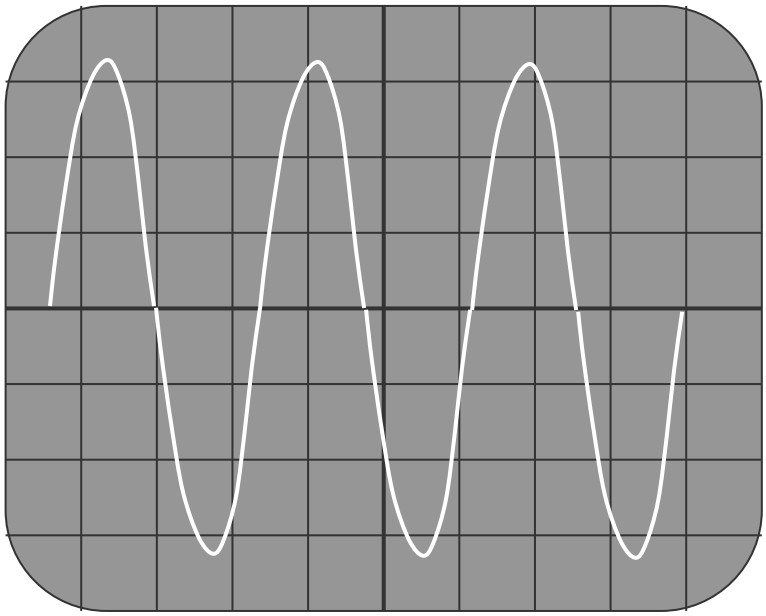
Leeds City College

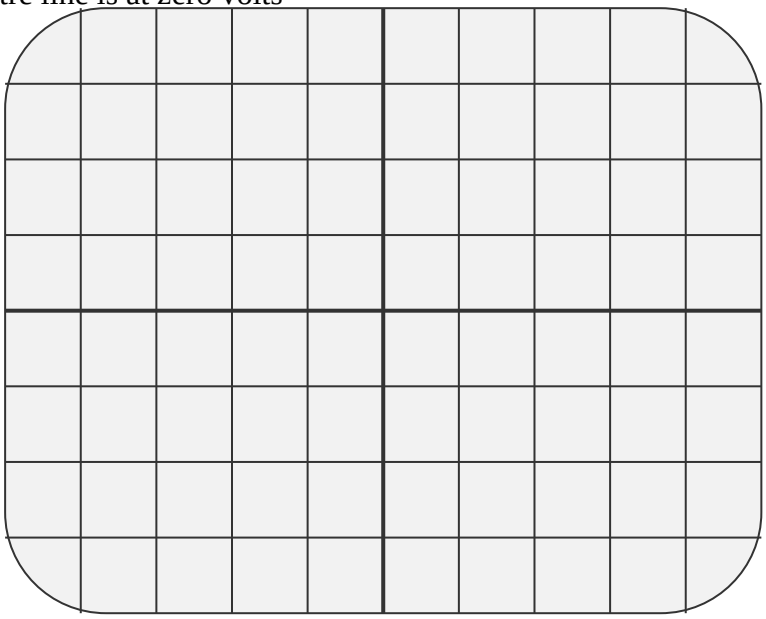
Name:

