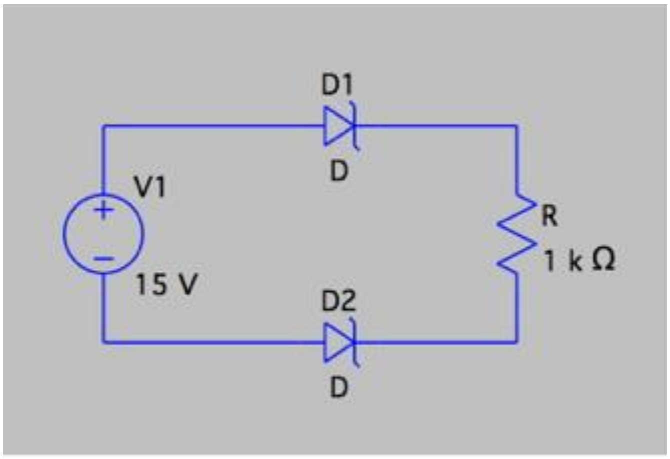


assume ideal Si diodes with 0.7 V threshold, and a Si BJT. The current in resistor R2 is:

1. 1 mA
2. 0 mA
3. 1.28 mA

Question 10

In this circuit,

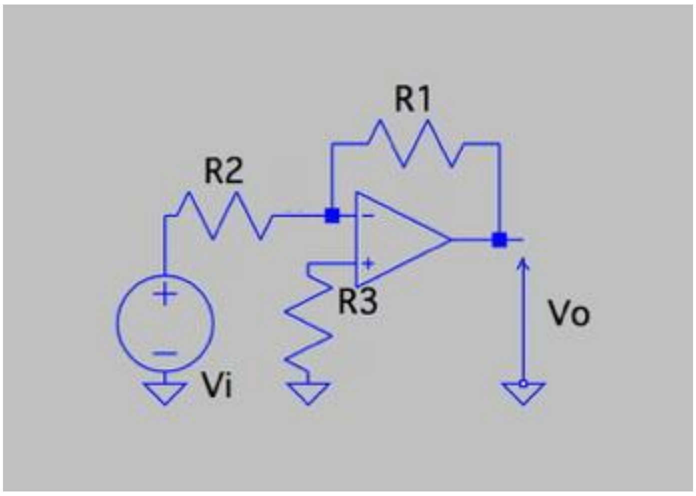


assume ideal 5 V Zener diodes with 0.7 V threshold. The mesh current is:

1. 0 mA
2. 9.3 mA
3. 10.7 mA

Question 11

In this circuit,

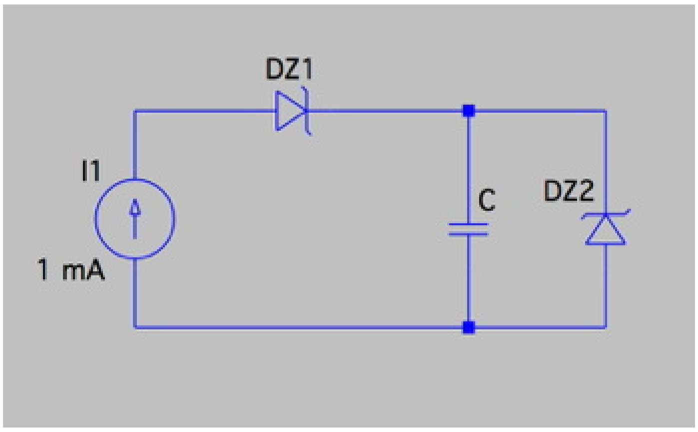


assume an ideal operational amplifier, and 1kΩ resistors. The gain v_o/v_i is:

