KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

POLITEKNIK MALAYSIA
KUCHING SARAWAK

	ELECTRICAL ENGINEERING DEPARTMENT		
	DET40073 & POWER ELECTRONICS		
LECTURER NAME	**FAIZAL BIN AHMAD**		
TYPE OF ASSESSMENT	**PRACTICAL WORK 1**		
TOPIC	**2 (AC TO DC CONVERTER)**		
DURATION	**2 HOURS 30 MINUTES**		
DATE OF ASSESSMENT			
STUDENT'S INFORMATION	**NAME**	**REGISTRATION NO.**	**TICK STUDENT**
TOTAL MARKS	**CLO 2**		**/100**
	CLO 3		**/ 10**

POLITEKNIK MALAYSIA
KUCHING SARAWAK

DET40073 – POWER ELECTRONICS

PRACTICAL WORK 1 & SINGLE PHASE UNCONTROLLED RECTIFIER

CLO 2	Construct converters circuits and make observation on displayed waveforms using appropriate methods and equipment.	**PLO 4**	**DK DP NA (Not Related)**
CLO 3	Demonstrate the ability to practice leadership skills to complete assigned power electronics tasks.	**PLO 9**	**DK DP NA (Not Related)**

A. OBJECTIVES

Upon completion of this experiment, students should be able to:

i. Construct and explain the operation of single-phase AC to DC using single half wave uncontrolled rectifier and single full wave uncontrolled rectifier with center-tapped and bridge circuit.
ii. Determine output voltage (Vo) and voltage across diode (VD) waveforms.
iii. Explain the differences between a center-tapped and a bridge rectifier.
iv. Measure and calculate DC output voltage.

B. LEARNING OUTCOME

Construct converter circuits and make observation on displayed waveforms using appropriate methods and equipments

C. TOPIC SUMMARY/ THEORY

i. Single-Phase Half Wave Uncontrolled Rectifier

A single-phase half wave rectifier is the simplest type, but it is not normally used in industrial applications. However, it is useful in understanding the principle of rectifier operation. The circuit diagram with a resistive load is shown in Figure 2.1.

The diode is a basic electronic switch that allows current in one direction only. During the positive half-cycle of the input voltage, diode D_1 is conducts (forward-biased) and the input voltage appears across the load. Considering the diode to be ideal, the voltage across a forward-biased diode is zero and the current is positive.

During the negative half-cycle of the input voltage, the diode is in the blocking condition (reverse biased) and the output voltage is zero. The voltage across the reverse-biased diode is the source voltage, which has a negative value. The waveforms for the input voltage, output voltage, output current and voltage across a diode are shown in Figure 2.2.

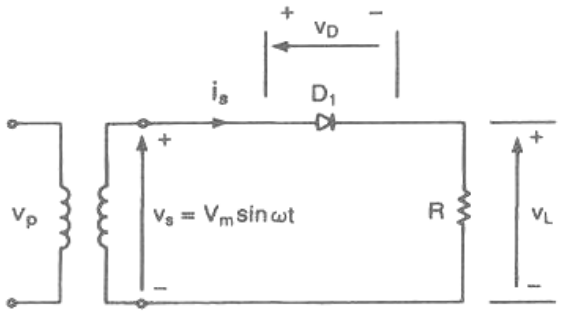


Figure 2.1 - Single-phase half wave uncontrolled rectifier circuit

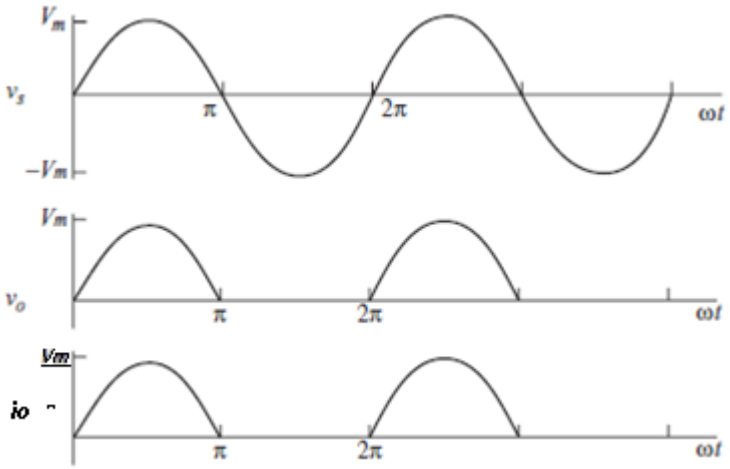


Figure 2.2 – Single-phase half wave uncontrolled rectifier waveform

Although the output as shown in Figure 2.2 is DC, it is discontinuous and contains harmonics. The average and rms (root-mean-square) value of the output voltage and current can be determined by the following formulas:

$$V_o = V_{\text{avg}} = \frac{1}{2\pi}\int_0^{\pi} V_m \sin(\omega t)\, d(\omega t) = \frac{V_m}{\pi}$$

Vo = Vdc = Vavg

$$V_{dc} = 0.318 V_m \qquad\qquad V_{rms} = 0.5 V_m$$

ii. Single-Phase Full Wave Uncontrolled Center-Tapped Rectifier

A single-phase full wave uncontrolled center-tapped rectifier is shown in Figure 2.3(a). Each half of the transformer with its associated diode acts as a half-wave rectifier and the input and output waveform of a full wave uncontrolled center-tapped rectifier is shown in Figure 2.3(b).

