# B.Sc. Semester-II (Honours) Examination, 2018

## ELECTRONICS

**Subject Code : 21701** **Course Code : SH/ELC/201/C3(T3)**

**Course Title : Semiconductor Devices**

**Time: 1 Hour 15 Minutes** **Full Marks: 25**

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

**1.** Answer *any three* of the following questions: 1×3=3

(a) What is Hall Effect?

(b) Draw the energy band diagram of an *n-p-n* transistor at thermal equilibrium.

(c) Draw the Circuit Symbol of enhancement NMOS or depletion PMOS.

(d) What is Mass-Action Law?

(e) What is Intrinsic Stand-off ratio of UJT?

(f) Mention two applications of tunnel diode.

**2.** Answer *any three* of the following questions: 2×3=6

(a) What are the major differences between a BJT and a FET?

(b) What are drift and diffusion currents in connection to *p-n* junction?

(c) How $\alpha$, $\beta$ and $\gamma$ of a transistor are related to each other?

(d) What is DIAC? Give its symbol.

(e) What do you mean by Ohmic and rectifying contacts?

(f) What is base width modulation / early effect?

**3.** Answer *any two* of the following questions: 5×2=10

(a) With a neat sketch, explain the various current components in an *n-p-n* bipolar junction transistor and hence derive the general equation for collector current $I_c$.

(b) What do you mean by 'deplection region' of a *p-n* junction? With the help of necessary diagram, derive expression for barrier potential.

(c) With the help of neat sketch and characteristic curves, explain the construction and operaton of a JFET. Show that in a JFET, the transconductance is given by the relation, $g_m = g_{mo}\left[1 - \frac{V_{GS}}{V_P}\right]$ (symbols have their usual meanings).

(d) What is an SCR? Draw its Current-voltage characteristic and explain it. Mention an applications of it. What is holding current?

**4.** Answer *any one* of the following questions: 6×1=6

(a) Draw the basic structure and equivalent circuit of a UJT. Explain how UJT can be used as a relaxation oscillator.

(b) Explain the construction and operation of an *n*-channel depletion MOSFET with the help of static drain characteristics. Draw its transfer characteristics also.

(c) What is Intrinsic semiconductor? Derive an expression for the density of electrons in the conduction band of an intrinsic semiconductor.

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# B.Sc. Semester-II (Honours) Examination, 2018

## ELECTRONICS

**Subject Code : 21702** **Course Code : SH/ELC/202/C4(T4)**

**Course Title : Applied Physics**

**Time: 1 Hour 15 Minutes** **Full Marks: 25**

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

**1.** Answer *any three* of the following questions: 1×3=3

(a) What is wave particle duality?

(b) What is quantum mechanical tunneling?

(c) How many types of crystal bonding are there? Name them.

(d) Define 'relaxation time' and 'collision time'.

*Or,*

What do you mean by a normalized wavefunction?

(e) Write down the Einstein's Photoelectric equation explaining the terms involved.

(f) 'All primitive cells are unit cells but all unit cells may or may not be primitive cells.'— Justify.

**2.** Answer *any three* of the following questions: 2×3=6

(a) How many types of 'Bravais lattices' are there? How they are grouped into various types of lattices? Name those lattice types.

(b) By which experiment the existence of de Broglie wavelength was confirmed? Give one basic postulate of quantum mechanics.

(c) Construct time independent Schrödinger wave equation in one dimension for a free particle with mass '$m$' in a force field.

(d) How many types of heat capacities are there in case of gases? Define them.

*Or,*

Express Plank radiation formula in terms of wavelength ($\lambda$).

(e) Classify each of the following materials according to crystalline bonding:

(i) NaCl (ii) Al

(iii) Ice (iv) Diamond

(f) Sketch the variation of electrical resistance of a super conductor with temperature and explain.

**3.** Answer *any two* of the following questions: 5×2=10

(a) Obtain the expression for either the wavefunction $\psi_n(x)$ or energy levels $E_n$ for a free particle of mass '*m*' in a one dimensional box with dim '*a*' from time independent Schrödinger wave equation. Extend this result in three dimension.