1. -1
2. -1/2
3. 2

Question 12

In this circuit,

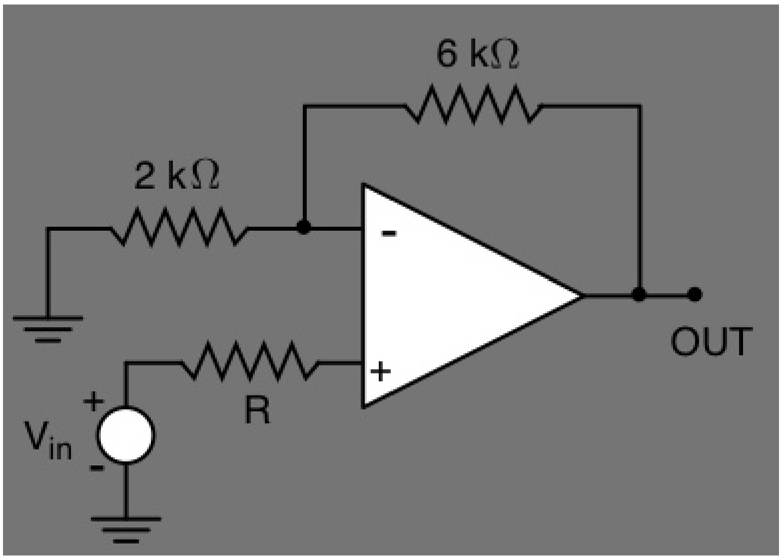


assume ideal 10 V Zener diodes, with 0.7 V threshold. The current generator is initially off, and the starting voltage across the capacitor C= 100 nF is zero. What does the voltage across C do after the current generator is activated?

1. It increases linearly to 10 V, then it saturates
2. It increases linearly to 0.7 V, then it saturates
3. It is always consistently 0.

Question 13

The noninverting amplifier in the figure below is based on an operational amplifier, which is ideal apart from input bias currents I+ and I-, with I+ = I- =100 nA.

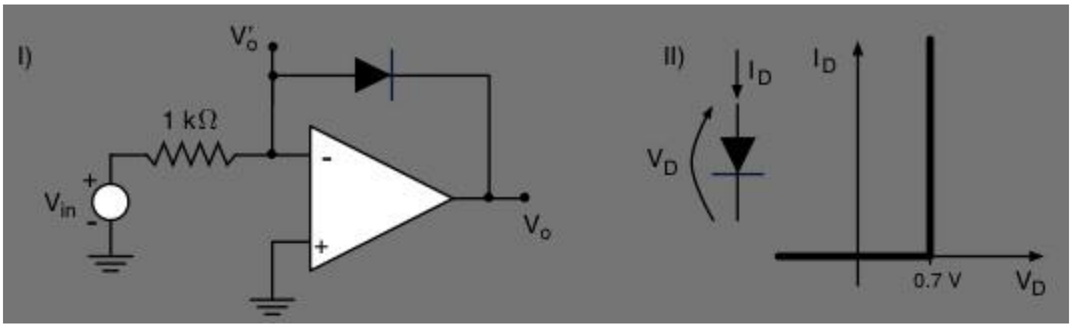


The value of the resistance R that minimizes the effect of the input bias currents at the non-inverting amplifier output is:

1. 1.5 kΩ
2. 2 kΩ
3. 2.5 kΩ

Question 14

The amplifier in figure I) below is based on an operational amplifier which is ideal apart from the presence of the saturation levels L+ and L-, with L+ = - (L-) = 5 V. The diode has the current-voltage characteristic shown in figure II) below.

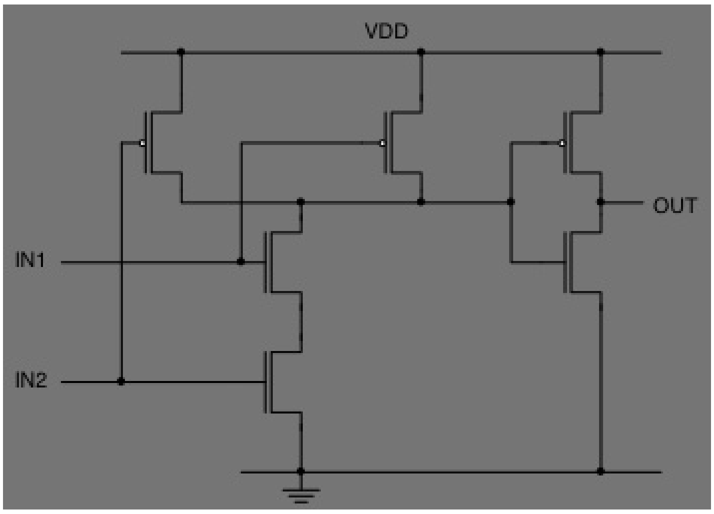


If Vin=-1 V, then:

