

AC ELECTRICAL FUNDAMENTALS TRIAL MID-SEMESTER TEST

- This test is **closed** book, calculator permitted.
- Answer questions in the spaces provided.
- Clearly label all currents, resistors and voltage drops in the circuits and state any assumptions in order to obtain a full mark
- When calculating values, show clearly all steps, starting with the formula, then substituting with numbers and finally show the measuring units of the obtained result. Otherwise **NO MARKS** are given
- It is permitted to use the formula sheets, given at the back of your lab book.
- Time permitted 1½ hours.
- **60 MARKS TOTAL (70% pass)**

Q1) In a certain magnetic field the cross-sectional area is 50 cm^2 and the flux is $1500 \mu\text{Wb}$.
What is the flux density? **[2 marks]**

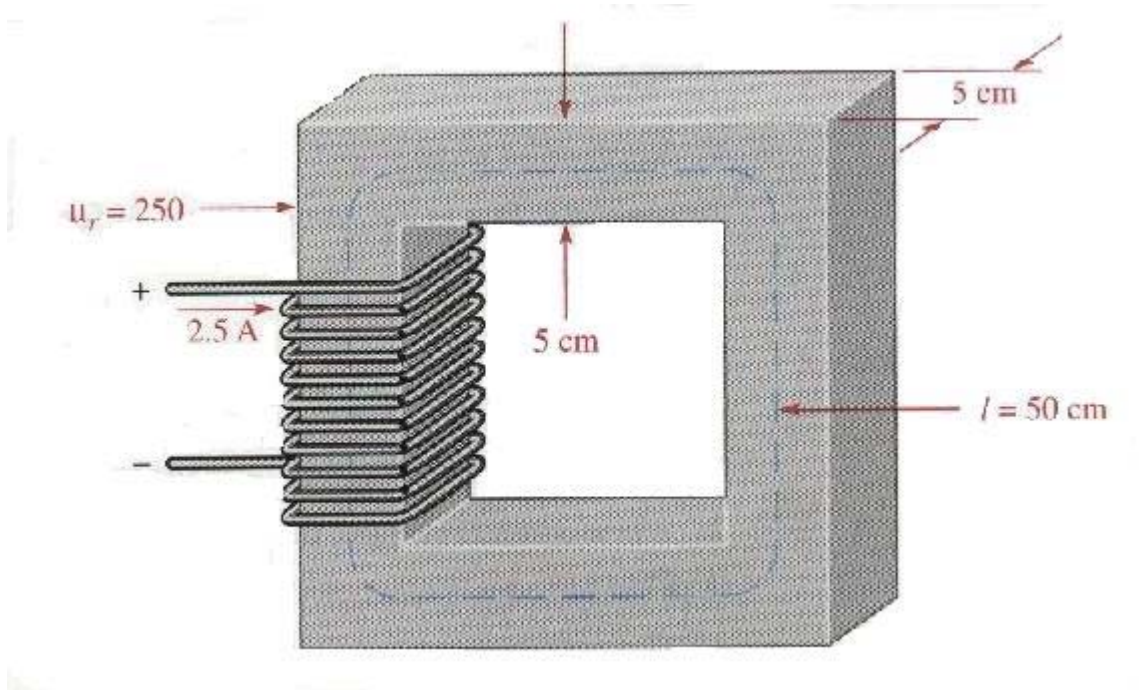
Q2) Determine the reluctance of a material with a length of 28 cm and a cross-sectional area of 800 mm^2 if the relative permeability is 1000. The permeability of vacuum is $4\pi \cdot 10^{-7} \text{ Wb/At.m}$.
[3 marks]

Q3) What is the magnetizing force in 1 50 turn coil of wire when there are 3A of current through it and the length of the core is 0.2m? **[3 marks]**

Q4) In the diagram below determine the following:

[3 marks]

- a. H
- b. Φ
- c. B



Q5). According to Faraday's Law, what happens to the induced voltage across a given coil if the rate of change of magnetic flux doubles? **[1 mark]**

Q6) A magnetic field is changing at a rate of $3500 \times 10^{-3} \text{ Wb/s}$. How much voltage is induced across a 50 turn coil that is placed in the magnetic field? **[1 mark]**

Q7) A sine wave has a frequency of 50kHz. How many cycles does it complete in 10ms? **[2 marks]**

Q8) Calculate the frequency for a sine wave with a period of 500 μs .