On the positive half-cycle, D1 is in forward biased and D2 is in reverse bias. This current will flow through D1 to the load and produce the output voltage (Vo) in a positive cycle of the same as input voltage. On the negative half-cycle, D2 is in forward biased and D1 will be reverse biased. So, this current will flow through D2 to the load and produce the output voltage (Vo) in a positive cycle of the same as input voltage.

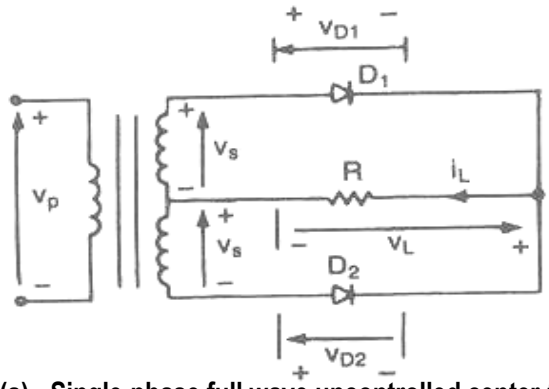


Figure 2.3(a) - Single-phase full wave uncontrolled center-tapped rectifier circuit

The average output voltage is $V_{dc} = 0.6366 V_m$.

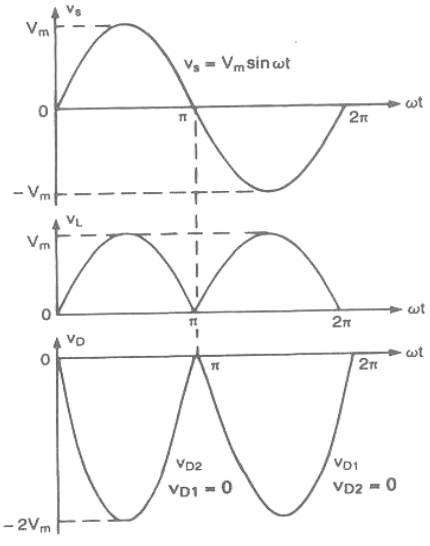


Figure 2.3(b) : Single-phase full wave uncontrolled center-tapped rectifier voltage waveform

iii. Single-Phase Full Wave Uncontrolled Bridge Rectifier

Instead of using a center-tapped transformer, we could use four diodes, as shown in Figure 2.4(a). During the positive half-cycle of the input voltage, the power is supplied to the load through diode D_1 and D_2. During the negative cycle, diodes D_3 and D_4 conduct.

The waveform for the input and output voltage is shown in Figure 2.4(b). The peak-inverse voltage of a diode is only V_m. This circuit is known as a *bridge rectifier*, and it is commonly used in industrial applications.

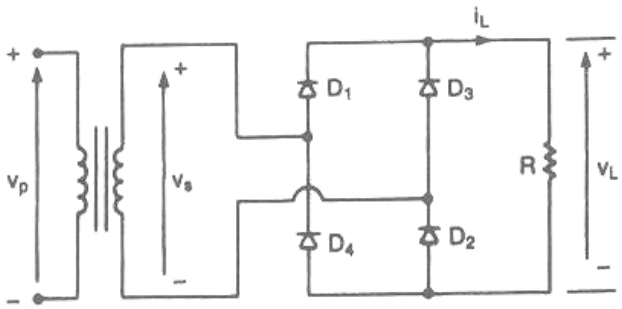


Figure 2.4(a) - Single-phase full wave uncontrolled bridge rectifier circuit

The average output voltage is $V_{dc} = 0.6366 V_m$.

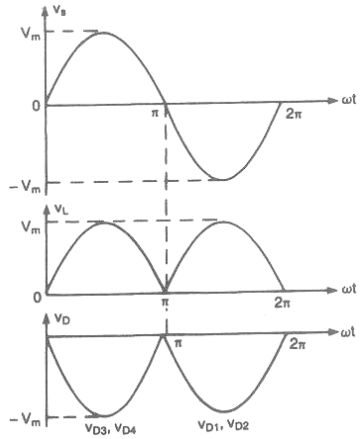


Figure 2.4(b) - Single-phase full wave uncontrolled bridge rectifier voltage waveform

D. MATERIAL / TOOLS

i. Three Phase Isolation Transformer
ii. Power Diodes
iii. Resistive Load Resistance (100 ohm)
iv. Oscilloscope
v. Apparatus Stand
vi. Cable Connector

E. GENERAL INSTRUCTION / SAFETY PROCEDURE

i. Wear suitable PPE where required.
ii. Identify location of Fire Exit, Fire Extinguisher, First Aid Kit box and HIRARC sheets.
iii. Avoid unsafe activities during practical work.
iv. Carefully follow the lecturers' instructions to avoid personal injury and damage to the equipment.
v. Check the hand tools and equipment in good working condition.
vi. Verify electrical power supply connection before powering up. Seek advice from lecturer when necessary or if the practical work procedures require you to do so.
vii. Never remove any component when the power is on.
viii. Read direction and procedure of the experiments very carefully.
ix. Always take precautions in handling measurements of voltage and current.