1. $V_o - V'_o = -0.7$ V
2. $V_o - V'_o = -4$ V

3. V_o-V'_o=6 V

Question 15



The two-input, CMOS logic gate in the figure above is

1. a NOR gate
2. an AND gate
3. an EXOR gate

Question 16

In a folded cascode OpAmp, the load capacitance is halved. Assuming that the amplifier is still stable, the unity-gain frequency is:

1. doubled
2. halved
3. approximately the same

Question 17

For a common-source amplifier loaded with a resistor, the voltage gain is:

1. larger when the MOS is in the linear region
2. larger when the MOS is in saturation
3. the same in the two cases

Question 18

The input impedance of a common-emitter amplifier is:

1. Practically zero
2. Equal to infinity
3. Typically, on the order of kΩ

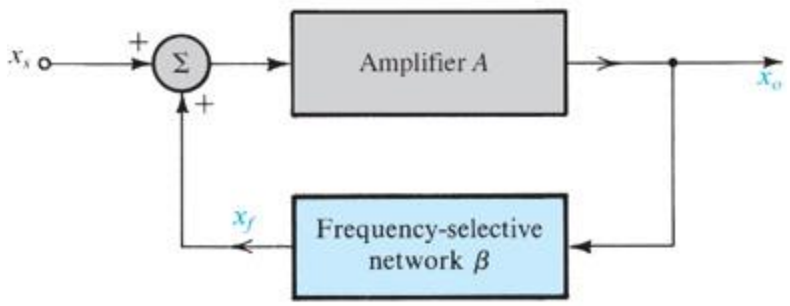
Question 19

In a two-stage OpAmp using CMOS transistors, the W/L of the input stage transistors is halved while their bias current is doubled, so that their overdrive voltage doubles. The slew-rate is:

1. approximately the same
2. doubled
3. halved

Question 20

The block diagram shows an amplifier (with gain A) in feedback with a passive network (with transfer function β(ω)



Which condition must be verified on the loop gain L(ω)=Aβ(ω) to have an oscillatory output signal?

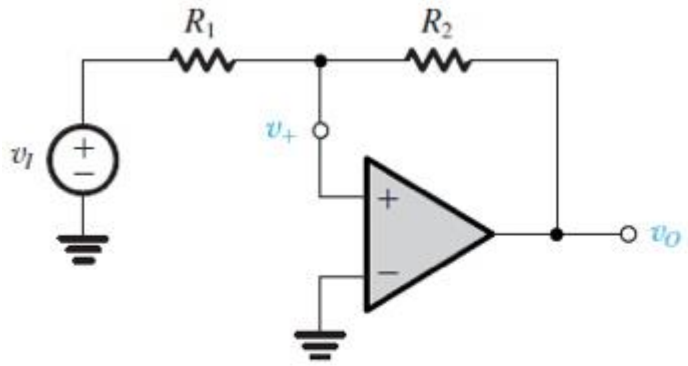
1. Magnitude of L(ω)≥1 or phase of L(ω) multiple of 360°
2. Magnitude of L(ω)≥1 and phase of L(ω) multiple of 360°
3. Any the above conditions give an oscillatory output.

To implement a variable resistor using a MOS transistor, the device must operate in:

1. Linear region, with small drain-to-source voltage
2. Saturation, biased with a constant drain current
3. Saturation with large drain-to-source voltage

Question 22

Considering the ideal operational amplifier with resistive feedback in the figure, the circuit implements:



1. A non-inverting signal amplifier
2. A voltage comparator with 0V threshold
3. A bistable circuit or comparator with hysteresis

Question 23

Referring to a source follower circuit implemented with an *n*-channel input transistor, identify the incorrect statement:

1. the voltage gain between the input and the output roughly equals one
2. the output voltage can be rail-to-rail
3. the output node is at low impedance

Question 24

A MOS transistor is operating in the linear region, and its "*on* resistance" is dominated by the silicon channel resistance. In principle, how could one double its "*on* resistance"?