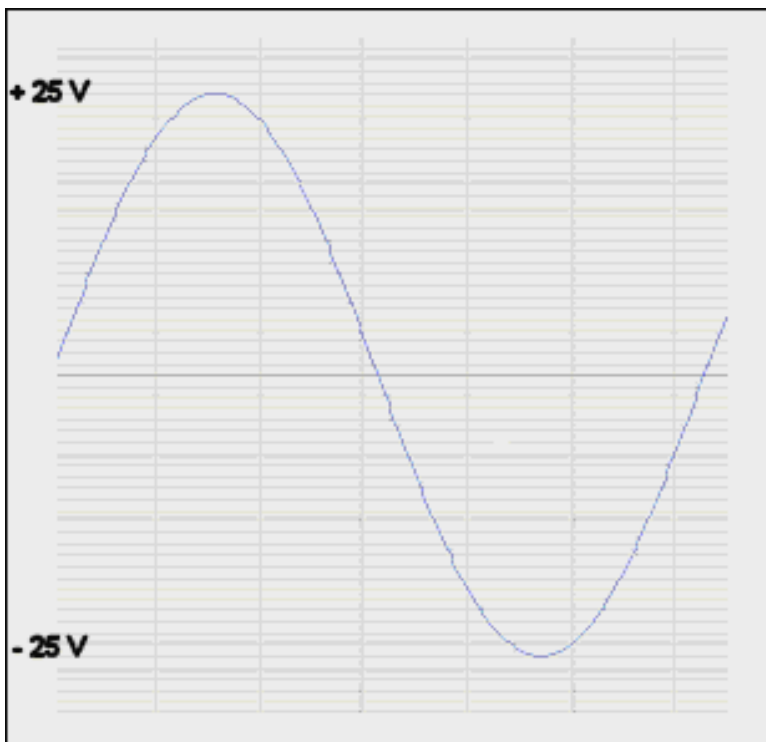
[1 mark]

Q9) Calculate the time period for a sine wave with a frequency of 500 MHz.

[1 mark]

Q 10) For the sine wave below, determine the peak, peak-to peak, and RMS values.

[3 marks]



Q 11) Convert $\pi/8$ rad to degrees.

[1 mark]

Q 12) Convert 108° into radians.

[1 mark]

Q13) One sine wave has a positive peak at 75° and another has a positive peak at 100° . How much has each wave shifter in phase from the 0° reference? What is the phase angle between them?

[1 mark]

Q 14) A certain sine wave has a positive going zero crossing at 0° and an rms value of 20V. Calculate its instantaneous value at each of the following angles: **[3 marks]**

- a. 15°
- b. 110°
- c. 325°

Q 15) For a 0° reference sine wave with an rms value of 6.37V, determine its instantaneous value at each of the following points: **[3 marks]**

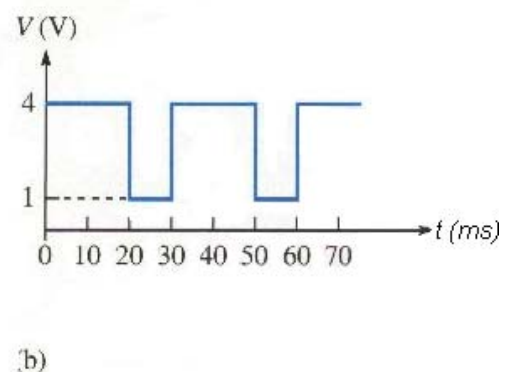
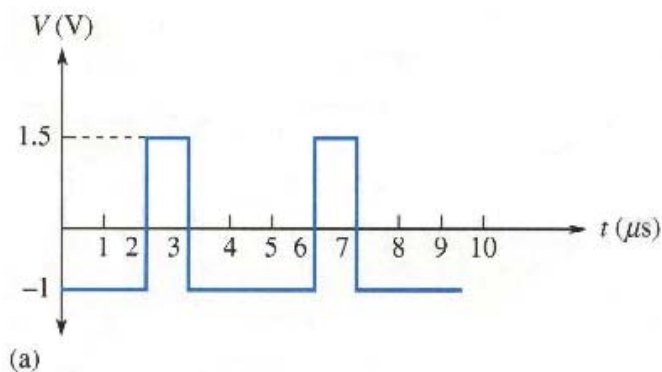
- a. $\pi/8$ rad
- b. $3\pi/4$ rad
- c. $3\pi/2$ rad

