University of Ruhuna

Bachelor of Science General Degree Level II (Semester I) Examination

July -2016

Subject: Physics

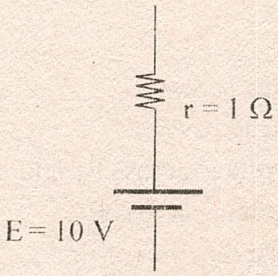
Course Unit: PHY 2112

PART B - 01 hour & 15 minutes

Answer FIVE questions only.

All symbols have-their usual meaning.

1.

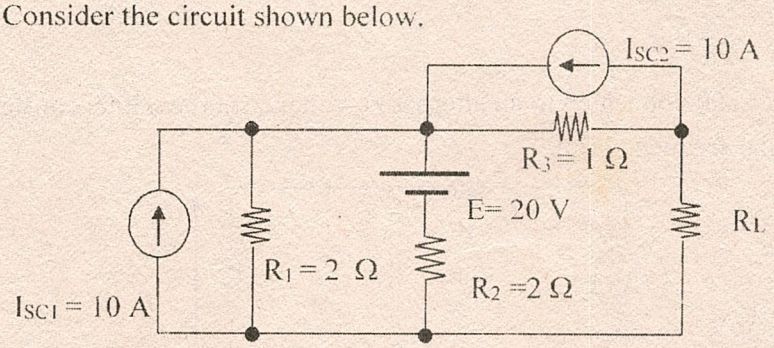


(a) A practical voltage source of 1 Ω internal resistance is shown in the above figure.

i Calculate the maximum power that can be provided by this source to an externally connected load resistor. **[2 Marks]**

ii Calculate the short circuit current and the internal resistance of the practical current source, which is equivalent to the above voltage source. **[2 Marks]**

(b) Consider the circuit shown below.



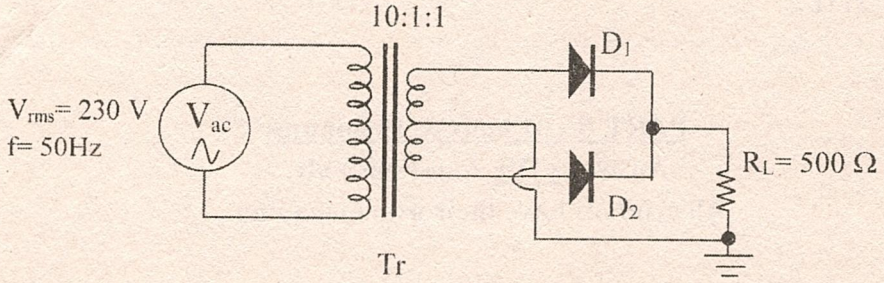
i What is the maximum voltage which is operated across R_L? **[2 Marks]**

ii What would be the maximum current passing through R_L? **[2 Marks]**

iii What would be the value of R_L in order to draw the maximum power from the circuit? **[1 Marks]**

iv Calculate the maximum power drawn through the circuit by R_L. **[1 Marks]**

2. Consider the following rectifier circuit. Neglect the resistance of the secondary windings of the transformer and consider the diodes as ideal diodes.



(a) Calculate the

i Peak value of the voltage across R_L, **[2 Marks]**

ii rms value of the voltage across R_L, **[1 Marks]**

iii d.c. component of the voltage across R_L and **[2 Marks]**

iv a.c. component of the voltage across R_L. **[1 Marks]**

(b) Sketch the voltage across D_1 as a function of time. **[2 Marks]**

(c) If D_1 in the above circuit is open-circuited due to a fault, calculate the total power dissipation of the R_L, and the peak inverse voltage across D_2. **[2 Marks]**

3. $V_p e^{j\omega t}$ can be used to represent an alternative voltage in exponential (Euler) format, where;

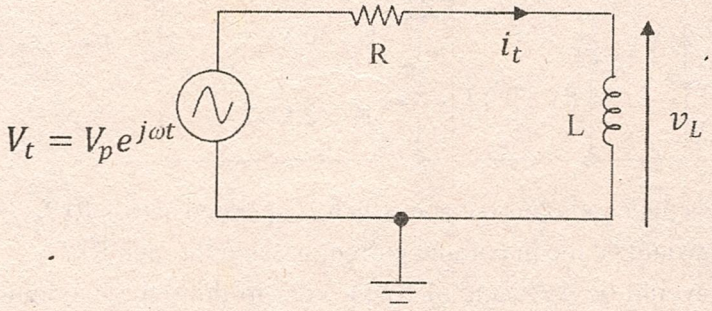
V_p – amplitude of the input voltage

ω - angular frequency

t - time

$j = \sqrt{-1}$

Consider the following circuit connected to an alternative voltage source with a constant amplitude (V_p) and a variable angular frequency (ω).



i Find the current through the circuit (i_t). **[3 Marks]**

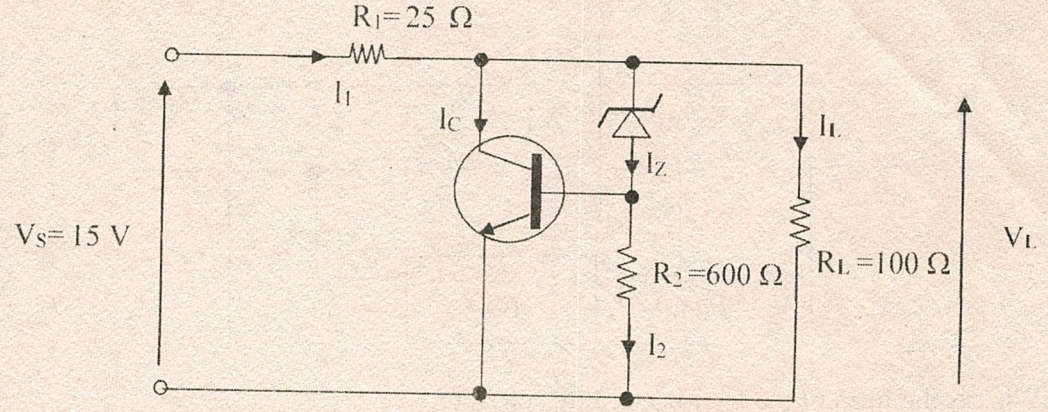
ii Find voltage across the inductor (v_L) in Euler format. **[2 Marks]**