Semester 1 Exam on Electrical Principles

Examination Time – 75 minutes

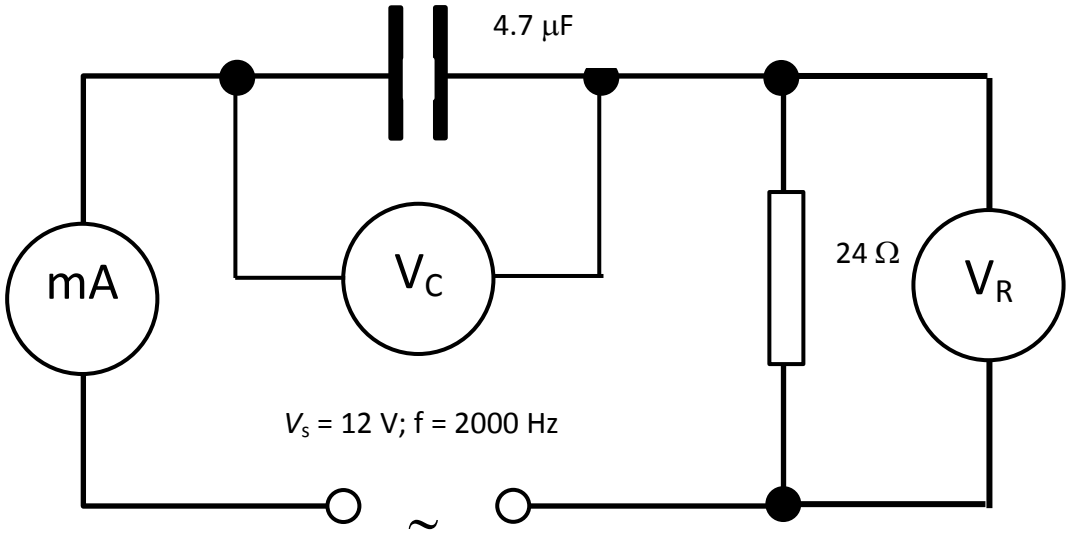
- *Write your answers in the spaces provided.*
- *You are expected to use a calculator.*
- *For full credit in numerical problems, it is not sufficient just to write the correct numerical answer. All calculation steps should be shown, including correct physics and electrical principles.*
- *Final numerical answers should not be given to more than three significant figures.*
- *Correct units must be included where indicated.*
- *You are reminded of the need for good English and clear presentation.*

1.	The CRO screen shows an alternating sinusoidal wave-form.  The time base is set to 2 ms/cm; The voltage gain is set to 1 V/cm. Each square is 1 cm.		
	(a)	Show that the peak-to-peak voltage is about 6.5 V	(1)
	(b)	What is the peak voltage?	(2)
	V_0 = V		

	(c)	What is the RMS voltage?	(2)
	V_{RMS} = V		
	(d)	Calculate the frequency of this wave	(3)
	Frequency = Hz		
	(e)	Explain the difference between an alternating and a unidirectional waveform.	(2)
	(f)	On the blank CRO screen draw one cycle of a symmetrical **unidirectional** triangular wave of peak voltage 1.5 V and frequency 100 Hz. Assume that the centre line is at zero volts  State what the voltage gain control and the time-base control are set at.	(4)
	Time-base: s/cm		
	Voltage-gain: V/cm		
			14

2.	An alternating voltage is given by the expression: $V = 36\sin[(30\pi t) - 0.25]$		
	(a)	What is the amplitude?	(1)
	Amplitude = V		
	(b)	Show that the frequency of the wave is 15 Hz	(2)
	(c)	Draw a phasor diagram for this wave when $t = 0$. Show the direction of rotation and the phase angle in degrees	(4)
	(d)	Show that the voltage when $t = 100$ ms is about 9 V	(3)
	(e)	The waveform is connected to a resistor of resistance 30 Ω. Calculate the maximum current and write a suitable equation for the current. Give a reason for your answer	(5)
	Current = A		
	Equation:		
	Reason:		
			15

3.



The capacitor in this circuit has a capacitance of 4.7 μF. It is connected to a sinusoidally alternating supply of 12 V of frequency 2000 Hz. It is also connected to a resistor of resistance 24 Ω.