Q 16) Sine wave A lags sine wave B by 30° . Both have peak values of 15V. Sine wave A has reference with positive going at 0° . Determine the instantaneous value of sine wave B at 45° , 200° and 300° . **[3 marks]**

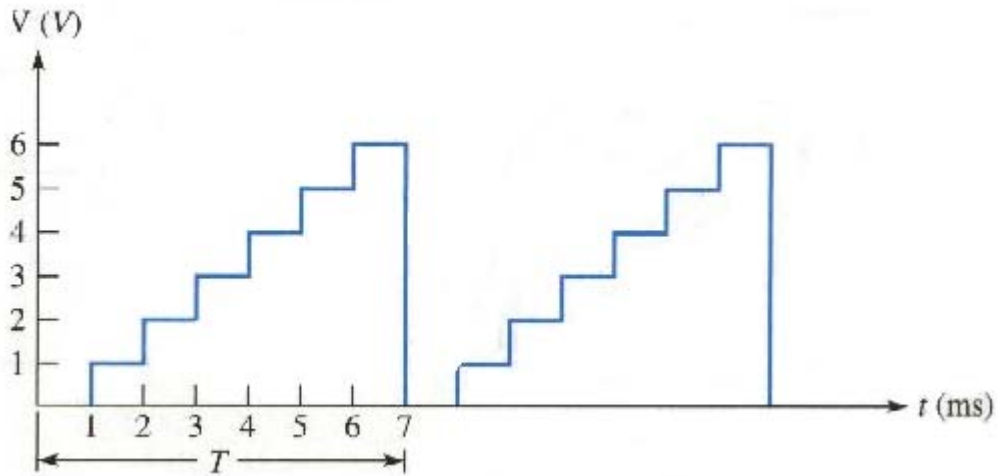
Q 17) How much dc voltage must be added to a 3V rms sine wave in order to make the resulting voltage nonalternating (no negative values)? **[1 mark]**

Q 18) The repetition frequency of a pulse waveform is 2kHz, and the pulse width is $1\mu\text{s}$. What is the percent duty cycle? **[2 marks]**

Q 19) Determine the duty cycle for each waveform below. **[2 marks]**



Q 20) A non-sinusoidal waveform called a staircase is shown below. Determine its average value. **[1 mark]**

