

BITS PILANI DUBAI CAMPUS
SECOND SEMESTER 2010-11

Comprehensive Examination (Closed Book)

Course No: EA C416

Duration: 3Hrs

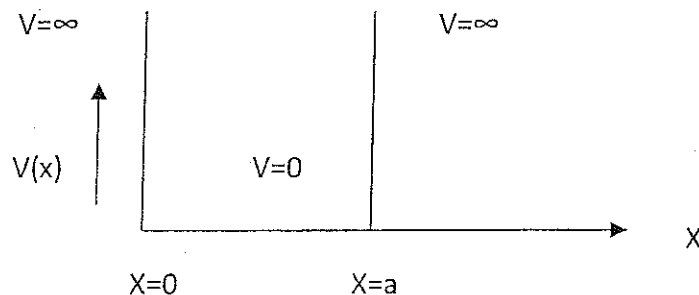
Weightage: 40%

Course Name: Introduction to Nanoscience

Max Marks: 40

Date: 25.5.2011

- Q1. (a) Calculate the density of electrons per meter³ in a intrinsic semiconducting nano material having energy band gap of 1 eV at temperature of 300 K. Assume that effective mass of proton and electron is same as rest mass of electron. (2)
- (b) What is the band theory of solids? Define 1st and 2nd Brillouin zone in band theory. (2)
- (c) Define the properties of Fermi distribution function? (1)
- Q2. Explain the working operation with proper diagrams of the following which are used for the characterization of the nano materials
- (a) Scanning Tunneling Microscope (2)
- (b) IR and Raman Spectroscopy (3)
- Q3. Discuss the application of carbon nanotubes as a (i) chemical sensor (ii) field emission and shielding device (iii) useful for mechanical reinforcement. (2+2+1=5)
- Q4. Consider a particle of mass m in a box with impenetrable walls (infinite potential well) as shown in figure below:
- a) Starting from Schrödinger equation derive the expression for the wave function and hence probability P_2 for $n=2$ state (3)
- b) Calculate the energy Eigen value of the particle for $n=2$ state (2)



- Q5.(a) Mention the size of the following biological nano material:
- (1) Amino acids
 - (2) Nucleotide
 - (3) Protein
 - (4) Influenza virus (1)
- (b) Mention any two difference between DNA and RNA (1)
- (c) What are the maximum number of codons possible and why? (1)
- (d) What is transcription (0.5)
- (e) What is the role t-RNA in protein synthesis (0.5)
- (f) Mention the sequence of start codon (0.5)
- (g) Mention any two stop codons (0.5)
- Q6. (a) List the advantages of MEMS over the macro electromechanical systems. (2)
- (b) RF Switch is one of the RF MEMS device used widely in telecommunication technology. Give reasons why RF MEMS have shown an exponential growth in their use. (3)
- Q7. (a) Mention at least four techniques involved in each Top down and Bottom up approach for the synthesis of nanostructures. (2)
- (b) What are the advantages and disadvantages of Top down and Bottom Up approach in nanomanufacturing? Which one is preferred where? (3)
- Q8. Explain with suitable diagram how a nano cantilever can be used to detect presence of specific gases in the environment. (5)

-----best Of luck-----

**BITS PILANI DUBAI CAMPUS
SECOND SEMESTER 2010-11**

Test-2 (Open Book)

Course No: EA C416

Duration: 50 Mints

Weightage: 20%

Course Name: Introduction to Nanoscience Max Marks;20

Date: 8.5.2011

Note: All the questions are compulsory.

Q1.(a) How many types of carbon nano tube(CNT) exist. In what sense they differ from each other. Explain through diagrams? (2)

(b) What are the different techniques for fabrication of CNT. Discuss one of them in detail. (3)

Q2(a) Give the definition of quantum well, quantum wire and quantum dot. Explain through diagram. (2)

(b) Discuss in detail how to fabricate quantum dot structure (mentioning all the steps involved). (3)

Q3(a) CNTs apart from many other applications, are ideal material for nano sensors. Explain briefly the characteristics of CNT, that make them as an ideal material for nano sensors. [2]

(b) List four nano sensor applications where macro-micro sensors are either not feasible or are clumsy. Explain the working of one of them. [2]

(c) Give an example of CNT based sensor. [1]

Q4(a) Why 'small' is preferred in nature by nature? Explain briefly. [2]

(b) With a micro/nano cantilevers or RF MEMS it is possible to get the cut-off frequency in GHz while macro cantilevers can achieve cut-off frequency only in MHz. Why micro/nano cantilevers or RF MEMS give this high cut-off frequency? [3]

BITS PILANI DUBAI CAMPUS
SECOND SEMESTER 2010-11

Course No: EA C416 Duration: 50 Mints Weightage: 20% Test-1(Closed Book)

