

The Norwegian University of Science and Technology
ENGLISH

Department of Physics

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EXAM IN TFY 4185 Measurement Technique/Måleteknikk

1 Dec 2014

Time: 09:00-13:00

Number of pages: 9

Permitted aids:

- 1) Dictionary (ordinary or bi-lingual)
- 2) All calculators
- 3) 1 side of an A5 sheet with printed or handwritten formulas permitted

You can answer in either Norwegian or English. The weight for each multiple-choice question is 4%, the weight for each calculation problem is given in parentheses.

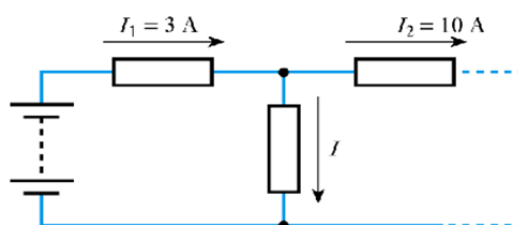
Multiple Choice Questions-1 (40% total).

There is only **one** correct answer so you must **choose the best answer**. Answer A, B, C... (Capital letters), or leave the answer blank. Correct answer gives +4; incorrect answers give 0, and blank (unanswered) gives +1.

Write the answers for the multiple choice questions **on the answer sheet you turn in** using a table similar to the following:

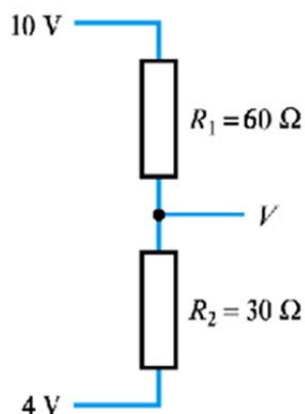
Question	1	2	3	4	5	6	7	8	9	10
Answer										

1. Calculate the magnitude of the current I in the following circuit:



- A) -7 A B) 13 A C) 7 A D) -13 A

2. Calculate the output voltage V of the following circuit:

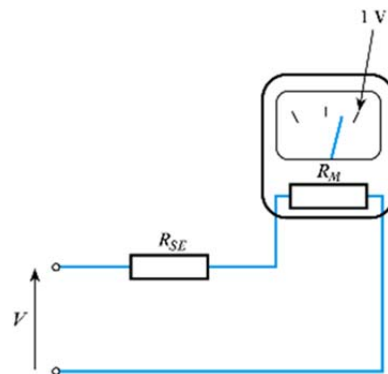


- A) 2 V B) 4 V C) 6 V D) 8 V

3. If a sinusoidal voltage $v = V_p \sin \omega t$ is applied across a capacitor, C , what is the average value of the power dissipated in the capacitor?

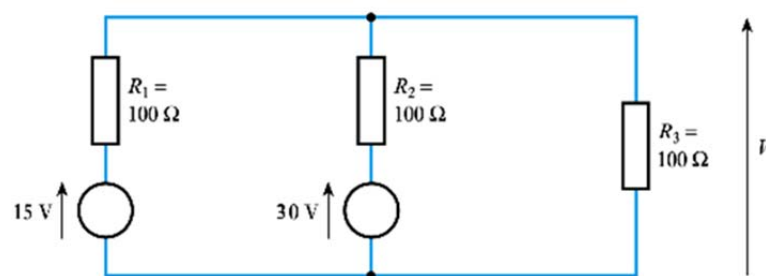
- A) 0 B) CV_p^2 C) V_p^2 / C D) $2CV_p^2$

4. A moving-coil meter produces a full-scale deflection for a current of $100\ \mu\text{A}$ and has a resistance of $500\ \Omega$. Select a series resistor (R_{SE}) that will turn this device into a voltmeter with an full scale deflection of $1\ \text{V}$.



