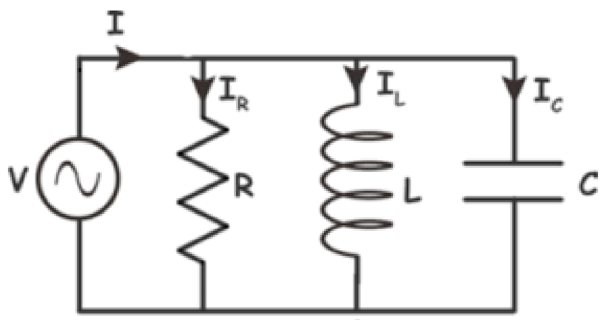
SUBJECT and GRADE	Electrical Technology Grade 12	
TERM 1	Week 4	
TOPIC	RLC Lesson 2 (parallel circuits)	
AIMS OF LESSON	This lesson is about the understanding and calculation of Impedance, currents and phase angle in a parallel RLC circuit.	
RESOURCES	**Paper resources**	**Digital resources**
	Electrical Technology Textbook Grade 12 (pg. 47-83)	YouTube links and web pages for this lesson 1. https://www.youtube.com/watch?v=C8o2UpqzuKI (RLC) 2. https://www.electronics-tutorials.ws/accircuits/parallel-circuit.html RLC circuit parallel 3. https://www.youtube.com/watch?v=VH3MTiJSXFY calculations 4. https://www.youtube.com/watch?v=8MMzeeHNjlw Calculations 5. https://www.youtube.com/watch?v=49ZE1DtTQ-M Phasor diagram
INTRODUCTION	• Your basic understanding of phasors w.r.t. magnitude and direction is important to understand the work done in this lesson. • You will have to be familiar how to change the subject of a formula. • This lesson is about the understanding and calculation parallel RLC circuit. • This lesson must be done in conjunction with your textbook. • Always remember to choose the correct formula and make sure your answer has a correct unit.	
CONCEPTS AND SKILLS	**Parallel RLC circuit** Parallel RLC circuit work differently with the series RLC circuit, on Series RLC circuit the current is common, and voltage is divided but on RLC parallel circuit the voltage supplied is equal to the voltages drop across each component: $V = V_R = V_L = V_C$ and the currents are not the same:	**Do You know:** • How to calculation of Impedance, currents and phase angle in a parallel RLC circuit. • Parallel resonance, Q-factor as well as selectivity with reference to parallel RLC circuits • How to interpret data from a given graph

$I_R = \frac{V}{R}$ $I_L = \frac{V}{X_L}$ $I_C = \frac{V}{X_C}$ and $Z = \frac{V_T}{I_T}$

Also, I_X = the difference between I_L and I_C

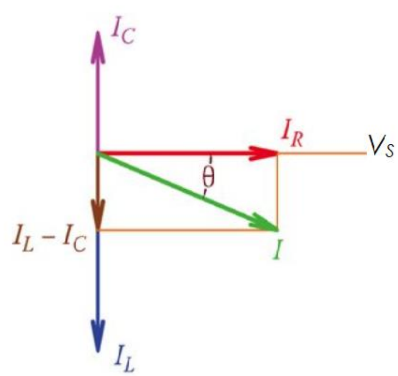
VOLTAGE IS THE REFERENCE QUANTITY IN A PARALLEL CIRCUIT

The currents on each branch of the circuit has a phase shift with reference to the voltage . Combining the three phasor diagrams into one, all using the common supply voltage as the reference.



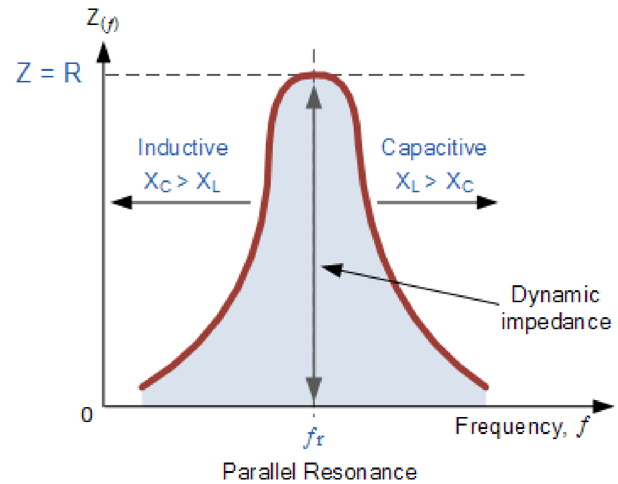
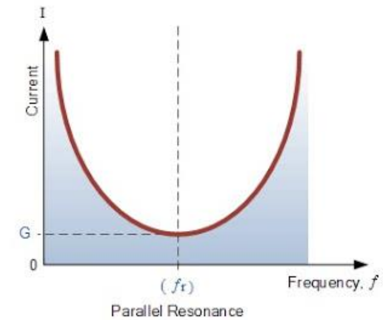
If $I_L > I_C$: $I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$