(b) State Clausius statement of second law of thermodynamics. What is the importance of an isenthalpic process? What do you mean by an indicator diagram? Derive the expression for efficiency of a carnot's engine ($\eta$) from T-S indicator diagram.

(c) What do you understand by reciprocal lattice? Show that reciprocal lattice of fcc(face centered cubic) is a bcc (body centered cubic) structure.

(d) (i) Disuss the formation of allowed and forbidden energy bands on the basis of Krönig-Penny model. 3

(ii) What do you mean by effective mass of an electron in a lattice? 2

**4.** Answer *any one* of the following questions: 6×1=6

(a) Plot the graph of the simplified equation obtained by Krönig-Penny in periodic crystal lattice with periodic potential after necessary approximation and correction. What conclusions were drawn by them from that plot? Finally plot the E~K curve from there and classify the solid with Metal, Insulator and semiconductor from that E~K curve.

(b) What are the laws of 'Intermediate metals' and 'Intermediate temperature' in Thermo-electricity? Applying thermodynamic considerations to the working of a thermo-couple show that $\pi = T\frac{de}{dt}$, where the symbols have their usual meanings.

(c) Calculate the number of atoms per unit cell and packing fraction for (i) simple cubic and (ii) Body centred cubic lattices with relevant diagrams. 2½+2½+1=6

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*SH-II/ELC-201/C3/P3/18*

# B.Sc. Semester-II (Honours) Examination, 2018

# ELECTRONICS

**Subject Code : 21711** **Course Code : SH/ELC/201/C3(P3)**

**Course Title : Semiconductor Devices Lab**

**Time: 2 Hours 30 Minutes** **Full Marks: 15**

**Perform *one* experiment**

1. Draw the V-I characteristics of a p-n junction diode. Hence find out the AC and DC resistances of the given diode.

2. Draw the V-I characteristics of the given Zener diode. Hence, find out the breakdown voltage of the diode.

3. Draw the output characteristics curves of the given BJT operating in CE mode (at least three). Hence, find out the values of $\beta$ and $r_o$.

4. Draw the output characteristics curves of the given BJT operating in CB mode (at least three). Hence, find out the values of $\alpha$ and $r_o$.

5. Measure the variation of drain current ($I_D$) of the given JFET with the variation of drain-source voltage ($V_{DS}$) for at least three different values of gate-source voltage ($V_{GS}$). Take one $V_{GS} = 0V$. Represent your result graphically. Find out the approximate value of Pinch-off Voltage ($V_P$).

6. Perform an experiment to obtain the drain (or output) characteristics of the given n-channel enhancement type MOSFET. Hence, determine the output resistance and transconductance.

7. Perform an experiment to draw the V-I characteristics of the given UJT and calculate the Intrinsic-stand-off ratio.

8. Perform an experiment to obtain the V-I characteristics of the given SCR and hence find the ON state resistance of the given SCR. (Keep $I_g = 0$)

9. Perform an experiment to calculate the carrier concentration and mobility from the magnitude of Hall Voltage and the given experimental variables (i.e., magnetic field and sample resistance).

10. Perform an experiment to plot the I-V characteristic curve of a solar cell and identify the maximum power input, the short circuit current and the open circuit voltage.

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# B.Sc. Semester-II (Honours) Examination, 2018

## ELECTRONICS

**Subject Code : 21712** **Course Code : SH/ELC/202/C4(P4)**

**Course Title : Applied Physics Lab**

**Time: 2 Hours 30 Minutes** **Full Marks: 15**

**Perform *one* experiment**

**1.** Perform an experiment to study the temperature variation of resistivity of the given Ge crystal by four-probe method. Vary the temperature from room temperature to 200ºC (take at least five readings).

**2.** Experimentally study the forward (I-V) characteristics of the given semiconductor diode. Plot the graph with at least seven readings. Hence determine the value of Boltzman constant ($k_B$).

**3.** Determine the value of Planck's constant by using the given LED. Perform the experiment for at least 4 different wavelengths.

**4.** Measure the temperature variation of resistance of the given thermistor. Estimate the value of Energy Bandgap of the thermistor.

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