(a) Show that the reactance of the capacitor is about 17 ohms. (2)

(b) Calculate the impedance of the circuit. Give the unit. (3)

Impedance =

(c) Calculate the current flowing in the circuit. Give your answer to an appropriate number of significant figures. (3)

Current = mA

(d) Work out the phase angle between the source voltage and the voltage in the resistor. (2)

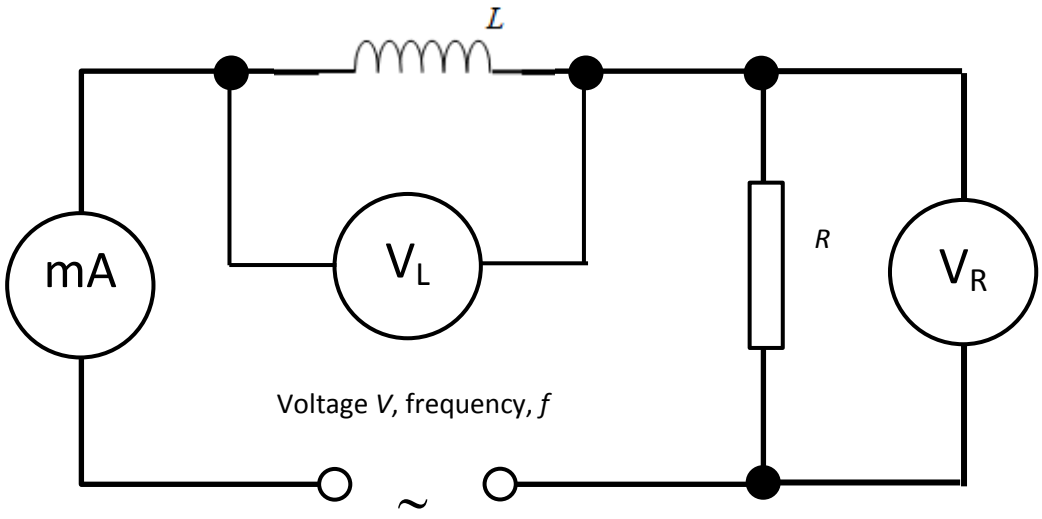
Phase angle = degrees

10

4.	A motor connected to an AC supply can be modelled as an inductor in series with a resistor.		
	(a)	In a demonstration, a 240 V **universal** motor is connected to a low voltage DC power supply. It starts to turn when the voltage reaches about 8 V, and is turning rapidly by the time the voltage reaches 12 V. When it is connected to a 20 V AC supply, nothing happens. Explain these observations.	(3)
	Many machines use **induction** motors which can be modelled in exactly the same way. A customer wants to buy this circular saw from a leading supplier.  In looking at the information supplied with the saw, he sees that the power is as shown: Voltage = 230 V AC Power = 2200 W The supplier says that a 16 A supply is needed.		
	(b)	The customer knows a bit about basic electricity, but nothing about the electrical engineering you have done. He calculates (correctly using $P = VI$) the current and gets an answer of about 9.6 A. Explain to him why wiring the machine to an ordinary mains plug is not a good idea and that a 16 A supply is recommended. The quality of technical authorship will be assessed in this question.	(8)

	(c)	What is the true power of this machine? Give the unit.	(2)
	True power =		
	(d)	The power factor in this machine is known to be 0.716. Calculate the apparent power of the machine and give the correct unit.	(3)
	Apparent power =		
	(e)	Calculate the current.	(2)
	Current = A		
			15

5.



The frequency is set at 1500 Hz and the current is measured at 50 mA. The voltage across the resistor is found to be 10 V while the voltage across the inductor is found to be 6 V.

(a) Show that the supply voltage is just under 12 V (2)

(b) Calculate the resistance of the resistor. (2)

Resistance = Ω

(c) Calculate the reactance of the inductor. (2)

Reactance = Ω

(d) Draw the impedance triangle for this circuit. Put values on for R, X_C, and Z. (4)

	(e)	Calculate the phase angle.	(3)
	Phase angle = degrees		
	(f)	Use your result to work out the power factor in this circuit.	(3)
	Power factor =		
			16
		Total = 70 marks	

End of Examination

Now go back and check your work