If $I_C > I_L$: $I_T = \sqrt{I_R^2 + (I_C - I_L)^2}$



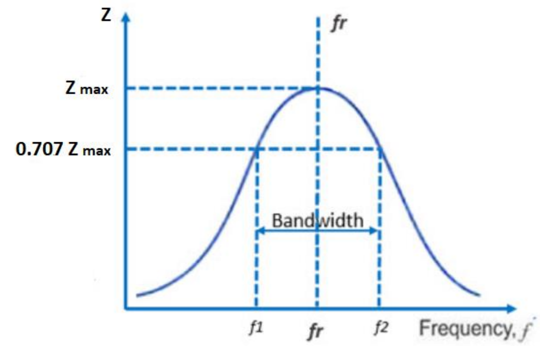
Phase Angle (θ ***)***

$\therefore \theta = cos^{-1} \frac{IR}{IZ}$

	Parallel Resonance At parallel resonance the following conditions will exist: • $X_L = X_C$ • Z = maximum • I - minimum • From the curve at parallel resonant frequency, the impedance of the circuit is maximum. • For frequencies lower than resonant frequency the circuit is Inductive and for frequencies higher than resonant frequencies the circuit is capacitive  From the curve on the right, the current is minimum at resonant frequency.  Resonant frequency in a parallel circuit can be calculated with the following formula. $$\mathrm{Fr} = \frac{1}{2\mathrm{x}\ \pi\sqrt{\mathrm{LC}}}$$ **Q - Factor in parallel circuit.** The Q-factor of a parallel circuit can be defined as the ratio of the inductive/capacitive reactance to the impedance during resonance or the ratio of the inductive/capacitive current to the supply current during resonance. The quality factor of a parallel circuit can be calculated by the following formula $$Q = \frac{X_L}{Z} = \frac{X_C}{Z} = \frac{I_L}{I_T} = \frac{I_C}{I_T} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Bandwidth

- Bandwidth is defined as the size of frequency range that is passed or rejected by the tuned circuit.
- The bandwidth of the parallel resonant response curve is measured between the half power points. This corresponds to the 70.7% voltage points.
- Since voltage is proportional to impedance, we may use the impedance curve.



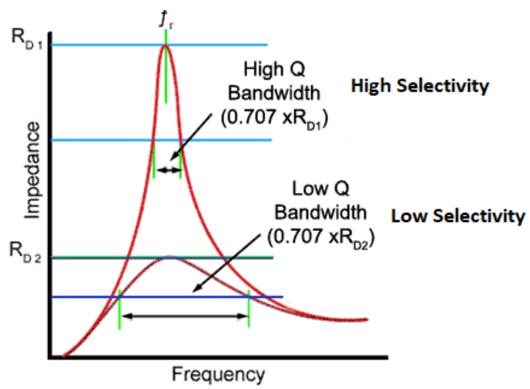
$BW = f_2 - f_1$ Hz and

$$f_r = \frac{f_1 + f_2}{2}$$ Hz also

$$BW = \frac{f_r}{Q}$$

Selectivity

- Selectivity of a circuit is how well a resonant circuit responds to a range of frequencies and separates others.
- If the band of frequencies to be selected or rejected is narrow, the quality factor of the resonant circuit must be high
- The sharpness of the curve is a measure of what is called the circuit's quality factor Q. The higher the Q the smaller is bandwidth and the more selective the circuit is.



Typical Question 1:

The Parallel circuit consists of a capacitor with a capacitive reactance of 20 Ω, an inductor with an inductive reactance of 40 Ω and a resistor with a resistance of 30 Ω connected across a 240 V/50 HZ supply. Calculate the Impedance of the circuit.