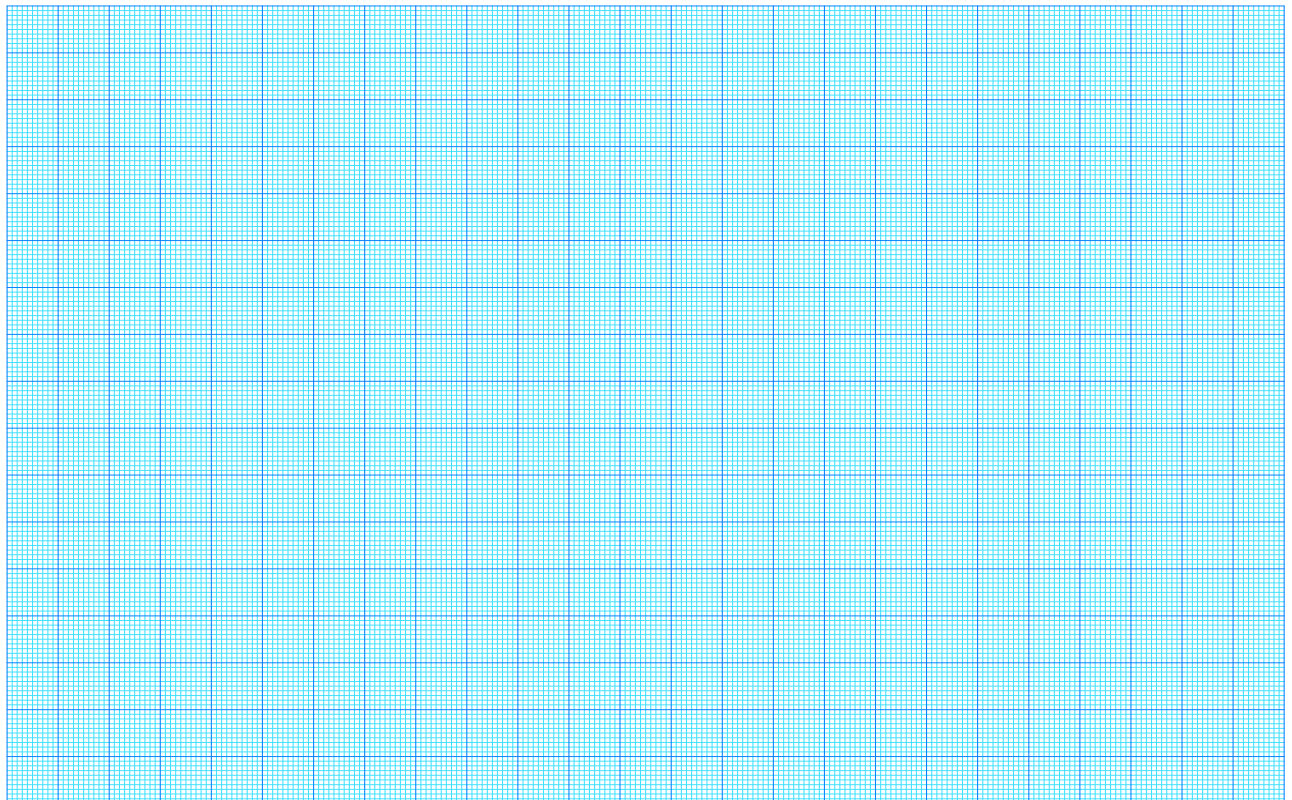
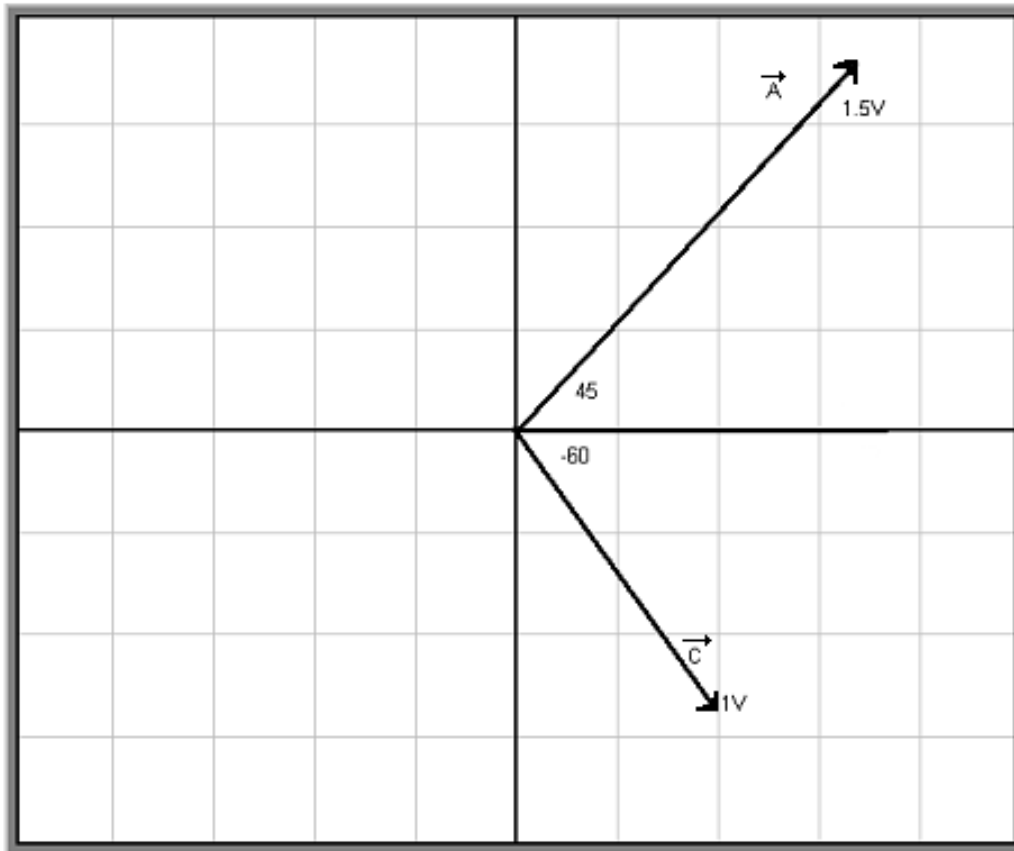


