RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
Second Year – Semester I Examination – June/July 2018

PHY2103 – ELECTRONICS I

Time: One and Half ($1\frac{1}{2}$) hours

Answer **All** Questions.

Electron Charge, e = 1.6×10^{-19} C

Intrinsic Carrier Concentration of Si at 300 K = $1.45 \times 10^{10} cm^{-3}$

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1. The electrical conductivity of a material can be written as $\sigma = ne\mu$. Where n is the carrier concentration, e is the electron charge and μ is the electron mobility.
   a) Show that the conductivity in an intrinsic semiconductor is given by $\sigma = n_i(\mu_e+\mu_p)$, where, n_i is the intrinsic carrier concentration, μ_e and μ_p represent the mobility of electrons and holes respectively.
   b) The intrinsic carrier concentration of an intrinsic semiconductor is 2.5×10^{19} m^{-3}. If the mobilities of electrons and holes are 0.40 m^2/Vs and 0.20 m^2/Vs respectively, calculate the resistivity of the material.
   c) Determine the electron concentration in the conduction band of an n – type semiconductor at 300 K and has donor concentration of 2.73×10^{16} cm^{-3}.
   d) Determine the hole concentration in the valance band of the above semiconductor.
   e) If the substrate is overdoped with an acceptor concentration of 3.5×10^{16} cm^{-3}, determine the electron and hole concentrations. Is the resulting material n-type or p-type?

2. Diodes are active electronic devices with n – type and p – type semiconductors.
   a) Draw the characteristic curve of a diode and mark forward bias region, reverse bias region, threshold voltage, leakage current and breakdown voltage on it.
   b) Explain the main factors contributing to the breakdown of the p-n junction at high voltage in reverse bias mode.

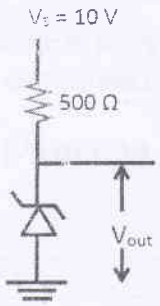
c) Explain the origin of leakage current of a commercial diode.

d) A Zener diode has following characteristics.

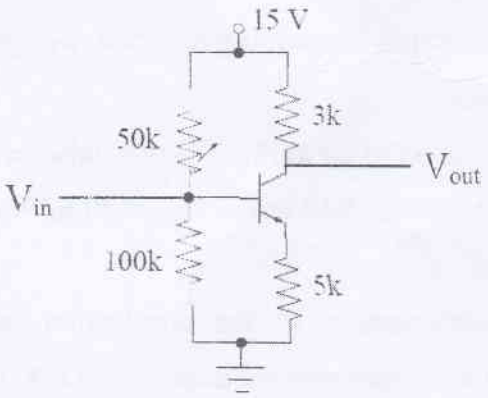
7.0 V rating at 10 mA, r_Z= 20 Ω and I_{ZK}= 0.2 mA.

Using given ratings find the V_{Z0}.

e) Find the change in V_{out} resulting from $\pm 1\ V$ change in Vs in the following circuit.



3. Following is a common emitter transistor amplifier circuit using an npn transistor with DC current gain β = 200.



a) Using Thevenin's Theorem find V_{TH} and R_{TH} for the base terminal.

b) Find the open circuit voltage and short circuit current of the circuit.

c) Sketch the load line of the circuit.

d) Find the DC biasing point (Q point) of the above circuit.

e) Check whether the Q point is independent of β change.