F. WORK INSTRUCTION / PROCEDURE

i.

a) Single-Phase Half Wave Uncontrolled Rectifier with Resistive load

1. Set up the circuit as shown in Figure 2.5.
2. Connect AC-Power Supply to the chosen voltage, 45Vrms at the Three Phase Isolation Transformer.
3. Use an oscilloscope to display V_{AC} on channel 1 and V_L on channel2.
4. Bypass diode with cable 1.
5. Switch On AC-Power Supply.
6. Measure the waveforms for input voltage, Vs and output voltage, V_{L1} (bypass diode) by using the oscilloscope and use the voltmeter to measure the actual values of Vdc.
7. Draw the waveforms that you measure on the answer sheet.
8. Remove cable 1.
9. Measure the waveforms for output voltage, V_{L2} by using the oscilloscope and measure the actual values Vdc.
10. Draw the waveforms that you measure on the answer sheet.

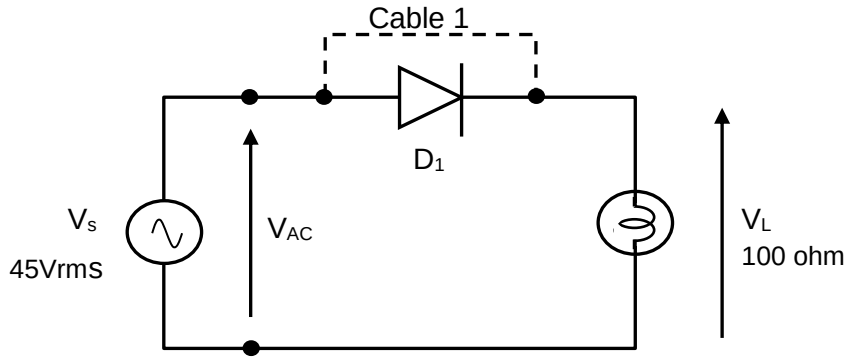


Figure 2.5 - Single-phase half wave uncontrolled rectifier circuit

b) Single-Phase Half Wave Uncontrolled Rectifier with Resistive-Inductive load

1. Set up the circuit as shown in Figure 2.6.
2. Connect AC-Power Supply to the chosen voltage, 45Vrms at the Three Phase Isolation Transformer.
3. Use an oscilloscope to display Input Voltage (V_{in}) and Output Voltage (V_{out}).
4. Switch On AC-Power Supply.
5. Measure the waveforms for input voltage and output voltage, by using the oscilloscope and use the voltmeter to measure the actual values of Vdc.
6. Draw the waveforms that you measure on the answer sheet.

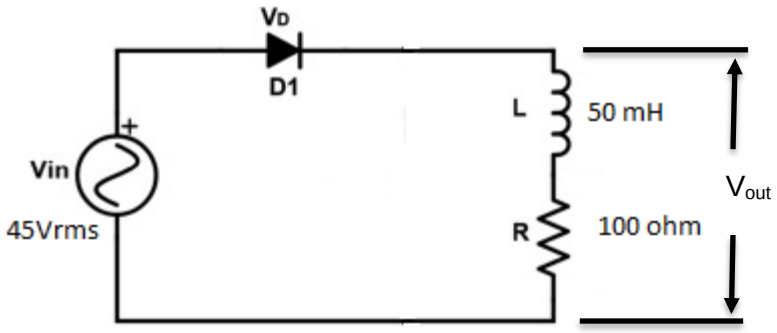


Figure 2.6 - Single-phase half wave uncontrolled rectifier circuit with RL load

7. Connect freewheeling diode parallel to RL load as shown in Figure 2.7.
8. Measure the waveforms for output voltage by using the oscilloscope and draw the waveform on the answer sheet.

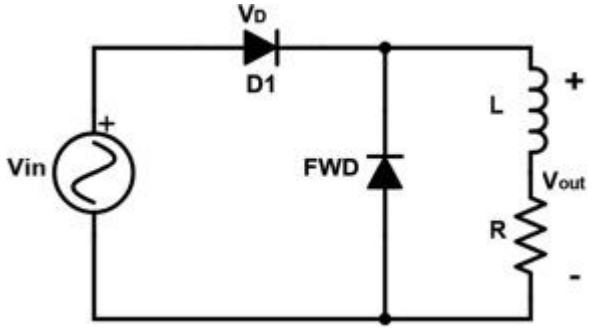


Figure 2.7 - Single-phase half wave uncontrolled rectifier circuit with RL load and freewheeling diode