Q 21) What is the fundamental frequency of a square wave with a period of $40\mu\text{s}$? **[1 mark]**

Q 22) A square wave has a period of $40\mu\text{s}$. List the first six odd harmonics. **[2 marks]**

Q 23) What value capacitor is capable of storing 10mJ of energy with 100V across its plates? **[1 mark]**

Q 24) Draw the sine waves represented by the phasor diagram below. The phasor lengths represent peak values. **[3 marks]**



Q 25) Determine the frequency for the angular velocity of 1256 rad/s **[1 mark]**

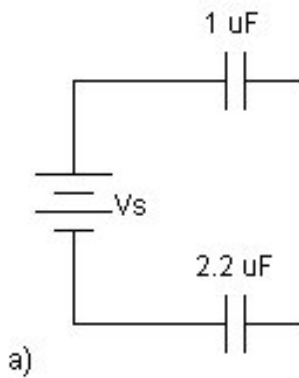
Q 26) Determine the angular velocity for frequency of 2 kHz. **[1 mark]**

Q 27) The frequency of a sine wave with 0° phase shift is 5kHz. The peak value of the sine wave is 1 V. Determine the instantaneous value of the sine wave at $30\mu\text{s}$, $75\mu\text{s}$ and $125\mu\text{s}$, measured from the initial positive going zero crossing. **[3 marks]**

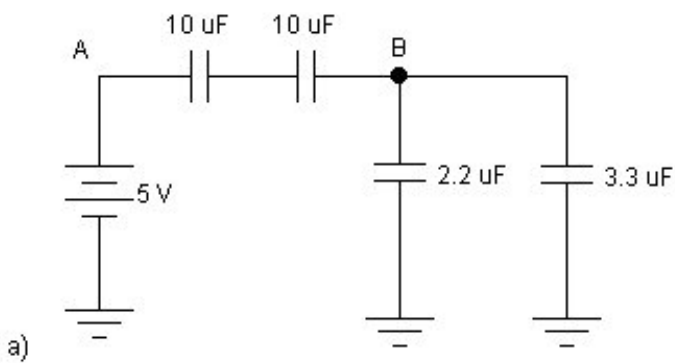
Q 28) A mica capacitor has a plate area of 40 cm^2 and a dielectric thickness of 8 mm. What is its capacitance? The dielectric constant of mica is 5.0. The absolute permittivity of vacuum is $8.85 \times 10^{-12}\text{ F/m}$. **[3 marks]**

Q 29) Five 1000pF capacitors are in series. What is the total capacitance? **[1 mark]**

Q 30) For the circuit below, determine the voltage across each capacitor if the value of the battery is 10 V. **[2 marks]**



Q 31) What is the voltage between points A and B in the circuit below? **[3 marks]**



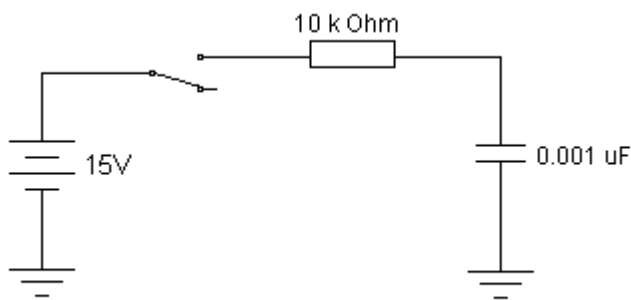
Q 32) Determine the time constant for RC circuit, where $R = 100\Omega$, $C = 1\mu\text{F}$

[1 mark]

Q 33) In the circuit below, the capacitor is initially uncharged. Determine the capacitor voltage at the following times after the switch is closed:

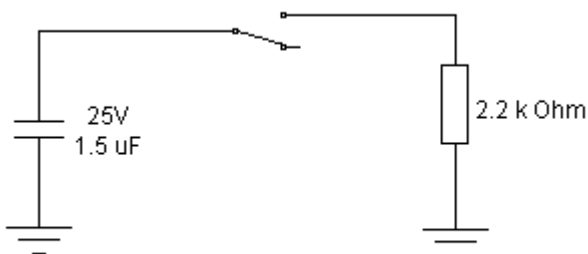
[3 marks]

- a. $10\mu\text{s}$
- b. $30\mu\text{s}$
- c. $50\mu\text{s}$



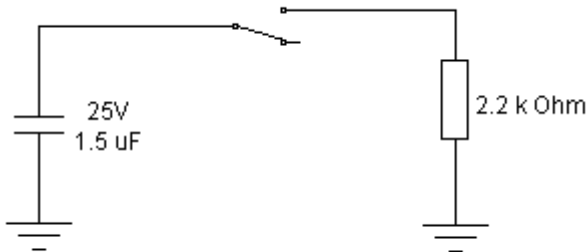
Q 34) On the diagram below the capacitor is initially fully charged to 25V. Determine how long it take for it to discharge to 3V after the switch is closed?