- A) $8.5\ \text{k}\Omega$ B) $9\ \text{k}\Omega$ C) $9.5\ \text{k}\Omega$ D) $10\ \text{k}\Omega$

5. Use the principle of superposition to determine the output voltage V of the following circuit.



- A) $5\ \text{V}$ B) $7.5\ \text{V}$ C) $12\ \text{V}$ D) $15\ \text{V}$

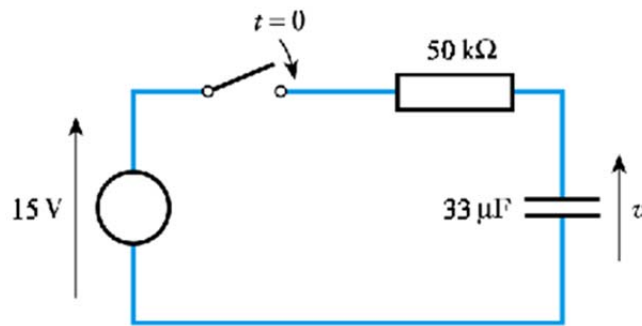
6. Which one of the following statements is correct in relation to alternating waveforms:

- A) In a capacitor, the voltage leads the current.
 B) In an inductor, the voltage lags the current.
 C) In a capacitor, the current leads the voltage.
 D) In an inductor, the current leads the voltage.

7. Which of the following combination of components represents an impedance of $110 + j\ 314\ \Omega$ at a frequency of $100\ \text{Hz}$?

- A) A resistor of $100\ \Omega$ in series with a capacitor of $5\ \mu\text{H}$
 B) An inductor of $50\ \text{mH}$ in series with a capacitor of $5\ \mu\text{H}$
 C) A resistor of $314\ \Omega$ in series with an inductor of $5\ \text{mH}$
 D) A resistor of $110\ \Omega$ in series with an inductor of $500\ \text{mH}$

8. The switch in the following circuit closes at $t = 0$. If the capacitor is initially discharged, calculate the time, t , at which the voltage on the capacitor is 12.6V.



- A) 1.21 ns B) 3.0 s C) 12.6 s D) 15 s
9. When unconnected to any other circuit elements, an amplifier has a voltage gain of 20, an input resistance of 500 ohms and an output resistance of 50 ohms. The amplifier is connected to a voltage source that produces an output voltage of 1 V and has an output resistance of 75 ohms (when unconnected to any other circuit elements), and to a load resistance of 800 ohms. What will the voltage across the load resistor be when this circuit is connected?
- A) 20 V B) 16.4 V C) 18.8 V D) 17.4 V
10. What is the voltage gain of the amplifier in question 9 when it is connected to the source and load resistance?
- A) 18.9 B) 20 C) 17.4 D) 16.4

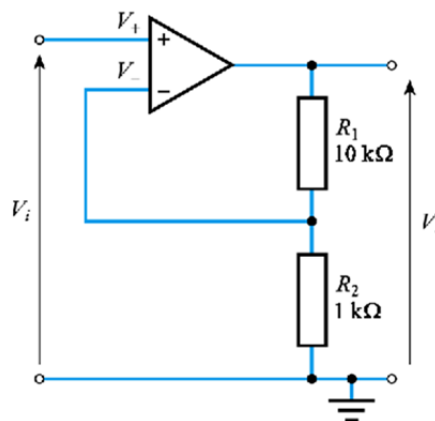
Multiple Choice Questions-2 (40% total).

There is only **one** correct answer so you must **choose the best answer**. Answer A, B, C, ... (Capital letters), or leave the answer blank. Correct answer gives +4; incorrect answers give 0, and blank (unanswered) gives +1.