ii. Single-Phase Full Wave Uncontrolled Bridge Rectifier

1. Construct the circuit as shown in Figure 2.8 below.

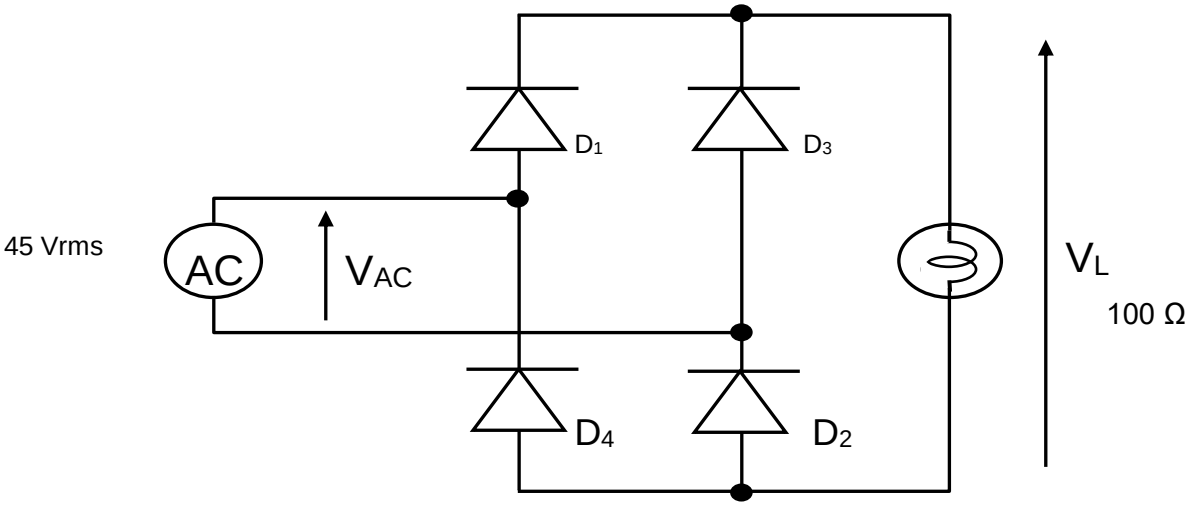


Figure 2.8 - Single-phase full wave uncontrolled bridge rectifier circuit

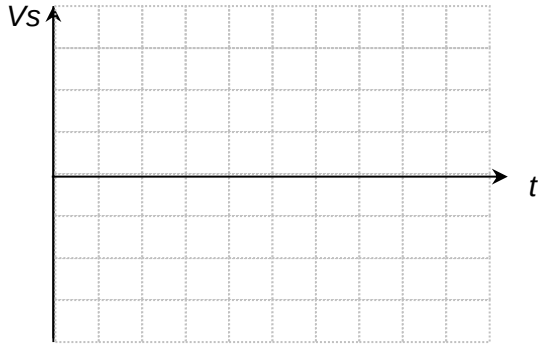
2. Connect AC-Power Supply to the chosen voltage, 45Vrms at the Three Phase Isolation Transformer.
3. Switch “ON” the AC-Power Supply.
4. Measure the waveforms for output voltage (V_L) by using the oscilloscope.
5. Draw the waveforms that you measure on the answer sheet.
6. Measure the output voltage (Vdc) by using the multimeter and record the value.
7. Switch “OFF” the AC-Power Supply.
8. Analyze the resulted graphs.

G. RESULT

Section i: a)Single-Phase Half Wave Uncontrolled Rectifier with resistive load

Volt / Div = _____ Time / Div = _____

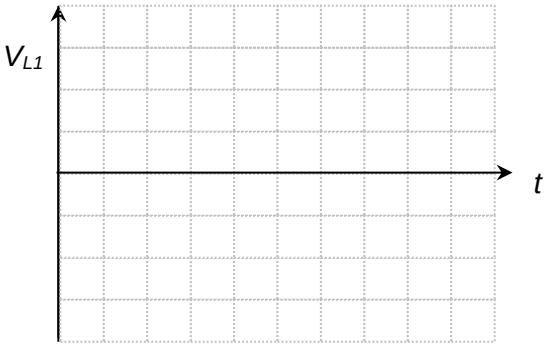
Note: Please use the same Volt/Div. and Time/Div. for all the waveforms.



V_M = _____

(1 marks)

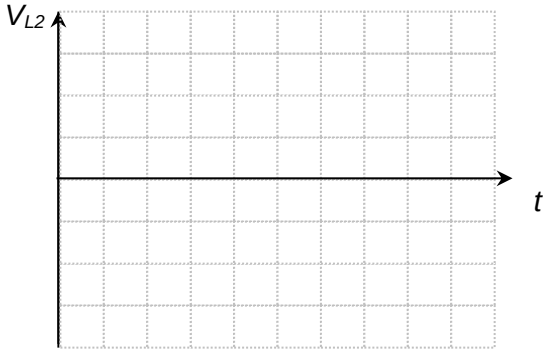
Bypass Diode



V_{dc} = _____

(2 marks)

With Diode



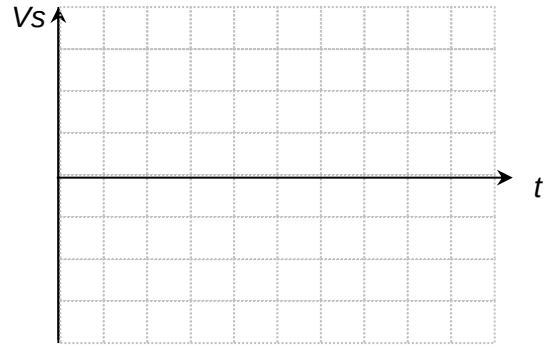
V_{dc} = _____

(2 marks)

Section i: b)Single-Phase Half Wave Uncontrolled Rectifier with resistive-inductive load

