University of Ruhuna

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

July -2015

Subject: Physics

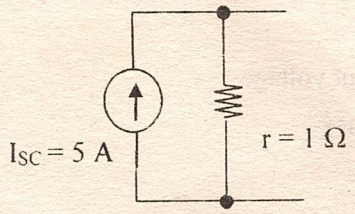
Course Unit: PHY 2112

PART B - 01 hour & 15 minutes

Answer FIVE questions only

All symbols have their usual meaning

1.

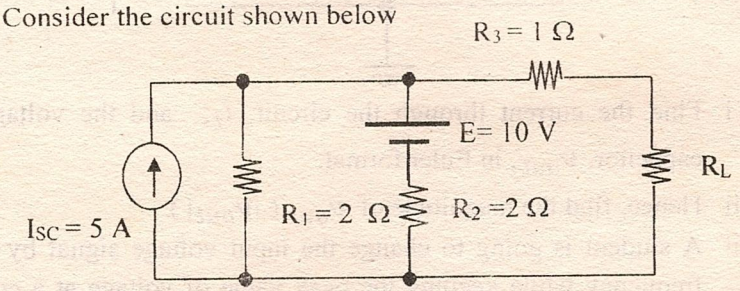


(a) A practical current source with 1 Ω internal resistance is shown in the above figure

i Sketch the voltage across a load as a function of the current through the load when the load is connected to the source.

ii Calculate the open circuit voltage and the internal resistance of the practical voltage source, which is equivalent to the above current source.

(b) Consider the circuit shown below



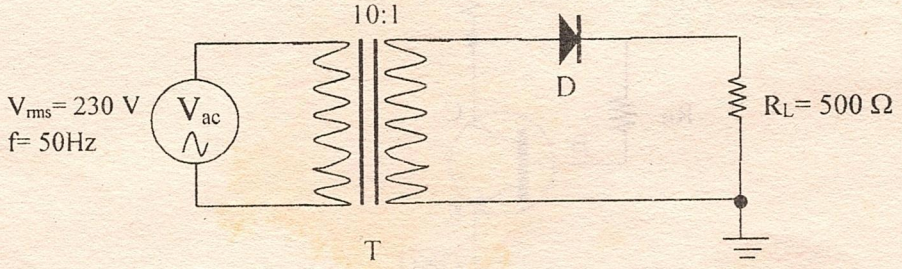
i What is the maximum voltage that can be operated across R_L?

ii What would be the maximum current passing through R_L?

iii What would be the value of R_L in order to draw the maximum power from the circuit?

iv Calculate the maximum power drawn through the circuit by R_L.

2. Consider the following rectifier circuit. Neglect the resistance of the secondary coil of the transformer and consider the diode as an ideal diode.



(a) Sketch the voltage across the diode as a function of time.

(b) Calculate the

i Peak value of the current through the R_L,

ii d.c. value of the voltage across the diode,

iii rms value of the current through the R_L and

iv power dissipation of the R_L

(c) If the diode in the above circuit is short-circuited due to a fault, recalculate the power dissipation of the R_L,

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

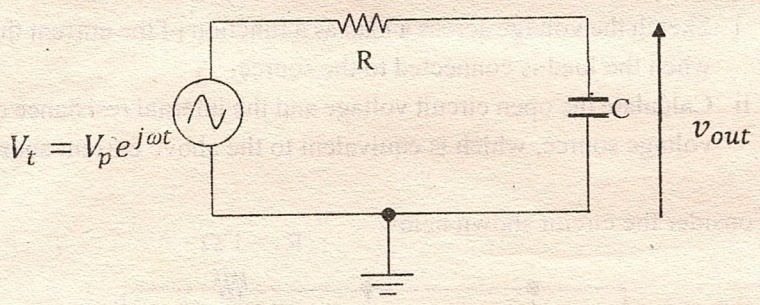
V_p – peak of the input voltage

ω - angular frequency

t - time

$j = \sqrt{-1}$

Consider the following circuit connected to an alternative voltage source.



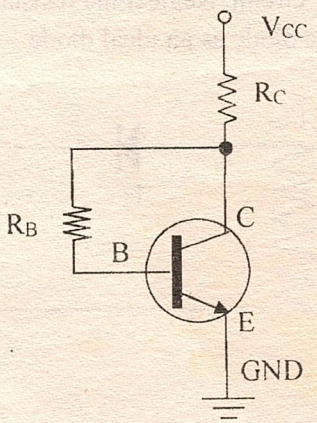
i Find the current through the circuit, i_t, and the voltage across the capacitor, v_{out}, in Euler format.

ii Hence, find the magnitude of v_{out} ($|v_{out}|$).

iii A student is going to change the input voltage signal by changing the frequency while keeping the peak value of voltage at a constant. What would be the maximum value of $|v_{out}|$ that can be obtained under this process?

iv What would be the frequency when $|v_{out}| = \frac{|v_{out}|_{max}}{\sqrt{2}}$ under the process mentioned in part (iii)?