Again, **on the answer sheet you turn in** use a table similar to the following:

Question	11	12	13	14	15	16	17	18	19	20
Answer										

11. What is the voltage gain of this circuit?



- A) 0.091 B) 0.1 C) 10 D) 11

12. A Zener diode:

- A) Has a high forward voltage rating
- B) Has a sharp breakdown at low reverse voltage
- C) Is useful as an amplifier
- D) None of the above

13. A long section of p-type semiconductor material:

- A) Is positively charged
- B) Is electrically neutral
- C) Has an electric field directed along its length
- D) None of the above

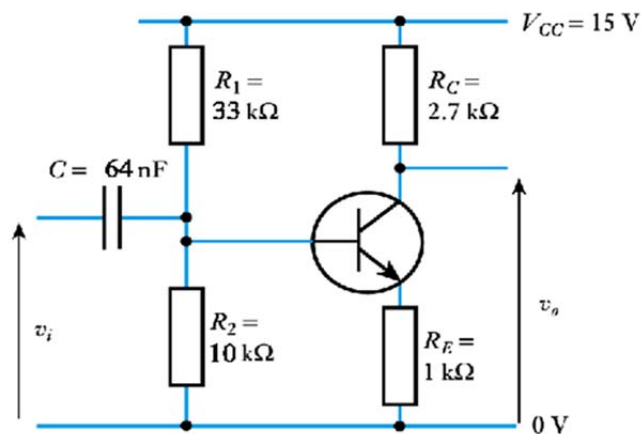
14. The drain current in JFET is always controlled by:

- A) Voltage drop along the channel
- B) Magnitude of the depletion
- C) Channel length
- D) Reverse-bias at the gate

15. A bipolar junction transistor is in the saturation region if:

- A) Base-emitter junction is reverse-biased and base-collector junction is forward-biased.
- B) Both the junctions are reverse-biased.
- C) Both the junctions are forward-biased.
- D) Base-emitter junction is forward-biased and base-collector junction is reverse-biased.

16. In the following circuit, how is the input to the base filtered?

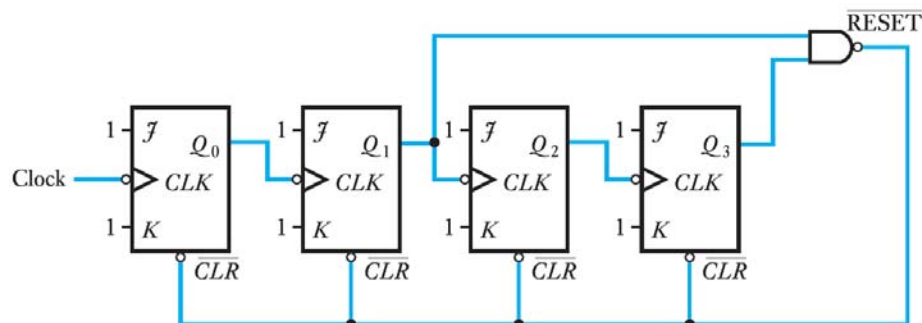


- A) It is high-pass filtered.
- B) It is low-pass filtered.
- C) It is band-pass filtered.
- D) It is notch-filtered

17. Determine the lower-frequency cut-off of the input to the base in the circuit of question 16.

- A) 18 Hz
- B) 178 Hz
- C) 324 Hz
- D) 2037 Hz

18. What is the function of the following circuit?



- A) A modulo-12 counter.
- B) A modulo-10 counter.
- C) A modulo-8 counter.
- D) A modulo-6 counter.

19. What is the resolution of a 10-bit analogue to digital data converter?

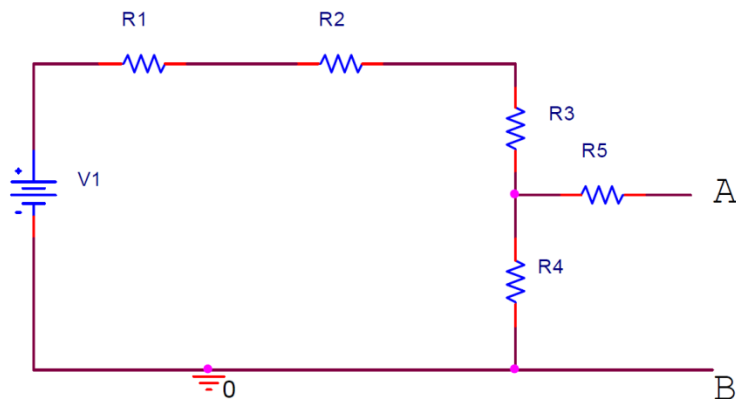
- A) 0.00098% B) 0.098% C) 0.024% D) 0.41%