Volt / Div = _____ Time / Div = _____

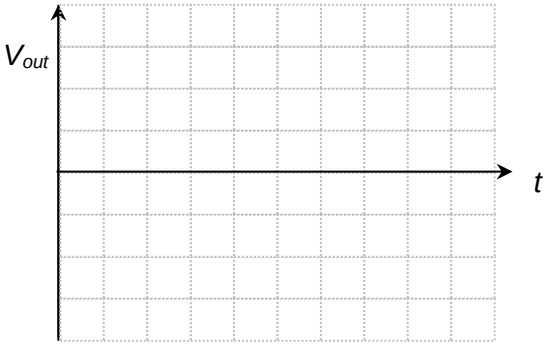
Note: Please use the same Volt/Div. and Time/Div. for all the waveforms.



V_M = _____

(2 marks)

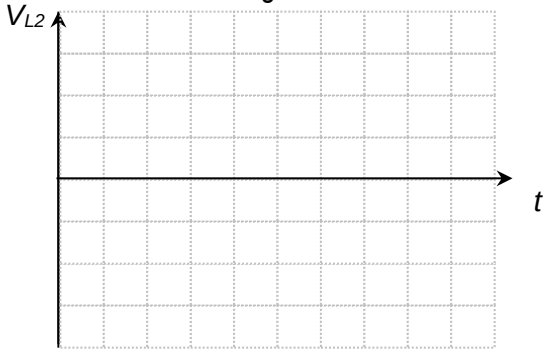
Without Freewheeling Diode



V_{dc} = _____

(2 marks)

With Freewheeling Diode



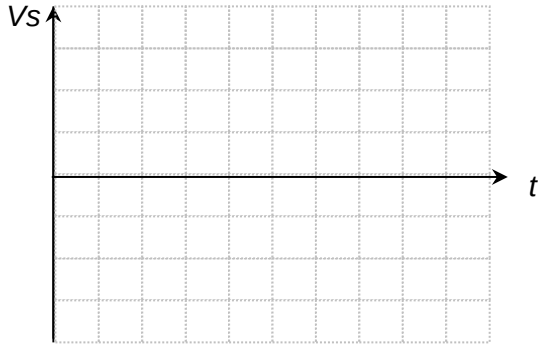
V_{dc} = _____

(2 marks)

Section i: b)Single-Phase Half Wave Uncontrolled Rectifier with resistive-inductive load

Volt / Div = _____ Time / Div = _____

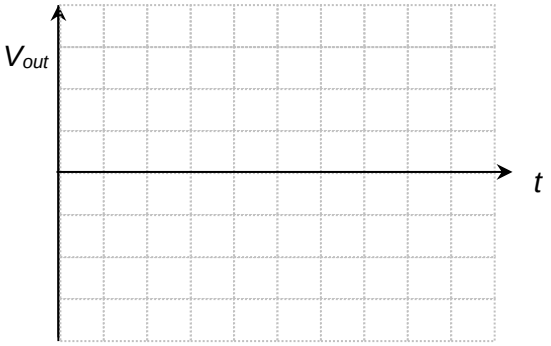
Note: Please use the same Volt/Div. and Time/Div. for all the waveforms.



V_M = _____

(2 marks)

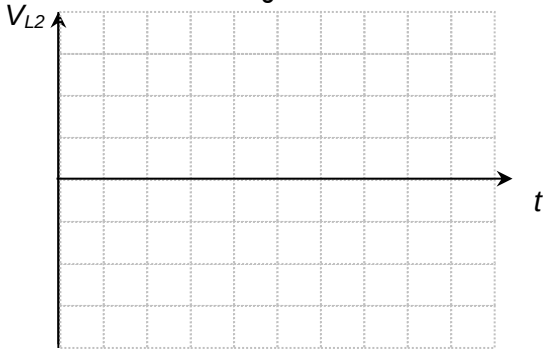
Without Freewheeling Diode



V_{dc} = _____

(2 marks)

With Freewheeling Diode



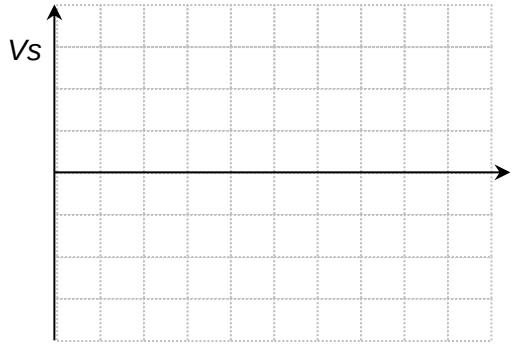
V_{dc} = _____

(2 marks)

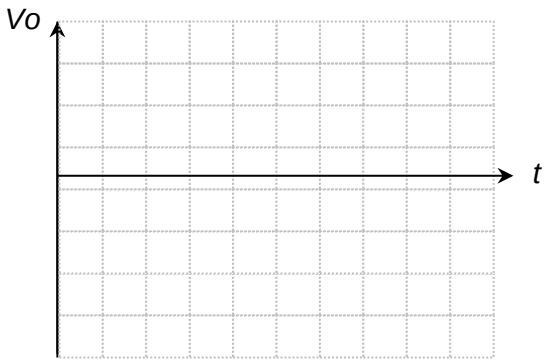
Section ii: Single-Phase Full Wave Uncontrolled Bridge Rectifier

Volt / Div = _____ Time / Div = _____

Note: Please use the same Volt/Div. and Time/Div. for all the waveforms.