[1 mark]

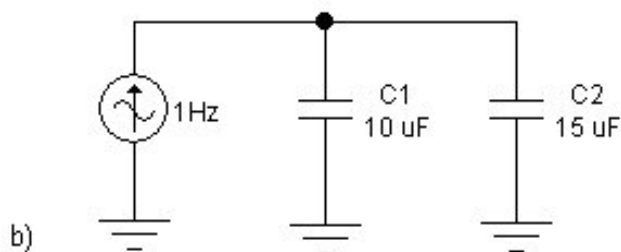


Q 35) In the figure below, the capacitor is initially fully charged. Determine the capacitor voltage at the following times after the switch is closed: **[3 marks]**

- a. 5ms
- b. 10ms
- c. 15ms



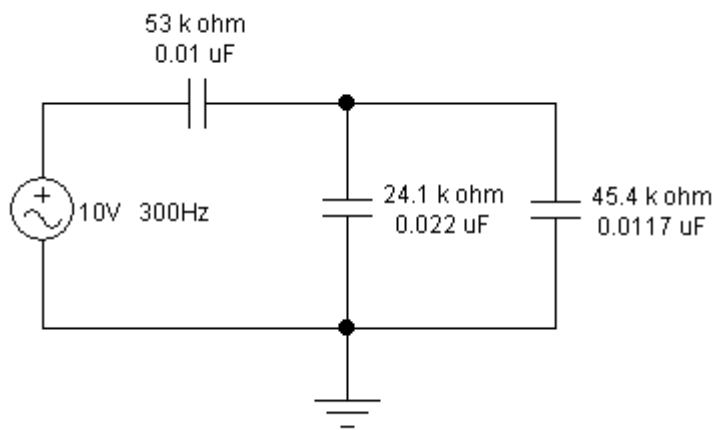
Q 36) What is the value of the total capacitive reactance of the circuit below? **[1 mark]**



Q 37) In the previous question Q36, what frequency is required to produce an X_C of 100 Ω ? **[1 mark]**

Q 38) A 1 kHz voltage is applied to a $47\mu\text{F}$ capacitor, and 1mA of rms current is measured. What is the value of the voltage? **[2 marks]**

Q 39) Determine the ac voltage across each capacitor and the current in each branch of the circuit below. What is the phase angle between the current and the voltage in each case? **[5 marks]**

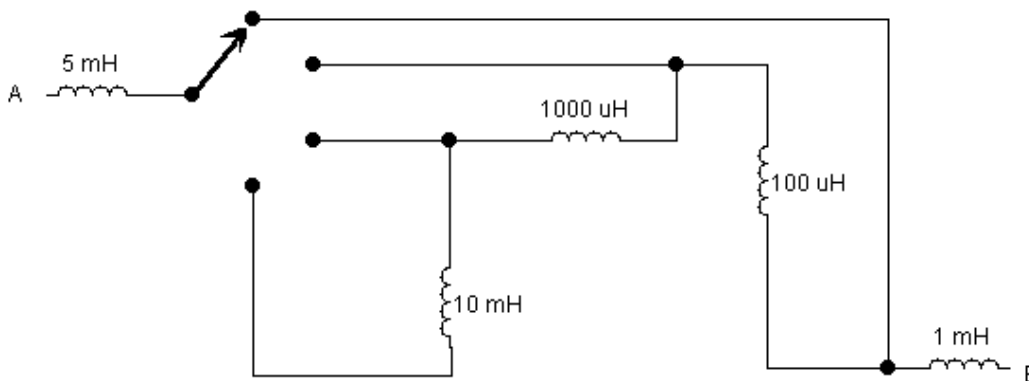


Q 40) Fifty volts are induced across a 25mH coil. At what rate is the current changing? **[1 mark]**