Typical Answer:

$$z = \frac{1}{\sqrt{(\frac{1}{R})^2 + (\frac{1}{x_L} - \frac{1}{x_c})^2}}$$

$$z = \frac{1}{\sqrt{(\frac{1}{30})^2 + (\frac{1}{40} - \frac{1}{20})^2}}$$

$$z = 24\ \Omega$$

Typical Question 2:

2.6 Refer to FIGURE 2.6 and answer the questions that follow.

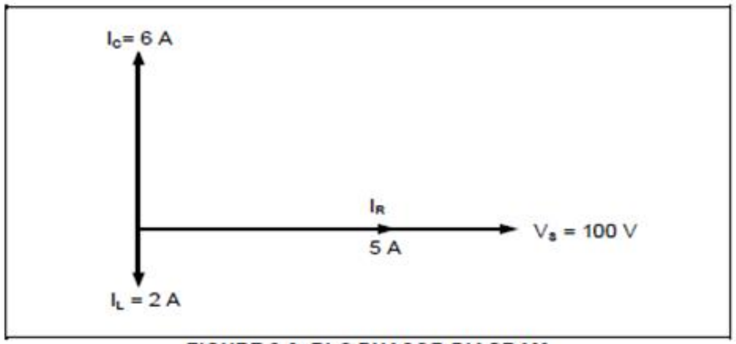
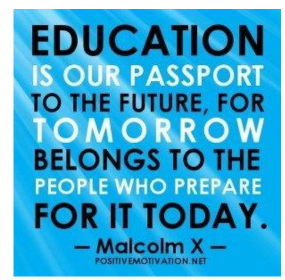


FIGURE 2.6: RLC PHASOR DIAGRAM

2.6.1 Calculate the following:

(a)	Inductive reactance	(3)
(b)	Capacitive reactance	(3)
(c)	Reactive current	(3)
(d)	Total current	(3)

2.6.2 State whether the phase angle is lagging or leading. (1)

	Typical Answer: 2.6 a. $X_L = \frac{V_S}{I_L}$ ✓ $= \frac{100}{2}$ ✓ $= 50\ \Omega$ ✓ (3) b. $X_C = \frac{V_S}{I_C}$ ✓ $= \frac{100}{6}$ ✓ $= 16,67\ \Omega$ ✓ (3) c. $I_X = I_C - I_L$ ✓✓ $= 6 - 2$ $= 4$ A ✓ (3) Note: If the learner sets one or a difference in reactive currents, the d. $I_T = \sqrt{I_R^2 + (I_C - I_L)^2}$ ✓ $= \sqrt{5^2 + (6-2)^2}$ ✓ $= 6,4$ A ✓ (3) 2.6.2 Phase angle is leading. ✓ (1)
ACTIVITIES/ ASSESSMENT	**NB**: It is important that you do all the questions on your own first, before you consult any resources. Refer to end of chapter activity and do all the questions related to this section of the work. (page 84) Time per question (1 mark = 1 minute) Also do the questions in revision exercise at the end of this lesson.
CONSOLIDATION	The work done in the lesson was about the effect of AC on parallel R, L and C circuits and related calculations Always remember to choose the correct formula for the calculation and make sure the answer has the correct unit. Many learners are losing valuable marks because they do not add a unit to their answer. Remember, in order to master calculations, you need to practice, practice and continue practicing. Congratulations on completing this lesson 
VALUES	We use electrical circuits to help people with real world solutions to everyday problems. As you gain experience and Value Learning new concepts you will be able to design better solutions.

REVISION EXERCISE

Time per question (1mark = 1minute)

2.3 FIGURE 2.3 below shows an RLC parallel circuit that consists of a 40 Ω resistor, an inductor with unknown inductance and a capacitor with a capacitive reactance of 60 Ω, all connected across a 220 V/60 Hz supply. Answer the questions that follow.

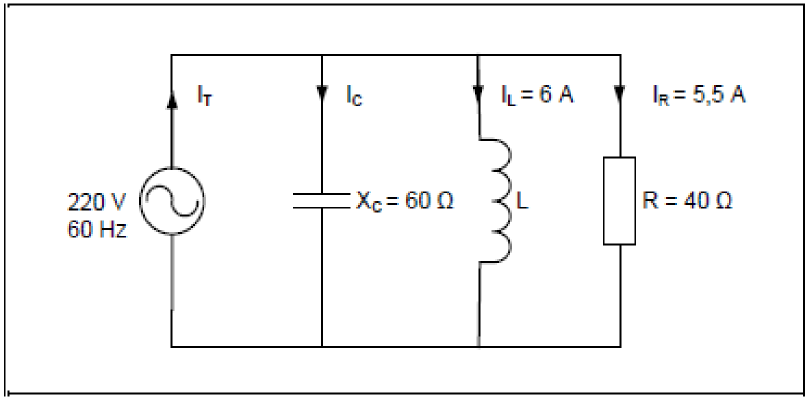


FIGURE 2.3: RLC PARALLEL CIRCUIT

Given:

V_S	=	220 V
F	=	60 Hz
R	=	40 Ω
X_C	=	60 Ω
I_L	=	6 A
I_R	=	5,5 A

2.3.1 Calculate the current through the capacitor. (3)

2.3.2 Calculate the reactive current. (3)

2.3.3 State, with a reason, whether the phase angle is leading or lagging. (2)