1. by halving the length of the transistor
2. by doubling the width of the transistor
3. by doubling the length of the transistor

Question 25

Which is the correct expression for the power of an AM-SSB-USB signal, assuming the carrier amplitude equals A and the power of the modulating signal equals P_m?

1. $P_m \cdot A^2/2$
2. $A^2/4$
3. $P_m \cdot A^2/4$

Question 26

What is the Fourier Transform of $v(t)\cos(2\pi f_1 t+\phi)$?

1. $(V(f-f_1) + V(f+f_1)) /2$
2. $(V(f-f_1)e^{j\phi} + V(f+f_1)e^{-j\phi}) /2$
3. $e^{j\phi} \cdot (V(f-f_1) + V(f+f_1)) /2$

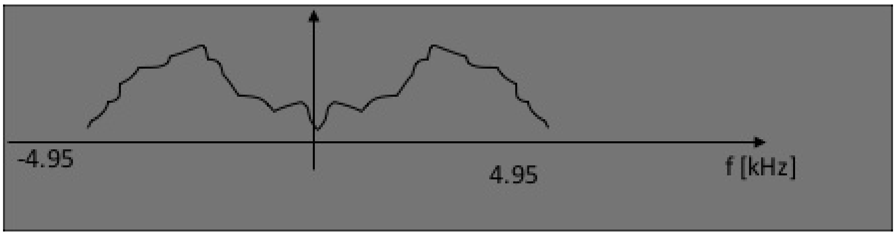
Question 27

Which among those presumed properties of the Fourier Transform is incorrect?

1. $s(t+t_1) \Longrightarrow S(f) \cdot e^{+j2\pi f t1}$
2. $a \cdot s_1(t) + a^3 \cdot s_2(t) \Longrightarrow a \cdot S_1(f)+ a^3 \cdot S_2(f)$
3. $s(t) \cdot \sin(2\pi f_1 t) \Longrightarrow S(f-f_1)+S(f+f_1)$

Question 28

Which sampling frequency is correct for the signal whose power spectrum is non-zero between -4.95 kHz and +4.95 kHz, zero elsewhere? By "correct" we mean here “greater than the minimum value required for complete reconstruction from samples”.



1. 10 kHz
2. 4 kHz
3. 5 kHz

Question 29

Compute the power of the signal output by the system in the figure below, assuming s(t) has a bandwidth equal to 5 kHz and a power of 2 W. The Band Pass is 10 kHz around 1 MHz.

1. A^2
2. $A^2/2$
3. $A^2/4$

Question 30

Compute the maximum modulation index for an AM-DSB modulated signal in case the modulating signal is 4 · rectangle(t-300).

1. 4
2. 1
3. 0.25

Question 31

What is the (approximate) bandwidth of a filter with impulse response h(t)=sin(6280t)3t ?

1. 15 kHz
2. 1 kHz
3. 3 MHz

Question 32

Consider the baseband transmission techniques NRZ (Non-Return-to-Zero) and Manchester. In the comparison, NRZ:

1. halves the bandwidth but doesn't allow self-synchronization
2. offers no bandwidth gain but allows self-synchronization
3. offers no bandwidth gain and doesn't allows self-synchronization

Question 33

In a transmission channel, reflections lead to

1. Phase distortions
2. Inter-symbol interference
3. Raised AWGN floor

Question 34

What is the meaning of the Parseval's Theorem?

1. Energy can be computed only in the time domain.
2. Energy can be computed in both the time and the frequency domain.
3. For some signals it does not make sense to compute energy.

Question 35

Compute the power of an AM Single Side Band (AM-SSB) signal, characterized by a carrier with amplitude equal to 1 and by a modulating signal with constant power spectral density equal to U within the frequency interval [-B, B].

1. 2·B·U
2. B·U/2
3. B·U·2

Question 36

A signal with a peak-to-peak dynamic range of 5 V is quantized using a uniform quantizer so that the maximum error is lower than 0.025V. How many bits will be required to represent the digitized signal?

1. 7 bits
2. 5 bits
3. 8 bits