(1 marks)



V_M = _____

V_{dc} = _____

(2 marks)

H. DISCUSSION

Section A: Single-Phase Half Wave Uncontrolled Rectifier

1. When the diode is bypassed using cable 1, explain what you can observed on the output waveform, V_{L1}. (2 marks)

2. When cable 1 is removed, explain what you can observed on the output waveform, V_{L2}. (2 marks)

3. Explain why there is a difference between V_{L1} and V_{L2} in-terms of the waveforms and the voltages. (2 marks)

4. Based on the output waveform, V_{L2}, calculate the average output voltage (V_{dc}) and rms output voltage (V_{rms}) produced by this half-wave rectifier. (3 marks)

Section B: Single-Phase Full Wave Uncontrolled Rectifier

1. State TWO (2) differences in terms of average output voltage between a half wave rectifier and a full wave rectifier. (2 marks)

2. Based on the output waveform in Section B, calculate the average output voltage. (4 marks)

I. CONCLUSION

Summarize your experiment by relating to the objective of this experiment. (5 marks)

PREPARED BY: *(Course Lecturer)* …… **( )** **Date:**	**CHECKED BY:** *(Course Coordinator/ Head of Programme)* …… **( )** **Date:**	**APPROVED BY:** *(Head of Programme/ Head of Department)* …… **( )** **Date:**

POLITEKNIK MALAYSIA
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DET40073 – POWER ELECTRONICS

PRACTICAL WORK 1 & SINGLE PHASE UNCONTROLLED RECTIFIER

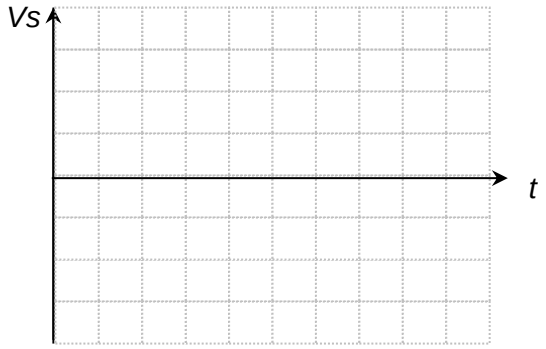
CLO 2	Construct converters circuits and make observation on displayed waveforms using appropriate methods and equipment.	**PLO 4**	**DK DP NA (Not Related)**
CLO 3	Demonstrate the ability to practice leadership skills to complete assigned power electronics tasks.	**PLO 9**	**DK DP NA (Not Related)**

A. RESULT

Section i: a)Single-Phase Half Wave Uncontrolled Rectifier

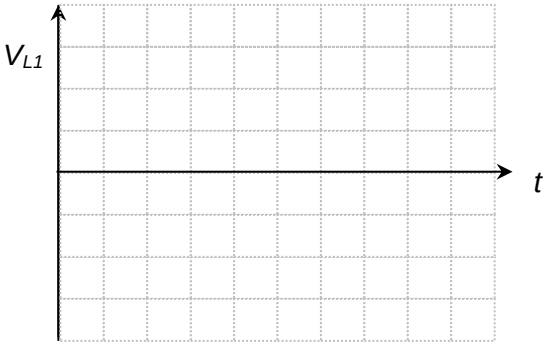
Volt / Div = _____ Time / Div = _____

Note: Please use the same Volt/Div. and Time/Div. for all the waveforms.



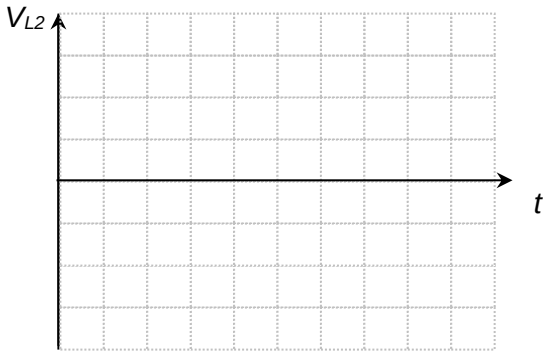
V_M = _____

(2 marks)



V_{dc} = _____

(2 marks)



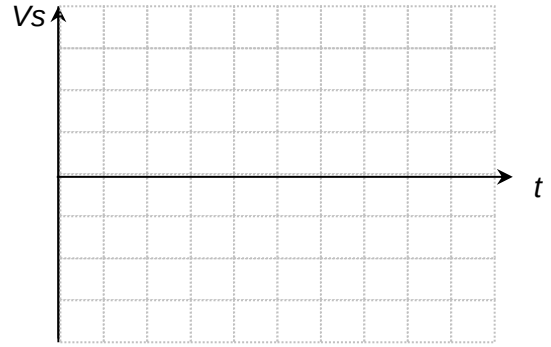
V_{dc} = _____

(2 marks)

Section i: b)Single-Phase Half Wave Uncontrolled Rectifier with resistive-inductive load