iii Hence, find the magnitude of the voltage across the inductor $(|v_L|)$. **[1 Marks]**

iv Sketch the variation of $|v_L|$ as a function of frequency. **[2 Marks]**

v What is the frequency which corresponds to $|v_L| = \frac{V_P}{\sqrt{2}}$? **[2 Marks]**

4. Following circuit consists a transistor with V_{BE} = 0.6 V, β= 100 and a Zener diode with Zener break-down voltage 9.4 V



(a) Considering the constant voltage model of the Zener diode, calculate the followings:

i Voltage across R_L (V_L). **[1 Marks]**

ii Current through R_L (I_L), **[1 Marks]**

iii Current through R_1 (I_1), **[1 Marks]**

iv Current through R_2 (I_2), **[1 Marks]**

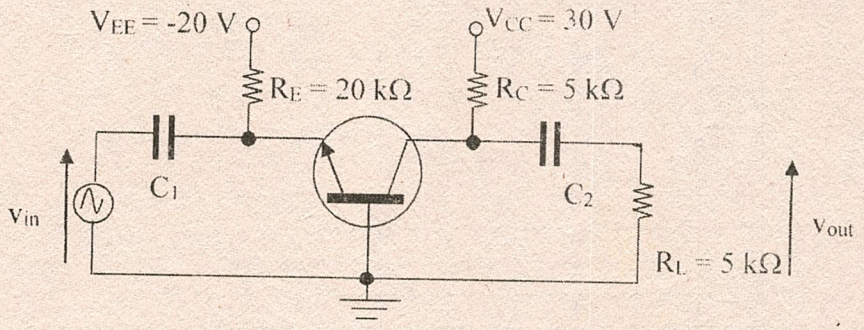
v Collector current (I_C). **[2 Marks]**

vi Zener current (I_Z) and **[1 Marks]**

vii power dissipations of the transistor and the Zener diode. **[2 Marks]**

(b) If Zener diode in the above circuit is open-circuited due to a fault, recalculate V_L. **[1 Marks]**

5. Consider the following amplifier circuit.



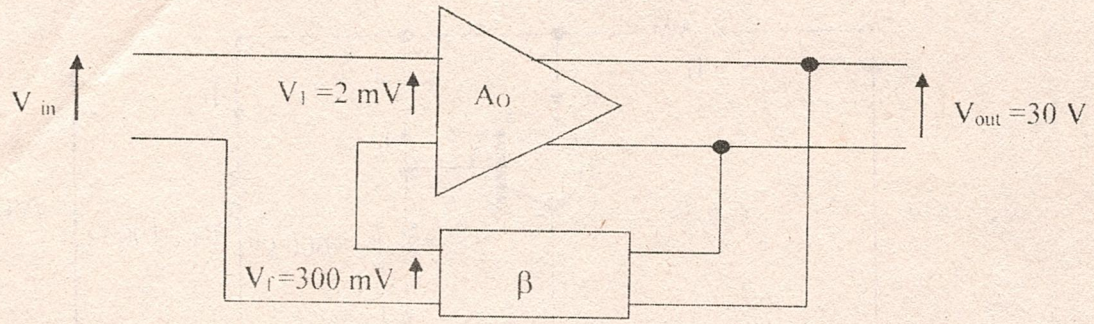
(a) What is the configuration of the transistor? **[Marks 2]**

(b) Calculate I_E of the above circuit assuming I_B and V_{BE} are very small. **[Marks 3]**

(c) Assuming the reactance of the capacitors against the ac signals are very small, draw the ac equivalent circuit for the above circuit. Hence, find the alternative current (ac) voltage gain (take emitter intrinsic resistance, $r_e' = \frac{25\,mV}{I_E}$ and β =100).

[Marks 5]

6. Answer the following questions considering the feedback amplifier given below.



(a) What is the form of the feed-back of this circuit? **[2 Marks]**

(b) Calculate the following quantities.

(i) Open-loop gain (Ao). **[2 Marks]**

(ii) feed-back fraction (β). **[1 Marks]**

(iii) closed-loop gain of the amplifier and **[2 Marks]**

(iv) Sacrifice factor. **[1 Marks]**

(c) If the open loop gain of this amplifier changes by 20% due to a temperature variation, find the percentage change in closed loop gain. **[2 Marks]**

7.

(a) A logic circuit has three inputs (A,B, and C) and one output (Z). All input/output logic combinations of the circuit are shown in the following truth table.

A	B	C	Output Z
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

i Derive a logic expression for output signal (Z) as a logic function of inputs. **[2 Marks]**

ii Simplify the logic expression you have obtained above. **[2 Marks]**

iii Construct a logic circuit by using the minimum number of 2-input NAND gates in order to implement the above logic expression. **[3 Marks]**

(b) Simplify the following expression using a Karnaugh-Map (K-Map).

$X = B.\bar{C}.\bar{D} + \bar{A}.B.\bar{C}.D + \bar{A}.B.C.D + A.B.\bar{C}.D + A.B.C.D$ **[3 Marks]**

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