4. Answer this question considering the circuit shown below



(a) Derive an expression for the collector-emitter voltage (V_{CE}) in terms of R_B, R_C, V_{CC}, V_{BE} and β, where, V_{BE} is the base- emitter voltage and $\beta = \frac{I_C}{I_B}$)

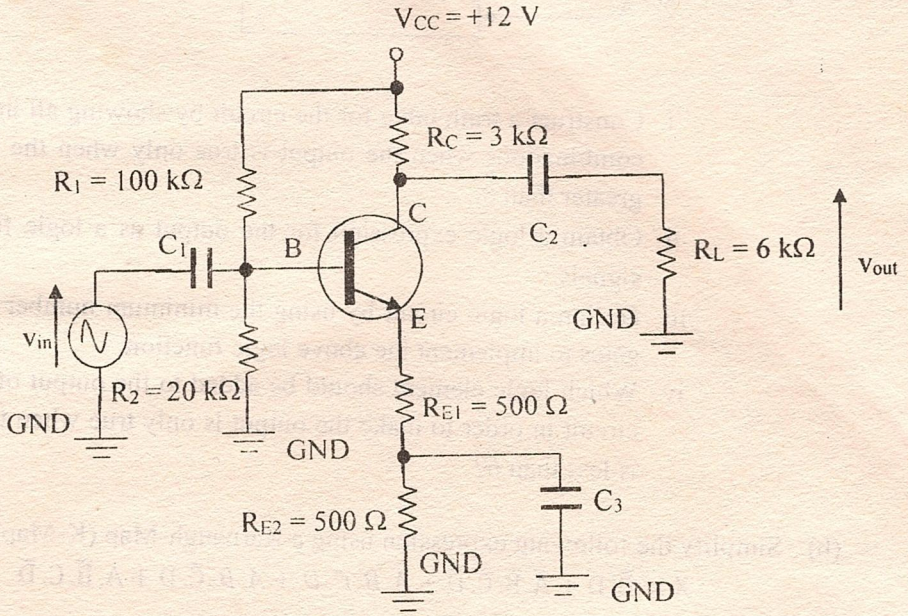
(b) Calculate the V_{CE} for the following cases.

i. RB = 0

ii. RB $\rightarrow \infty$

(c) Find the power dissipation of the transistor when R_B = 100 kΩ, R_C = 1 kΩ, V_{BE} = 0.7 V, V_{CC} = 10 V and β = 100.

5. Consider the following amplifier circuit.



(a) What is the configuration of the transistor?

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

(c) 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)

6. Answer the following questions regarding the feedback amplifiers

(a) Name the 4 types of feedback connections and illustrate them in diagrams.

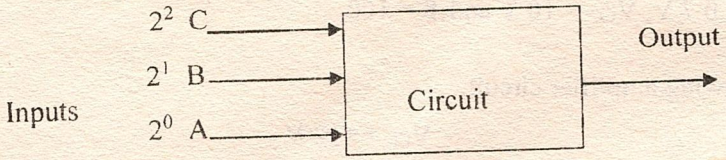
(b) An amplifier has an open loop gain of 20000. After introducing a negative feedback the voltage gain reduces to 10. Calculate the feedback fraction (β).

(c) The feedback fraction an amplifier is 0.01 of feedback fraction (β). Close loop gain is changed by 1% when the open loop gain is changed by 21%. Calculate the open loop gain of the amplifier.

7.

(a) You have to construct a logic circuit in order to compare a given positive integer with the value 5, under the following specifications;

- Range of the testing numbers : positive integers from 0 to 7 (including both 0 and 7)
- Inputs and output are maintained as in the following figure.



i Construct a truth table for the circuit by showing all input/output logic combinations when the output is true only when the input number is greater than 5.

ii Obtain a logic expression for the output as a logic function of input signals.

iii Design a logic circuit by using the minimum number of 2-input NOR gates to implement the above logic function.

iv Which logic element should be added to the output of the above logic circuit in order to make the output is only true when the input number is less than 6?

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

$$X = \overline{B}.D + \overline{A}.\overline{B}.\overline{C}.\overline{D} + \bar{A}.B.C.D + A.B.\overline{C}.D + A.\overline{B}.C.\overline{D}$$

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