Q 41) How many turn are required to produce 30mH with a coil wound up on a cylindrical core having a cross-sectional area of 100 mm^2 and a length of 50 mm? The core has a permeability of $1.2 \times 10^{-6} \text{ H/m}$. **[2 marks]**

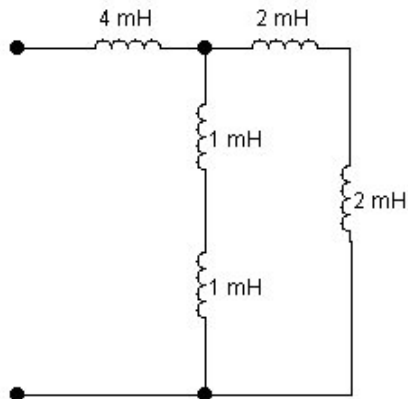
Q 42) How much energy is stored by a 100mH inductor with a current of 1A. **[1 mark]**

Q 43) What is the total inductance between points A and B for each switch position below: **[4 marks]**



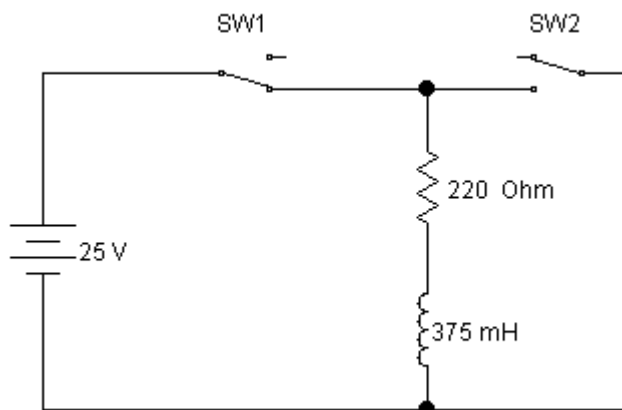
Q 44) Determine the total inductance of the circuit below:

[1 mark]



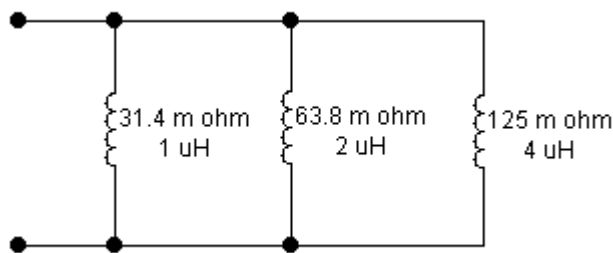
Q 45) In a series RL circuit, determine how long it takes the current to build up to its full value if $R = 56\Omega$ and $L = 50\mu\text{H}$. **[2 marks]**

Q 46) Initially SW1 is opened. Determine the current through the inductor at 1ms, 3ms and 5 ms after the switch SW1 is closed. **[3 marks]**



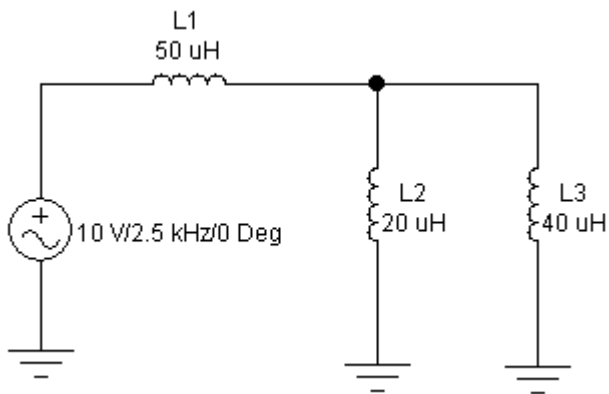
Q 47) For the circuit in the previous question, initially the final steady value of the current through the inductor is reached. Then SW1 opens and SW2 closes simultaneously. Determine the current through the inductor at 1ms, 3ms and 5 ms after the switch SW2 is closed. **[3 marks]**

Q 48) What is the value of the total inductive reactance of the circuit below, when the frequency is 1MHz? **[2 marks]**



Q 49) Five inductors are connected in series. The lowest value is 5 μH . If the value of each inductor is twice that of the preceding one, and if the inductors are connected in order of ascending values, what is the total inductance? **[1 mark]**

Q 50) Determine the ac voltage across each inductor and the current in each branch of the circuit below. What is the phase angle between the current and the voltage in each case? **[5 marks]**



END OF TEST
(Check your work!)