Volt / Div = _____ Time / Div = _____

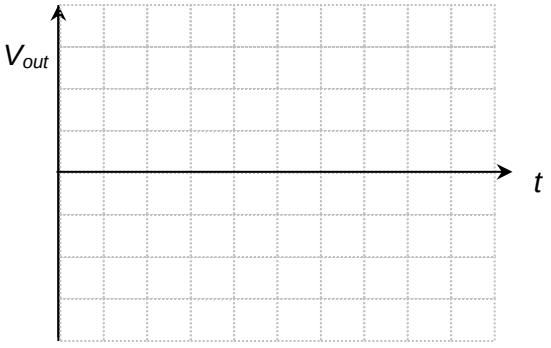
Note: Please use the same Volt/Div. and Time/Div. for all the waveforms.



V_M = _____

(2 marks)

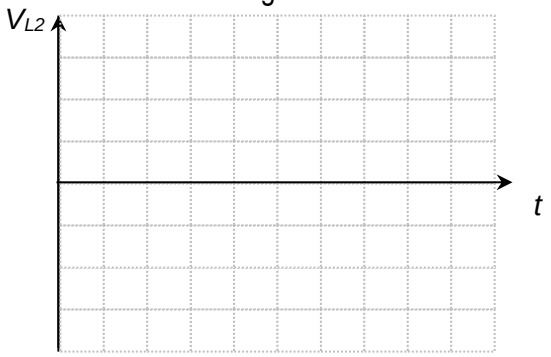
Without Freewheeling Diode



V_{dc} = _____

(2 marks)

With Freewheeling Diode



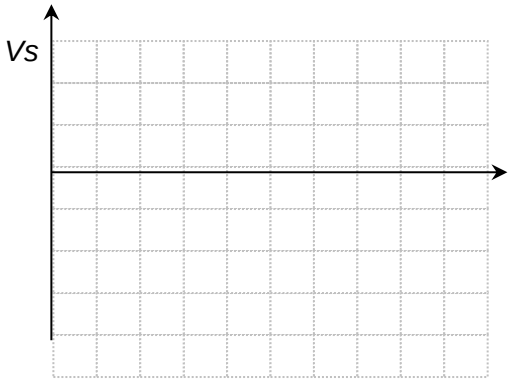
V_{dc} = _____

(2 marks)

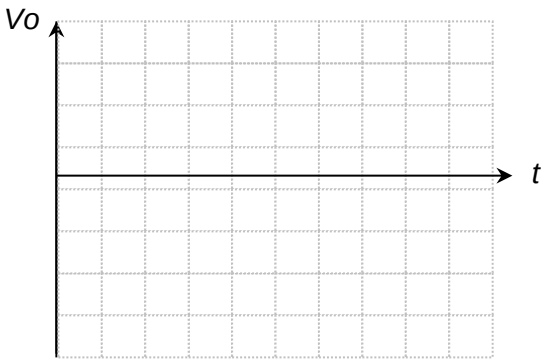
Section ii: Single-Phase Full Wave Uncontrolled Bridge Rectifier

Volt / Div = _____ Time / Div = _____

Note: Please use the same Volt/Div. and Time/Div. for all the waveforms.



(2 marks)



V_M = _____

V_{dc} = _____

(2 marks)

B. DISCUSSION

Section A: Single-Phase Half Wave Uncontrolled Rectifier

1. When the diode is bypassed using cable 1, explain what you can observed on the output waveform, V_{L1}. (2 marks)

_____
_____
_____
_____

2. When cable 1 is removed, explain what you can observed on the output waveform, V_{L2}. (2 marks)

_____
_____
_____
_____

3. Explain why there is a difference between V_{L1} and V_{L2} in-terms of the waveforms and the voltages. (2 marks)

_____
_____
_____
_____

4. Based on the output waveform, V_{L2}, calculate the average output voltage (V_{dc}) and rms output voltage (V_{rms}) produced by this half-wave rectifier. (3 marks)

Section B: Single-Phase Full Wave Uncontrolled Rectifier

1. State TWO (2) differences in terms of average output voltage between a half wave rectifier and a full wave rectifier. (2 marks)

   _____
   _____
   _____
   _____

2. Based on the output waveform in Section ii, calculate the average output voltage.

   (4 marks)

C. CONCLUSION

(5 marks)

RUBRIC FOR PRACTICAL WORK (80%)

COURSE CODE : **DET40073**

COURSE NAME : **POWER ELECTRONICS**

STUDENT NAME : _____

REGISTRATION NO. : _____

PRACTICAL TITLE : **SINGLE PHASE UNCONTROLLED RECTIFIER**

CLO2: Construct converters circuits and make observation on displayed waveforms using appropriate methods and equipments. (P4,PLO5)	**PLO 5:** Apply appropriate techniques, resources, and modern engineering and IT tools to well-defined engineering problems, with an awareness of the limitations	**DK DP NA (Not Related)**