20. A signal contains components with frequencies up to 10 kHz, although no useful information is contained at frequencies above 6 kHz. What is the minimum frequency at which the signal should be sampled?

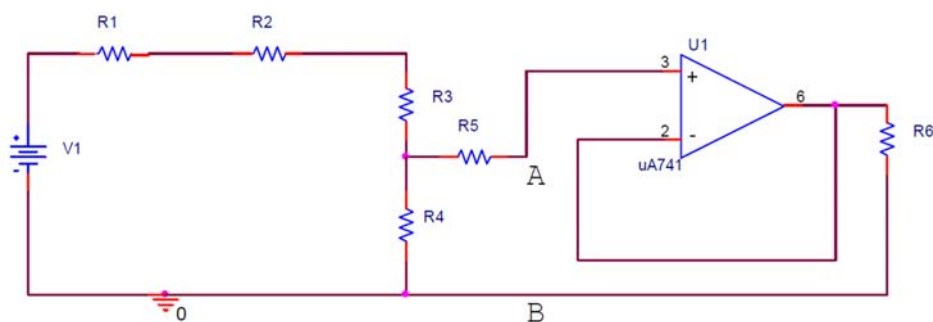
- A) 6 kHz. B) 12 kHz. C) 14.4 kHz. D) 20 kHz.

Calculations (20% total)

21. You build the following circuit with $V_1 = 6\text{ V}$, and $R_1 = 30\ \Omega$, $R_2 = 2\text{ k}\Omega$, $R_3 = 3\text{ k}\Omega$, $R_4 = 2\text{ k}\Omega$ and $R_5 = 1\text{ k}\Omega$.

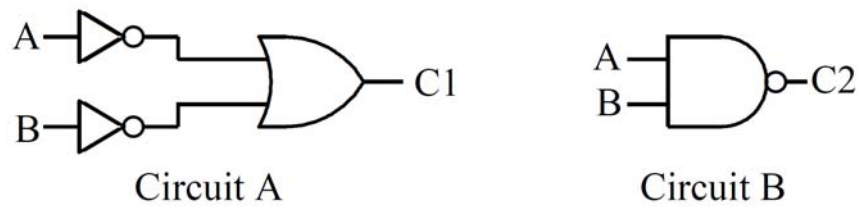


- Find the Thévenin Equivalent voltage, $V_{th} = V_{OC}$, of this circuit between point A and point B (2%)
- Find the Thévenin Equivalent Resistance, R_{th} , of this circuit between points A and B. (2%)
- Find the Norton Equivalent Current, I_{SC} , of this circuit between points A and B. (1%)
- Redraw the Thévenin and Norton equivalent circuits. (2%)
- A $2\text{ k}\Omega$ load is connected between A and B. What is the voltage and current through this load? (2%)
- Instead of connecting directly to the load, A and B are connected to a 741 operational amplifier in the circuit shown below, where R_6 is the $2\text{ k}\Omega$ load. Estimate the voltage and current through the load, R_6 , now? (1%)



22. Digital logic

- a) Show that circuits A and B are equivalent by setting up a truth table for the two circuits. What is the Boolean expression for the circuits? (2%)



- b) For the following truth table, write down and simplify the Boolean expression. (2%)

A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

- c) Using logic gates, implement the simplified Boolean expression of part b. (3%)
- d) Re-draw the waveforms for the circuits below and include the waveform at the Q output. (3%)