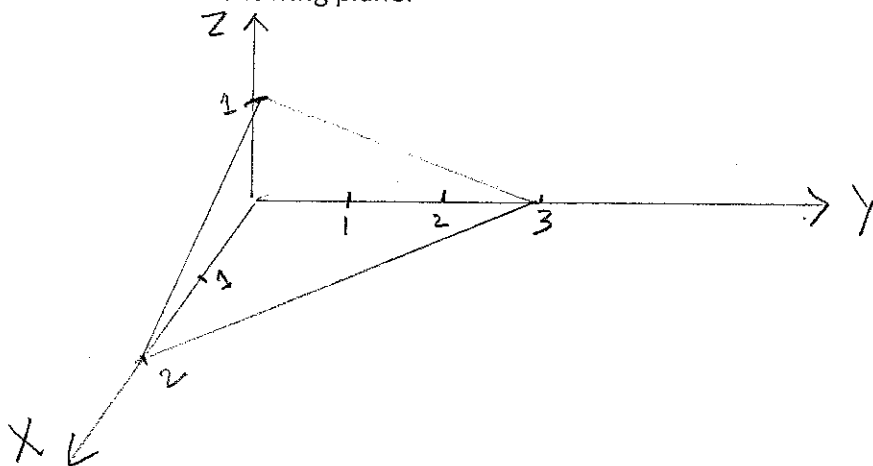
Course Name: Introduction to Nanoscience Max Marks;20 Date: 20.3.2011

Note: All the questions are compulsory.

Q1. Define primitive and non primitive cell. Identify primitive and nonprimitive cell out of cubic unit cell, face centered unit cell and body centered unit cell nanoparticle with proper explanation? (3)

Q2(a) Draw the lattice plane for which Miller indices are given as (010), (110) and (111). (3)

(b) What is the Miller Indices for the following plane. (2)



(c) Calculate d_{011} : d_{101} : d_{112} for a simple cubic nanoparticle of lattice parameter a ? (2)

Q3 (a). Show that reciprocal of any reciprocal lattice vector is direct lattice itself. (2)

(b) Given a two dimensional nanostructure having square lattice with unit cell size of 0.3nm. Calculate the angles for Bragg scattering in second order on the lattice for X rays of wavelength 0.2nm? (2)

Q4. What is the approximate resolution of Transmission Electron Microscope(TEM) if the energy of the electrons is 100kev is used to study the nanoparticles. (2)

Q5(a) Differentiate between Top Down and Bottom Up approach for fabrication of nano objects. (2)

(b) Mention all the steps involved in Nanosphere Lithographic technique? (2)

BITS PILANI DUBAI CAMPUS

SECOND SEMESTER 2010-11

Quiz(Closed Book)

Course Name: Introduction to Nanoscience

Course No: EA C416

Time: 20 Mints

Max Marks: 30(15x2)

Weightage:5%

Date: 11.4.2011

Name:

Id No:

Q1.	Give the definition of Brillouin zone .
Ans	The allowed energy bands availability of electrons in a periodic potential lattice
Q2.	An electron in a sodium metal has Fermi energy of 3.2eV. Calculate its Fermi temperature and Fermi velocity.($k_B=1.38 \times 10^{-23}$)
Ans	$1.06 \times 10^6 \text{ m/s}$
Q3	What is the relationship between resistivity and energy band gap of any semiconducting nanomaterial.
Ans	$\ln \rho_i = \ln A + E_g / 2k_B T$
Q4	What are the possible modes of lattice vibration. Mention their names
Ans	Acoustic mode and optical mode
Q5	Mention the name of different types of Carbon Nano Tubes.
Ans	Arm chair, zig zag and chiral
Q6	Mention at least three techniques for fabrication of carbon nano tubes.
Ans	CVD, Laser ablation, chemical arc discharge
Q7	By which mechanism scanning probe scan the surface in nanometer increments.
Ans	Piezo mechanism
Q8	Define stokes and anti-stokes line in Raman spectroscopy.
Ans	Stokes: emitted frequency is less than incidence Anti stokes: emitted frequency is greater than incidence

Q9	The deflection of a nano-cantilever can be used to quantify/sense different parameters/properties – from acceleration to presence/concentration of a gas. Name two different methods to measure the deflection of a nano-cantilever:
Ans	1. Laser beam deflection 2. Piezo mechanism
Q10.	List four applications of nanobiosensors
Ans	Detect sugar level, Cancer detection, detect antigens antibodies, detect blood component
Q11	List four common pressure sensors
Ans	Refer class notes
Q12	List four applications of acceleration sensors
Ans	Refer class notes
Q13	Describe one CNT based nanosensor
Ans	FET with Au in between source and drain acts as a gas sensor
Q14	Mention any three techniques in Top down approach for fabrication of nano structure.
Ans	Refer class notes
Q15	Mention any two techniques in Bottom Up approach for fabrication of nano structure.
Ans	Refer class notes