Criteria	**SCORE**					**CRITERIA WEIGHTAGE**	**MARKS**
	5	**4**	**3**	**2**	**1**		
Apply safety rules	**Display full attention to safety rules in fieldwork.**					**2**	
	The experiment is carried out with full attention to relevant safety procedures.	The experiment is carried out with some attention to relevant safety procedures	The experiment is carried out with some attention to relevant safety procedures.	The experiment is carried out with some attention to relevant safety procedures. Seldom need assistance.	Safety procedures were ignored. Always needs assistance.		
Identify Equipment	**Organizes proper equipment based on the type of fieldwork**					**3**	
	Always identifies equipment without any assistance.	Identifies 90% of the equipment.	Identifies equipment with some assistance.	Identifies equipment with full assistance.	Attempt to identify equipment most of the time. Always needs assistance.		
Follow the procedure.	**Construct the experiment by following the standard procedures based on the type of fieldwork.**					**3**	
	Demonstrate excellent knowledge of lab procedures, thoroughly follow each procedure independently	Demonstrate sound knowledge of lab procedures with minimal help	Demonstrate good knowledge of lab procedures with moderate help	Requires help from lecturer with some steps in procedures	Often requires help from the lecturer to even complete basic procedures		
Construct the circuit/equipment correctly.	**Construct and Organizes proper equipment based on the type of circuit.**					**4**	
	Successfully construct all circuits independently	Able to construct all circuits correctly with minimal supervision	Able to construct all circuits correctly with moderate supervision	Able to construct all circuits correctly with major supervision	Unable to construct circuits correctly, require constant supervision		
Displays the result/waveform.	**Display the ability to gather data**					**4**	
	Results/Waveforms are clearly displayed with proper justification and analysis.	Results/Waveforms are displayed with lack justification and analysis.	Results/Waveforms are displayed with wrong justification and analysis.	Results/Waveforms are displayed with no justification and analysis.	Results/Waveforms is incorrect with wrong justification and analysis.		
						TOTAL MARK (/80)	

PREPARED BY:	***CHECKED BY:***	***APPROVED BY:***
(Course Lecturer)	(Course Coordinator/ Head of Programme)	(Head of Programme/ Head of Department)
.....	.....	.....
( )	( )	( )
Date:	Date:	Date:

RUBRIC FOR PRACTICAL WORK REPORT (20%)

COURSE CODE : DET40073

COURSE NAME : POWER ELECTRONICS

STUDENT NAME : _____

REGISTRATION NO. : _____

PRACTICAL TITLE : SINGLE PHASE UNCONTROLLED RECTIFIER

CLO2: Construct converters circuits and make observation on displayed waveforms using appropriate methods and equipments. (P4,PLO5)	**PLO 5:** Apply appropriate techniques, resources, and modern engineering and IT tools to well-defined engineering problems, with an awareness of the limitations	**DK DP NA (Not Related)**

Criteria	**SCORE**					**CRITERIA WEIGHTAGE**	**MARKS**
	5	**4**	**3**	**2**	**1**		
DISCUSSION							
CONCLUSION	**Summarizes the main findings and their implications to the specified objectives, providing clear and concise insights.**					**1**	
	Exceptionally clear, concise, and strongly summarizes findings. Excellent connection, the conclusion aligns seamlessly with the introduction and hypotheses.	The conclusion is very clear and succinct. Strongly connects the conclusion with the introduction.	The conclusion is clear and summarizes key findings. Adequate connection to introduction.	The conclusion is vague or incomplete. Weak connection to the introduction land acks relevance.	The conclusion is unclear or missing. No connection between the conclusion and the introduction.		
						TOTAL MARK (/20)	

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.....	.....	.....
( )	( )	( )
Date:	Date:	Date:

iCGPA: RUBRIC FOR ATTRIBUTE TEAMWORK (10%)

COURSE CODE : DET40073

COURSE NAME : POWER ELECTRONICS

STUDENT NAME : _____

REGISTRATION NO. : _____

PRACTICAL TITLE : SINGLE PHASE UNCONTROLLED RECTIFIER

CLO3: Demonstrate the ability to practice leadership skills to complete assigned power electronics tasks. (A3, PLO9)	**PLO 9: Function effectively as an individual, and as a member in diverse technical teams.**	**DK6: Not Related**

Criteria	**SCORE**					**CRITERIA WEIGHTAGE**	**MARKS**
	5	**4**	**3**	**2**	**1**		
Leadership - Knowledge and skills in leadership	**Group Tasks (Practical)**					**1**	
	Very clear evidence of knowledge and understanding demonstrated in practice	Able to demonstrate knowledge and understanding in practice well	Able to demonstrate knowledge and understanding in practice and require minor improvements	Able to demonstrate knowledge and understanding in practice but require improvements	No clear evidence of knowledge and understanding demonstrated in practice		
Leadership - Effective leadership	**Group Tasks (Practical)**					**1**	
	High ability to lead effectively self and/or others towards goal achievement.	Able to lead effectively self and/or others towards goal achievement	Able to lead self and/or others towards goal achievement with some effect and require minor improvements	Able to lead self and/or others towards goal achievement but with limited effect and require further improvements	No clear evidence of ability to lead self and/or others		
						TOTAL MARK (/10)	

PREPARED BY:	***CHECKED BY:***	***APPROVED BY:***
(Course Lecturer)	(Course Coordinator/ Head of Programme)	(Head of Programme/ Head of Department)
.....	.....	.....
( )	( )	( )
Date:	Date:	Date: