# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
B.E. Nano Technology

| Management and Entrepreneurship<br>[As per Choice Based Credit System (CBCS) scheme]<br>(Effective from the academic year 2015 -2016)<br>Course: B.E. / Nano Technology<br>Semester: V | | | |
|---|---|---|---|
| Subject Code | 15NT51 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 04 | Exam Marks | 80 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |
| CREDIT – 04 | | | |

Course Objective:

- To learn various aspects and principles of Management, Planning, Organization and Directing & Control.
- To learn the concepts of Entrepreneurship, Small scale industry and Project Management

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>MANAGEMENT: Introduction - Meaning - nature and characteristics of Management, Scope and functional areas of management - Management as a science, art or profession Management & Administration - Roles of Management, Levels of Management, Development of Management Thought – early management approaches - Modern management approaches.<br>PLANNING: Nature, importance and purpose of planning process - Objectives - Types of plans (Meaning only) - Importance of planning - steps in planning & planning premises - Hierarchy of plans. | 10 | L1, L2 |
| Module 2:<br>ORGANIZING AND STAFFING: Nature and purpose of organization - Principles of organization - Types of organization - Departmentation - Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning only) Nature and importance of Staffing.<br>DIRECTING & CONTROLLING: Meaning and nature of directing - Leadership styles, Motivation Theories, Communication - Meaning and importance – Coordination, meaning and importance and Techniques of Co - ordination. Meaning and steps in controlling. | 10 | L1, L2, L3 |
| Module 3:<br>ENTREPRENEUR<br>Meaning of Entrepreneur; Evolution of the Concept, Functions of an | 10 | L1, L2, L3, L4 |

| | | |
|---|---|---|
| Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers. | | |
| Module 4:<br>SMALL SCALE INDUSTRY<br>Definition; Characteristics; Need and rationale: Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start an SSI - Government policy towards SSI; Different Policies of S.S.I.; Government Support for S.S.I. during 5 year plans, Impact of Liberalization, Privatization, Globalization on S.S.I., Effect of WTO/GATT Supporting Agencies of Government for S.S.I., Meaning; Nature of Support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition only). | 10 | L1, L2, L3, L4 |
| Module 5:<br>PREPARATION OF PROJECT<br>Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of Business Opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. | 10 | L1, L2, L3 |
| Course Outcome:<br>Students can learn about<br>• Management<br>• Planning<br>• Organization<br>• Directing & Controlling<br>• Entrepreneurship<br>• Small Scale Industry, and<br>• Project Management | | |
| Graduate Attributes (as per NBA):<br>• Engineering Knowledge.<br>• Problem Analysis.<br>• Design / development of solutions (partly).<br>• Interpretation of data. | | |
| Question paper pattern:<br>• The question paper will have ten questions.<br>• Each full Question consisting of 16 marks<br>• There will be 2 full questions (with a maximum of four sub questions) from each module.<br>• Each full question will have sub questions covering all the topics under a module.<br>• The students will have to answer 5 full questions, selecting one full question from each module. | | |

TEXT BOOKS:
1. Principles of Management – P.C. Tripathi, P.N. Reddy – Tata McGraw Hill, 2007.
2. Dynamics of Entrepreneurial Development & Management – Vasant Desai:, Himalaya Publishing House, 2007.
3. Entrepreneurship Development – Poornima M Charantimath – Small Business Enterprises, Pearson Education, 2006.

REFERENCE BOOKS:
1. Management Fundamentals: Concepts, Application, Skill Development – Robert Lusier –, Thompson, 2007.
2. Entrepreneurship Development – S. S. Khanka, S. Chand & Co, 2007.
3. Management – Stephen Robbins: 17th Edition, Pearson Education / PHI, 2003.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
## B.E. Nano Technology

| Course: B.E. / Nano Technology<br>Semester: V | | | |
|---|---|---|---|
| Subject Code | 15NT52 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 04 | Exam Marks | 80 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |
| CREDIT – 04 | | | |

Course Objective:

- To understand methods involved in the synthesis of nano materials
- To learn the techniques which are required for the synthesis of various nano materials.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>Synthesis of Metal oxides and semiconductor nanoparticles:Introduction, Defining Metal oxide and Semiconductor nanoparticles, Synthesis of Metal Oxide nanoparticles- CdO and AgO nanostructures.Synthesis by any two solution process methods. Different methods to synthesis CuO (Procedure), comparison, Advantages and Drawbacks CuO nanoparticles, Different methods to synthesis ZnO (Procedure), comparison, Advantages and Drawbacks ZnO nanoparticles, Different methods to synthesis $Al_2O_3$ (Procedure), comparison, Advantages and Drawbacks $Al_2O_3$ nanoparticles. Synthesis of Semiconductor nanoparticles- CdS, CdSe, ZnS, PbS, CuS, Cu2S, and $TiO_2$ (only procedure). Potential Uses of metal oxide and semiconductor nanoparticles. | 10 | L1, L2 |
| Module 2:<br>Synthesis of Quantum Dots and Metal Nanoparticles:<br>Introduction, Defining Nanodimensional Materials, Different methods to synthesis CdSe (Procedure), comparison, Advantages and Drawbacks CdSe quantum dots, Different methods to synthesis ZnS (Procedure), comparison, Advantages and Drawbacks ZnS quantum dots, Different methods to synthesis AgS (Procedure), comparison, Advantages and Drawbacks AgS quantum dots, Metal, Potential Uses for quantum dots.<br>Synthesis of Metal Nanoparticles - Ag, Au, Pt and Fe nanoparticles. | 10 | L1, L2, L3 |
| Module 3:<br>Synthesis of Oxide and Non-oxide Nanoparticles:<br>Introduction, Defining Oxide and Non-oxide Nanoparticles, Synthesis of Oxide nanoparticles- Magnetite Particles or magnetosomes, $CoFe_2O_4$, $MnFe_2O_4$ and $CoCrFeO_4$ nano | 10 | L1, L2, L3 |

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|---|---|---|
| particulate. Different methods to synthesis Magnetite Particles (Procedure), comparison, Advantages and Drawbacks of Magnetite Particles, Different methods to for the Preparation of Isolated Oxide Nanoparticles- Hydrolysis, Oxidation and solvothermal methods. Potential Uses for Oxide and Non-oxide Nanoparticles. | | |
| Module 4:<br>Synthesis of Nanoporous Materials:<br>Introduction, Defining nanoporous materials, Synthesis of Nanoporous materials- Aluminosilicate Zeolites, Metal Phosphates- Aluminium Phosphates, Phosphates of Gallium and Indium, Iron Phosphates, Cobalt and Manganese Phosphates, Copper and Nickel Phosphates, Zirconium and Titanium Phosphates (Procedure only). Advantages and drawbacks of nanoporous materials. Potential Uses of nanoporous materials. | 10 | L1, L2, L3, L4 |
| Module 5:<br>Biological methods:<br>Introduction, Advantages, disadvantages and applications of biological method, Use of bacteria, fungi, Actinomycetes for nanoparticles synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Green synthesis of nanoparticles, Synthesis by leaf extracts. | 10 | L1, L2 |
| Course Outcome:<br>Students can learn the various aspects of synthesis of nano materials (metal, metal oxide, semiconductor, oxide and non-oxide, and nanoporous materials) like physical, chemical and biological methods. Which are very important to deal the nanoparticles since they fall in the range of molecular to atomic level. | | |
| Graduate Attributes (as per NBA):<br>• Engineering Knowledge.<br>• Problem Analysis.<br>• Design / development of solutions (partly).<br>• Interpretation of data. | | |
| Question paper pattern:<br>• The question paper will have ten questions.<br>• Each full Question consisting of 16 marks<br>• There will be 2 full questions (with a maximum of four sub questions) from each module.<br>• Each full question will have sub questions covering all the topics under a module.<br>• The students will have to answer 5 full questions, selecting one full question from each module. | | |
| TEXT BOOKS:<br>1. Guozhong Cao, "Nano structures and Nano materials, synthesis, properties and applications", world scientific series in nano science and technology, Vol. 2, 2011. | | |

2. C. N. R. Rao, A. Muller, A. K. Cheetham "The Chemistry of Nano materials: Synthesis, Properties and Applications" @ 2004 WILEY-VCH Verlag GmbH & Co. KgaA, Weinheim, ISBN 3-527-30686-2.
3. T. Pradeep, "NANO The Essential, understanding Nano science and Nanotechnology". Tata McGraw-Hill Publishing Company Limited, 2007.
4. Charles P. Poole Jr. "Introduction to Nanotechnology", John Willey & Sons, 2003.

REFERENCE BOOKS:

1. Processing & properties of structural nano materials - Leon L. Shaw (editor)
2. C. A. Mirkin and C.M. Niemeyer, Nanobiotechnology- II, More Concepts and Applications, WILEY-VCH, VerlagGmbH&Co, 2007.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
## B.E. Nano Technology

| [As per Choice Based Credit System (CBCS) scheme]<br>(Effective from the academic year 2015 -2016)<br>Course: B.E. / Nano Technology<br>Semester: V | | | |
|---|---|---|---|
| Subject Code | 15NT53 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 04 | Exam Marks | 80 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |
| CREDIT - 04 | | | |

Course Objective:
To study the basic characterization tools and techniques
To understand the structural, morphological, and surface composition of nanomaterials
To understand the electrical measurement devices

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>Introduction to characterization techniques:<br>Introduction to characterization techniques-types of characterization techniques, Basics, Importance, Structural and compositional characterization tools, resolution, resolving power-abbe criterion, Rayleigh criterion. Different types of sources used, electron lenses, scan coils, lens aberrations, electron diffraction-interference, types of detectors used. | 10 | L1, L2 |
| Module 2:<br>X-Ray based characterization:<br>Basic Principles Instrumentation and applications of X-ray diffraction, powder (polycrystalline) and single crystalline XRD techniques; Debye-Scherrer equation. X-ray photoelectron spectroscopy – basic principle, instrumentation, X-ray absorption techniques: introduction to XANES, and EXAFS | 10 | L1, L2, L3 |
| Module 3:<br>Electron microscopy techniques:<br>Principles and applications of Electron beam, Electron beam interaction with matter. Scanning electron microscopy: working principle and application. Transmission electron microscopy: introduction, working and application. Electron-diffraction, introduction to SAED. Atomic Force Microscope: working and types of operating modes. Scanning Tunnelling Microscope: working principle and applications. | 10 | L1, L2, L3, L4 |
| Module 4:<br>Spectroscopic techniques:<br>Principles, operation and applications of UV-VIS | 10 | L1, L2, L3, L4 |

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|---|---|---|
| Spectrophotometers, IR/FTIR Spectrophotometers, and Raman spectroscopy. Optical microscope: Nanoparticle size measurement by Dynamic light scattering methods, zeta potential. | | |
| Module 5:<br>Electrical measurements:<br>Introduction to Potentiometry. Basics of Voltammetric techniques: Linear and Cyclic voltammetry. IV, AC and DC electric measurements. Impedence Measurement and analysis. | 10 | L1, L2, L3 |
| Course Outcome:<br>After completion of this course students can able to<br>Understand the tools and techniques for basic characterization of nanomaterials | | |
| Graduate Attributes (as per NBA):<br>• Engineering Knowledge.<br>• Problem Analysis.<br>• Design / development of solutions (partly).<br>• Interpretation of data. | | |
| Question paper pattern:<br>• The question paper will have ten questions.<br>• Each full Question consisting of 16 marks<br>• There will be 2 full questions (with a maximum of four sub questions) from each module.<br>• Each full question will have sub questions covering all the topics under a module.<br>• The students will have to answer 5 full questions, selecting one full question from each module. | | |
| TEXT BOOKS:<br>1. Characterization of Nanostructure materials by XZ.L.Wang<br>2. Instrumental Methods of Analysis, 7th edition- Willard, Merritt, Dean, Settle<br>3. Voltammetric techniques by Noel and Vasu | | |
| REFERENCE BOOKS:<br>1. X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials, 2nd Edition - Harold P. Klug, Leroy E. Alexander<br>2. Transmission Electron Microscopy: A Textbook for Materials Science (4-Vol Set)- David B. Williams and C. Barry Carter<br>3. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM - Ray F. Egerton | | |

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
## B.E. Nano Technology

| Course: B.E. / Nano Technology<br>Semester: V | | | |
|---|---|---|---|
| Subject Code | 15NT54 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 04 | Exam Marks | 80 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |
| CREDIT – 04 | | | |

Course Objective:

1. To design sub systems using combinational circuits and sequential circuits
2. To design digital systems using CMOS logic and understand the physical structure of digital systems in its transistor schematic form
3. To learn Verilog HDL programming and model digital systems using high level language

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>Fundamentals of Digital Systems: Combinational circuits, sequential circuits, basic gates, realization of logic using NAND, NOR and 2:1 Multiplexers, design of half adder, full adders, full subtractor, 1-bit comparator, decoders and encoders.<br>Introduction to Verilog HDL, coding types, behavioural, structural and data flow, modelling of basic gates, half adder and full adder using Verilog HDL | 10 | L1, L2, L3 |
| Module 2:<br>Designing with combinational circuits: 4-bit Ripple carry adder, 4-bit carry look ahead adder, 4-bit carry select adder, 4-bit comparator using 2-bit comparator, seven segment display controllers using encoders and decoders, parity generators and 3-bit shifters/rotators using multiplexers, barrel shifter/rotator using 2:1 multiplexer<br>Writing Verilog code for 4-bit ripple carry adder, parity generators. | 10 | L1, L2, L3 |
| Module 3:<br>Designing with sequential circuits: SR latch, SR-D Latch, T-Latch, flip flops using positive triggered and negative triggered latch, designing N-bit synchronous and asynchronous counters, up-down counters, designing clock dividers using counters, shift registers, SISO, SIPO, PISO, PIPO, 1-bit memory unit with read and write enable, 4-bit memory unit with address decoder. | 10 | L1, L2, L3 |
| Module 4:<br>Digital Circuit Design using MOS Transistor: MOS transistor, NMOS and PMOS transistor, CMOS inverter circuit, CMOS circuit design for NAND, NOR, AND, OR, XOR, XNOR gate, transmission gate using CMOS, 2:1 multiplexer design using CMOS transmission gate, 1-bit latch using CMOS (2:1 multiplexer), 1-bit flip flop using CMOS latch. Introduction to | 10 | L1, L2, L3, L4 |

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|---|---|---|
| propagation delay, rise time, fall time, noise margin for CMOS inverter. Introduction to power dissipation in CMOS circuits, dynamic power, static power, leakage power. | | |
| Module 5:<br>Subsystem design and modelling: writing Verilog code using data flow description for D-latch, JK-flip flop, counters, 2-Bit Magnitude comparators, 4x4 memory with read and write ports, behavioural model for 4-bit ALU design using Verilog HDL, writing test bench wave forms for functional verification of 4-bit adders and ALU<br>Introduction to programmable logics such as PLA, PAL and FPGAs | 10 | L1, L2, L3, L4 |

Course Outcome:
After successfully completing this course, students will be able to:

1. Understand the fundamental of digital systems and design of sub systems using combinational and sequential circuits
2. Apply the Verilog programming skills in modelling digital sub systems
3. Develop CMOS technology based transistor schematics for digital systems

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:
For Modules 1 – 3 & 5

1. N. Botros, HDL programing fundamental: VHDL and Verilog, Cengage learning, 2007
2. Thomas L. Floyd, Digital Fundamentals, Pearson Publications, 2012
3. John F. Wakerly, Digital Design Principles and Practices, Prentice Hall of India, 2014
4. Stephen Brown &ZvonkoVranesic, Fundamentals of Digital Logic Design with Verilog Design, Tata McGraw Hill Edition, 2015

For Module 4

1. Neil H. E. Weste& David Money Harris, CMOS VLSI Design: A circuit and systems perspective, 3rd edition, Pearson Education, 2010

REFERENCE BOOKS:

1. Leach D, Malvino A P, Saha G, Digital Principles and Applications, 8/e, McGraw Hill Education, 2015.
2. Harris D. M. and, S. L. Harris, Digital Design and Computer Architecture, 2/e, Morgan

| |
|---|
| Kaufmann Publishers, 2013 |

# Professional Electives

| Analog Circuit Design<br>[As per Choice Based Credit System (CBCS) scheme]<br>(Effective from the academic year 2015 -2016)<br>Course: B.E. / Nano Technology<br>Semester: V | | | |
|---|---|---|---|
| Subject Code | 15NT551 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 03 | Exam Marks | 80 |
| Total Number of Lecture Hours | 40 | Exam Hours | 03 |
| CREDIT – 03 | | | |

Course Objective:

4. To understand the concepts of analog circuits and design principles of analog circuits
5. To design and analyse working of CMOS based analog circuits and sub systems
6. To understand and design data converters using analog sub circuits

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>Operational Amplifier Fundamentals: Basic Op-amp circuit, Op-Amp parameters – Input and output voltage, CMRR and PSRR, offset voltages and currents, Input and output impedances, Slew rate and Frequency limitations. OP-Amps as DC Amplifiers – Biasing OP-amps, Direct coupled voltage followers, Non-inverting amplifiers, inverting amplifiers, Summing amplifiers, and Difference amplifiers. | 08 | L1, L2, L3 |
| Module 2:<br>Analog sub circuits and oscillators: Limiting circuits, Clamping circuits, Peak detectors, Sample and hold circuits, V to I and I to V converters, Differentiating Circuit, Integrator Circuit, Phase shift oscillator, Wein bridge oscillator, Crossing detectors, inverting Schmitt trigger. Log and antilog amplifiers, Multiplier and divider | 08 | L1, L2, L3 |
| Module 3:<br>Introduction to Analog Integrated Circuits: MOS devices, small signal model, large signal model, MOS operation in linear, saturation and cut off regions, MOS inverters, bipolar junction transistor, small signal model, large signal model, MOS based current mirrors, types of current mirrors, current reference circuits, voltage reference circuits | 08 | L1, L2, L3, L4 |
| Module 4: | 08 | L1, L2, L3, L4 |

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| Single stage amplifiers: MOS amplifier circuits, working principles of common source amplifier, common drain amplifier, common gate amplifier, differential amplifier, time domain response, frequency domain response, operational amplifier circuits, two stage amplifier and cascade amplifier, opamp comparators | | |
| Module 5:<br>Data Converters: Sampling and Quantization, sampling theorem, Nyquist rate sampling, Analog to digital converter, types of converters, working principles of flash ADC, SAR ADC, pipelined ADC, Sigma delta ADC, Digital to analog converters, resistor string converters, R-2R DAC, thermometric DAC, testing of data converters, low voltage data converter | 08 | L1, L2, L3, L4 |
| Course Outcome:<br>After successfully completing this course, students will be able to:<br>4. Understand the fundamental of analog circuit design and design of sub systems using opamps<br>5. Use MOS transistors and design analog sub circuits such as single stage amplifiers and two stage amplifiers<br>6. Build data converters using analog sub circuits and understand the design principles and working of data converters | | |
| Graduate Attributes (as per NBA):<br>• Engineering Knowledge.<br>• Problem Analysis.<br>• Design / development of solutions (partly).<br>• Interpretation of data. | | |
| Question paper pattern:<br>• The question paper will have ten questions.<br>• Each full Question consisting of 16 marks<br>• There will be 2 full questions (with a maximum of four sub questions) from each module.<br>• Each full question will have sub questions covering all the topics under a module.<br>• The students will have to answer 5 full questions, selecting one full question from each module. | | |
| TEXT BOOKS:<br>For Modules 1 & 2<br>2. David A. Bell, Operational Amplifiers and Linear ICs, 2nd edition, PHI/Pearson, 2004<br>3. Ramakant A Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson, 4th Ed, 2015. ISBN 81-7808-501-1.<br>For Modules 3 to 5<br>4. David Johns and KENNETH M. MARTIN, Analog Integrated Circuit Design, John Wiley and Sons, 2013<br>5. B. Razavi, Design of Analog CMOS Integrated Circuits, 2nd edition, McGraw-Hill, 2017. ISBN 978-0-07-252493-2. | | |
| REFERENCE BOOKS: | | |

1. D. Roy Choudhury and Shail B. Jain, Linear Integrated Circuits, 4th edition, Reprint 2006, New Age International ISBN 978-81-224-3098-1.
2. B Somanathan Nair, "Linear Integrated Circuits: Analysis, Design & Applications," Wiley India, 1st Edition, 2015.
3. Philips E. Allen, Douglas R. Holberg, CMOS Analog Circuit Design, Oxford University Press, 2012

**Biomaterials**

[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2015 -2016)
Course: B.E. / Nano Technology
Semester: V

| | | | |
|---|---|---|---|
| Subject Code | 15NT552 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 03 | Exam Marks | 80 |
| Total Number of Lecture Hours | 40 | Exam Hours | 03 |

CREDIT – 03

Course Objective:
1. To understand the fundamental principals in material science and chemistry, and how they contribute to biomaterial development and performance.
2. To apply the science and engineering knowledge gained in the course to biomaterial selection and design for specific biomedical uses.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>Fundamentals of biomaterials science. Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance. Disinfection and sterilization of biomaterials. Physico-chemical properties of biomaterials: mechanical (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear resistance), tribological (friction, wear, lubricity), morphology and texture, physical (electrical, optical, magnetic, thermal), chemical and biological properties. | 08 | L1, L2 |
| Module 2:<br>Elements in contact with the surface of a biomaterial: blood composition, plasma proteins, cells, tissues. Phenomena at the biointerfaces. Molecular and cellular processes with living environment, blood-materials interaction, short and long term | 08 | L1, L2, L3 |

| | | |
|---|---|---|
| reactions to the body. Testing of biomaterials: in vitro, in vivo preclinical and in vivo clinical tests. Concept of biocompatibility. Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials, Effects of wear particles. Testing of implants: Methods of test for biological performance- In vitro implant tests, In vivo implant test methods. | | |
| Module 3:<br>Properties of implant materials, metals and alloys, ceramics and composites, Stainless steel, Cobalt-Chromium alloys, Titanium based alloys, Nitinol, other metals, metallic Corrosion, Carbons, Alumina, Yttria stabilized zirconia, surface reactive ceramics, resorbable ceramics, composites, analysis of ceramic surfaces. Applications and Biocompatibility case studies of novel materials and alloys. | 08 | L1, L2, L3 |
| Module 4:<br>Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization. Polymers as biomaterials, heparin and heparin-like polysaccharides, proteoglycans, structure and biological activities of native sulfated glycosaminoglycans, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins. Applications and Biocompatibility case studies of novel polymeric materials. | 08 | L1, L2, L3, L4 |
| Module 5:<br>Technologies of biomaterials processing, as implants and medical devices; improvement of materials biocompatibility by plasma processing. Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, biodegradable polymers in drug delivery and drug carrier systems. Tissue properties of blood vessels, Treatments of atherosclerosis; Biomechanical design issues pertaining to stents, balloon angioplasty, and pacemakers. Soft Tissue Reconstruction; FDA requirements, standards on the biological evaluation of medical devices (ISO-10993) and implications to applications in human. Practical aspects of biomedical devices: manufacturing, storage quality, regulatory and ethical issues, price of implants and allocation of resources. | 08 | L1, L2, L3, L4 |
| Course Outcome:<br>After successfully completing this course, students will be able to:<br>1. Understand the fundamental principals in material science and chemistry, and how they contribute to biomaterial development and performance.<br>2. Apply the science and engineering knowledge gained in the course to biomaterial selection | | |

and design for specific biomedical uses.
3. Critically review papers from the scientific literature and identify areas of research opportunities

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Biomaterials Science: An Introduction to materials in medicine by Buddy D Ratner. Academic Press.
2. Biomaterials - Temenoff and Mikos, Pearson Prentice Hall.
3. Polymeric Biomaterials by SeverianDumitriu.
4. Polymeric Biomaterials by Piskin and A S Hoffmann, MartinusNijhoff

REFERENCE BOOKS:

1. Materials Science and Engineering: An Introduction – Callister, John Wiley and Sons.
Science and Engineering of Materials - Askland and Phule, Thomson.
2. Material Science by Smith, McGraw Hill.
3. Material Science and Engineering by V Raghavan, Prentice Hall.
4. Biomaterials by Sujata V. Bhat, Narosa Publishing House.
5. Biomaterials, Medical Devices and Tissue Engineering: An Integrated Approach by Frederick H Silver, Chapman and Hall publications.
6. Advanced Catalysts and Nanostructures Materials, William R Moser, Academic Press.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
## B.E. Nano Technology

| (Effective from the academic year 2015 -2016)<br>Course: B.E. / Nano Technology<br>Semester: V | | | |
|---|---|---|---|
| Subject Code | 15NT553 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 03 | Exam Marks | 80 |
| Total Number of Lecture Hours | 40 | Exam Hours | 03 |
| CREDIT – 03 | | | |

Course Objective:
This course will enable students to
1. Understand various concepts and definitions of thermodynamics.
2. Comprehend the I-law and II-law of thermodynamics.
3. Acquire the knowledge of various types of gas cycles

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>Fundamental Concepts and Work & Heat<br>Fundamental Concepts:<br>Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and noncyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Zeroth law of thermodynamics<br>Work and Heat: Mechanics-definition of work and its limitations. Thermodynamic definition of work. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Heat. Comparison between work and heat.<br>(Note: Numerical problems and not included) | 08 | L1, L2 |
| Module 2:<br>First Law of Thermodynamics:<br>Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non – cyclic processes, energy, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat at constant pressure. Extension of the First law to control volume; steady | 08 | L1, L2, L3 |

| | | |
|---|---|---|
| state-steady flow energy equation, important applications.<br>(Note: Numerical problems and not included) | | |
| Module 3:<br>Second Law of Thermodynamics and Entropy<br>Second Law of Thermodynamics:<br>Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; Clausius statement of Second law of Thermodynamics, Equivalence of the two statements.<br>Entropy: Clausius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy.<br>(Note: Numerical problems and not included) | 08 | L1, L2 |
| Module 4:<br>Pure Substances, Ideal Gases, Thermodynamic relations<br>Pure Substances & Ideal Gases: Mixture of ideal gases and real gases,ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example.Enthalpy of change of phase (Latent heat). Dryness fraction (quality).<br>Thermodynamic relations: Maxwells equations, Tds relations, evaluation of thermodynamic properties from an equation of state.<br>(Note: Numerical problems and not included) | 08 | L1, L2, L3 |
| Module 5:<br>Gas Cycles<br>Efficiency of air standard cycles, Carnot, Otto, Diesel cycles, P-V & T-S diagram, calculation of efficiency; Carnot vapour power cycle, simple Rankine cycle, Analysis and performance of Rankine Cycle, Ideal and practical regenerative Rankine cycles – Reheat and Regenerative Cycles, Binary vapour cycle.<br>(Note: Numerical problems and not included) | 08 | L1, L2, L3 |
| Course Outcome:<br>After studying this course, students will be able to:<br>1. Apply the concepts and definitions of thermodynamics.<br>2. Differentiate thermodynamic work and heat and apply I law and II law of thermodynamics to different process.<br>3. Apply the principles of various gas cycles | | |
| Graduate Attributes (as per NBA): | | |

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.
- Numerical problems and not included.

TEXT BOOKS:

1. A Venkatesh, "Basic Engineering Thermodynamics", Universities Press, India, 2007, ISBN 13: 9788173715877
2. P K Nag, "Basic and Applied Thermodynamics", 2nd Ed., Tata McGraw Hill Pub. 2002, ISBN 13: 9780070151314

REFERENCE BOOKS:

1. Yunus A. Cenegal and Michael A. Boles, "Thermodynamics: An Engineering Approach", TataMcGraw Hill publications, 2002, ISBN 13: 9780071072540
2. J. B. Jones and G. A. Hawkins, John Wiley and Sons, "Engineering Thermodynamics", Wiley 1986, ISBN 13: 9780471812029
3. G. J. Van Wylen and R. E. Sonntag, "Fundamentals of Classical Thermodynamics", Wiley Eastern, Wiley, 1985, ISBN 13: 9780471800149

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
B.E. Nano Technology

| Semester: V | | | |
|---|---|---|---|
| Subject Code | 15NT554 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 03 | Exam Marks | 80 |
| Total Number of Lecture Hours | 40 | Exam Hours | 03 |
| CREDIT – 03 | | | |

Course Objective:
1. To understand the fundamental principals in Self-assembly of nanostructures, and how they contribute and control development of nanostructures by self-assembly.
2. To apply the science and engineering knowledge gained in the course to nanomaterial self-assemblies and design for specific applications.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>Introduction, Materials Self-Assembly, Molecular *vs.* Materials Self-Assembly, What is Hierarchical Assembly?, Directing Self-Assembly, Supramolecular Vision, Genealogy of Self-Assembling Materials, Learning from Biominerals - Form is Function, Two-Dimensional Assemblies, SAMs and Soft Lithography, Clever Clusters, Mesoscale Self-Assembly, Materials Self-Assembly of Integrated Systems, Layer-by-Layer Self-Assembly, Building One Layer at a Time, Electrostatic Superlattices, Organic Polyelectrolyte Multilayers, Layer-by-Layer Smart Windows, How Thick is Thin?, Assembling Metallopolymers, Polyelectrolyte-Colloid Multilayers, Graded Composition LbL Films, LbL MEMS, Trapping Active Proteins, Layering on Curved Surfaces, Zeolite-Ordered Multicrystal Arrays, Crosslinked Crystal Arrays, Non-Electrostatic Layer-by-Layer Assembly | 08 | L1, L2 |
| Module 2:<br>Nanorod, Nanotube, Nanowire Self-Assembly introduction, Building Block Assembly, Templating Nanowires, Modulated Diameter Gold Nanorods, Modulated Composition Nanorods, Barcoded Nanorod Orthogonal Self-Assembly, Nanodisk Codes, Sir SERS, Self-Assembling Nanorods, Magnetic Nanorods Bunch Up, Magnetic Nanorods and Magnetic Nanoclusters, An Irresistible Attraction for Biomolecules, Hierarchically Ordered Nanorods, Nanorod Devices, Nanotubes from Nanoporous Templates, Layer-by-Layer Nanotubes from Nanorods. , Crossed Semiconductor Nanowires - Smallest LED, Nanowire Diodes and Transistors, Nanowire Sensors, Catalytic Nanowire Electronics. | 08 | L1, L2, L3 |
| Module 3:<br>Nanocluster Self-Assembly introduction, Building-Block Assembly, | 08 | L1, L2, L3 |

| | | |
|---|---|---|
| When is a Nanocrystal a Nanocluster or a Nanoparticle?, Synthesis of Capped Semiconductor Nanocrystals, Electrons and Holes in Nanocrystal Boxes, Nanocluster Phase Transformations, Watching Nanocrystals Grow, Nanocrystals in Nanobeakers, Capped Gold Nanocrystals - Nanonugget Rush, Alkanethiolate Capped Nanoclusters Diagnostics, Microporous and Mesoporous Materials from Soft Building Blocks, Escape from the Zeolite Prison, A Periodic Table of Materials Filled with Holes, Modular Self-Assembly of Microporous Materials, Hydrogen Storage Coordination Frameworks, Overview and Prospects of Microporous Materials, Mesoscale Soft Building Blocks, Micelle *vs.* Liquid Crystal Templating Paradox, Mesoporous Materials by Design, Tuning Length Scales, Mesostructure and Dimensionality, Mesocomposition - Nature of Precursors, Mesotexture, Periodic Mesoporous Silica-Polymer Hybrids | | |
| Module 4:<br>Self-Assembling Block Copolymers introduction, Polymers, Polymers Everywhere in Nanochemistry, Block Copolymer Self-Assembly - Chip Off the Old Block, Nanostructured Ceramics, Nano-Objects, Block Copolymer Thin Films, Electrical Ordering, Spatial Confinement of Block Copolymers, Nanoepitaxy, Block Copolymer Lithography, Decorating Block Copolymers, A Case of Wettability, Nanowires from Block Copolymers, Making Micelles, Assembling Inorganic Polymers, Harnessing Rigid Rods, Supramolecular Assemblies, Supramolecular Mushrooms, Structural Color from Lightscale Block Copolymers, Block Copolypeptides, Block Copolymer Biofactories | 08 | L1, L2, L3, L4 |
| Module 5:<br>Self-Assembly of Large Building Blocks introduction, Self-Assembling Supra-Micron Shapes, Synthesis Using the "Capillary Bond", Crystallizing Large Polyhedral-Shaped Building Blocks, Self-Assembling 2D and 3D Electrical Circuits and Devices, Crystallizing Micron-Sized Planar Building Blocks, Polyhedra with Patterned Faces That Autoconstruct, Large Sphere Building Block Self-Assemble into 3D Crystals, Synthetic MEMS?, Magnetic Self-Assembly, Dynamic Self-Assembly, Autonomous Self-Assembly, Self-Assembly and Synthetic Life | 08 | L3, L4, L5 |
| Course Outcome:<br>After successfully completing this course, students will be able to:<br>1. Understand the fundamental principals in Self-assembly of nanostructures, and how they contribute and control development of nanostructures by self-assembly.<br>2. To apply the science and engineering knowledge gained in the course to nanomaterial self-assembly s and design for specific applications.<br>3. Critically review papers from the scientific literature and identify areas of research opportunities | | |

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
B.E. Nano Technology

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:


1. Nanochemistry - A Chemical Approach to Nanomaterials-Ozin, Geoffrey A.; Arsenault, André C.; Cademartiri, Ludovico-RSC publication
2. Self-Assembled Nanostructures- Jin Z. Zhang, Zhong-lin Wang, Jun Liu, Shaowei Chen, Gang-yu Liu-Springer
3. Design of Nanostructures: Self-Assembly of Nanomaterials-by Himadri B. Bohidar , Kamala Rawat-Wiley VCH


REFERENCE BOOKS:


1. Self-Assembly of Nanostructures, Vol. III, Editors: Bellucci, Stefano (Ed.)- The INFN Lectures Italy-Springer-2012
2. Self-Assembly and Nanotechnology: A Force Balance Approach, Yoon S. Lee, John Wiley & Sons, Inc., Hoboken, New Jersey.
3. Handbook of Self Assembled Semiconductor Nanostructures for Novel Devices in Photonics and Electronics-Edited by:MohamedHenini, Publisher- Elsevier Ltd

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
B.E. Nano Technology

## Open Electives

| Introduction to Nanoscience and Nanotechnology<br>[As per Choice Based Credit System (CBCS) scheme]<br>(Effective from the academic year 2015 -2016)<br>Course: B.E. / Nano Technology<br>Semester: V | | | |
|---|---|---|---|
| Subject Code | 15NT561 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 03 | Exam Marks | 80 |
| Total Number of Lecture Hours | 40 | Exam Hours | 03 |
| CREDIT - 03 | | | |
| Course Objective:<br>To introduce the concept of nanoscience and nanotechnology.<br>To know the physics and chemistry concepts needed to understand the development of nanoscience and nanotechnology.<br>To learn about different nanomaterials and their applications.<br>To understand the importance and applications of nanotechnology. | | | |
| Modules | | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
| Module 1:<br>INTRODUCTION AND SCOPE<br>Introduction to nanoscale, History, Evolution of various disciplines towards nanoscale focus, Plethora of potential applications, Recent achievements in nanotechnology, short-term commercial commercially viable nanotechnology products, specific applications, challenges and opportunities, technology scope, areas and sub-disciples, commercialization scope, present course of investigation. | | 08 | L1, L2 |
| Module 2:<br>BASIC NANOTECHNOLOGY SCIENCE – PHYSICS<br>Introduction, approach & scope, Key sub atomic particles, basic entities/particles of interest, basic physics terms of interest, scale of atomic entities, atomic distances and metaphors, elementary and non-elementary particles, key physical properties of elements, basic properties of silicon and basics of transistor operations: transistor, manufacturing approaches, manufacturing limitations. | | 08 | L1, L2, L3 |
| Module 3:<br>BASIC NANOTECHNOLOGY SCIENCE – PHYSICS<br>Introduction and background, basic chemistry concepts, physical aspects, key chemistry concepts, basic formulations/machinery of chemical reactions, chemistry of carbon, packing of atoms, ferro | | 08 | L1, L2, L3 |

| | | |
|---|---|---|
| and antiferroelectrics, catalysts and sieves, super conductors, magnet. | | |
| Module 4:<br>NANOMATERIALS<br>Introduction, basic nanostructures: CNTs, nanowires, nanocones; applications of nanotubes, wires & cones, quantum dots, quantum dot nanocrystals, ultananocrystalline diamond, diamondoids, nanocomposites, thin films, nanofoams, nanoclusters, smart nanostructures, manufacturing techniques: general approaches & self-assembly methods, system design. | 08 | L1, L2, L3, L4 |
| Module 5:<br>NANOTECHNOLOGY & ITS APPLICATIONS<br>Introduction, materials used and applications in renewable energy generation, drug delivery, cosmetics, tissue engineering, bioinformatics, information technology, agriculture & food technology, high integrated circuits, nanomedicine, molecular motors, bioelectronics & spintronics. | 08 | L1, L2, L3, L4 |
| Course Outcome:<br>A useful subject to gain knowledge about evolution of nanoscience and nanotechnology, the physics and chemistry concepts needed to understand the development of nanoscience and nanotechnology, about different nanomaterials and their applications, and to understand the importance and applications of nanotechnology. | | |
| Graduate Attributes (as per NBA):<br>• Engineering Knowledge.<br>• Problem Analysis.<br>• Design / development of solutions (partly).<br>• Interpretation of data. | | |
| Question paper pattern:<br>• The question paper will have ten questions.<br>• Each full Question consisting of 16 marks<br>• There will be 2 full questions (with a maximum of four sub questions) from each module.<br>• Each full question will have sub questions covering all the topics under a module.<br>• The students will have to answer 5 full questions, selecting one full question from each module. | | |
| TEXT BOOKS:<br>1. Daniel Minoli, Nanotechnology applications to telecommunications and networking, John Wiley & Sons, 2013.<br>2. M. H. Fulekar, Nanotechnology importance and applications, I. K. International Publishing House Pvt. Ltd., New Delhi, 2013. | | |

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
B.E. Nano Technology

| Nanomaterials and their applications<br>[As per Choice Based Credit System (CBCS) scheme]<br>(Effective from the academic year 2015 -2016)<br>Course: B.E. / Nano Technology<br>Semester: V | | | |
|---|---|---|---|
| Subject Code | 15NT562 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 03 | Exam Marks | 80 |
| Total Number of Lecture Hours | 40 | Exam Hours | 03 |
| CREDIT - 03 | | | |

Course Objective:
To understand the importance of nanomaterials and their applications in
Electrical and electronics
Biomedical and pharmaceutics
Chemical industry
Food industry and Agriculture
Textile and Cosmetics

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>NANOMATERIALS FOR ELECTRICAL AND ELECTRONICS APPLICATIONS<br>Advantages of nano electrical and electronic devices –Integrated Circuits – Lasers - Micro and NanoElectromechanical systems – Sensors, Actuators, Optical switches, Bio-MEMS –Diodes and Nano-wire Transistors -Data memory –Lighting and Displays – Organic electroluminescent displays – Quantum optical devices – Batteries - Fuel cells- Photo-voltaic cells – Electric double layer capacitors – Lead-free solder – Nanoparticle coatings for electrical products | 08 | L1, L2 |
| Module 2:<br>NANOMATERIALS FOR BIOMEDICAL AND PHARMACEUTICAL APPLICATIONS<br>Nanoparticles in bone substitutes and dentistry – Implants and Prosthesis - Reconstructive Intervention and Surgery – Nanorobotics in Surgery – Photodynamic Therapy - Nanosensors in Diagnosis– Neuro-electronic Interfaces –Protein Engineering – Drug delivery – Therapeutic applications | 08 | L1, L2, L3 |
| Module 3:<br>NANOMATERIALS FOR CHEMICAL INDUSTRY<br>Nanocatalyts – Smart materials – Heterogenous nanostructures and composites – $TiO_2$ Nanoparticles for water purification-Photocatalytic mechanism, general pathways and kinetics- | 08 | L1, L2, L3 |

| | | |
|---|---|---|
| Treatment of Arsenic- Removal of Heavy metal ions by Iron and polymeric based nanoparticles- Magnetic Nanoparticles Nanoscale carbon for contaminant separation -Nanostructures for Molecular recognition (Quantum dots, Nanorods, Nanotubes) – Molecular Encapsulation and its applications – Nanoporous zeolites – Self-assembled Nanoreactors | | |
| Module 4:<br>APPLICATIONS OF NANOMATERIALS IN AGRICULTURE AND FOOD TECHNOLOGY<br>Nanotechnology in Agriculture -Precision farming, Smart delivery system – Insecticides using nanotechnology –Potential of nano-fertilizers – Nanotechnology in Food industry - Packaging, Food processing - Food safety and biosecurity – Contaminant detection – Smart packaging | 08 | L1, L2, L3, L4 |
| Module 5:<br>NANOMATERIALS FOR TEXTILES AND COSMETICS APPLICATIONS<br>Nanofibre production - Electrospinning – Controlling morphologies of nanofibers – Tissue engineering application – Polymer nanofibers - Nylon-6 nanocomposites from polymerization - Nano-filled polypropylene fibers -Bionics– Swim-suits with shark-skin-effect, Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, antibacterial, hydrophilic, self-cleaning, flame retardant finishes) –<br>Modern textiles; Lightweight bulletproof vests and shirts, Colour changing property, Waterproof and Germ proof, Cleaner kids clothes, Wired and Ready to Wear.<br>Cosmetics – Formulation of Gels, Shampoos, Hair-conditioners (Micellar self-assembly and its manipulation) –Sun-screen dispersions for UV protection using Titanium oxide – Color cosmetics | 08 | L1, L2, L3, L4 |
| Course Outcome:<br>After completion of this course students will be able to identify and apply different nanomaterials for the following applications<br>Electrical and electronics<br>Biomedical and pharmaceutics<br>Chemical industry<br>Food industry and Agriculture<br>Textile and Cosmetics | | |
| Graduate Attributes (as per NBA):<br>• Engineering Knowledge.<br>• Problem Analysis.<br>• Design / development of solutions (partly).<br>• Interpretation of data. | | |
| Question paper pattern:<br>• The question paper will have ten questions.<br>• Each full Question consisting of 16 marks | | |

- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:
1. Bharat Bhushan, "Handbook of Nanotechnology", Springer, 2010.
2. Jennifer Kuzma and Peter VerHage, "Nanotechnology in agriculture and food production", Woodrow Wilson International Center, 2006.
3. Brown P. J. and K. Stevens, "Nanofibers and Nanotechnology in Textile"s, Woodhead Publishing Limited, Cambridge, 2007.

REFERENCE BOOKS:
1. Neelina H. Malsch (Ed.), "Biomedical Nanotechnology", CRC Press, 2005.
2. Maqhong fan, C.P. Huang, Alan E. Bland "Environanotechnology",Elsevier,2010
3. Udo H. Brinker, Jean-Luc Mieusset (Eds.), "Molecular Encapsulation: Organic Reactions in Constrained Systems",Wiley Publishers, 2010
4. Lynn J. Frewer, WillehmNorde, R. H. Fischer and W. H. Kampers "Nanotechnology in the Agri-food sector",Wiley-VCH Verlag,2011.
5. Y-W. Mai, "Polymer Nano composites", Woodhead publishing, 2006.
6. Mark A. Ratner and Daniel Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", Pearson ,2003
7. W.N. Chang, "Nanofibres fabrication, performance and applications", Nova Science Publishers Inc, 2009

**Nanodevices and Applications**
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2015 -2016)
Course: B.E. / Nano Technology
Semester: V

| | | | |
|---|---|---|---|
| Subject Code | 15NT563 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 03 | Exam Marks | 80 |
| Total Number of Lecture Hours | 40 | Exam Hours | 03 |

CREDIT - 03

Course Objective:
To understand the fundamental concepts of nanosensors and devises
To understand the working and circuitry of nanosensors and devices

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1: | 08 | L1, L2 |

| | | |
|---|---|---|
| MODULE 1: Fundamentals of nanosensor devices<br>Micro and nano-sensors, biosensor. Thermal energy sensors: temperature sensors, heat sensors, electromagnetic sensors, electrical resistance sensors, electrical current sensors, electrical voltage sensors, electrical power sensors, magnetic sensors, Mechanical sensors, pressure sensors, gas and liquid flow sensors, position sensors, chemical sensors, optical and radiation sensors-gas sensor. | | |
| Module 2:<br>Nano based Inorganic Sensor devices<br>Density of states (DOS) – DOS of 3D, 2D, 1D and 0D materials, one dimensional gas sensors:- gas sensing with nanostructured thin films, absorption on surfaces, metal oxide modifications by additives, surface modifications, Nano optical sensors, nano mechanical sensors, plasmon resonance sensors with nano particles, AMR, Giant and colossal magnetoresistors, magnetic tunnelling junctions. | 08 | L1, L2, L3 |
| Module 3:<br>Nanoelectromechanical Systems (NEMS)<br>Introduction- Nano machining of NEMS based upon electron beam lithography, Nano electromechanical systems fabrication, nano imprint lithography, polymeric nanofiber templates, focused ion beam doping wet chemical etching, stencil lithography and sacrificial etching, large scale intergration, future challenges, applications. | 08 | L1, L2, L3 |
| Module 4:<br>Nanoparticles for Sensors and Circuitry<br>Photoinduced Electron Transport in DNA: Electronic Devices Based on DNA Architecture, DNA Nanowires, Charge Transport, DNA-Based Nanoelectronics, Electrical Manipulation of DNA on Metal Surfaces, Nanostructured Biocompartments, DNA-Gold nanoconjugates. Applications of alldevices. | 08 | L1, L2, L3, L4 |
| Module 5:<br>Nano-Biological Sensor devices<br>Noninvasive Biosensors in Clinical Analysis. Applications of Biosensor-based instruments for the bioprocess industry. Application of Biosensors for environmental samples. Introduction to Biochips and their application to genomics. BIAcore, an optical Biosensor. | 08 | L1, L2, L3, L4 |
| Course Outcome:<br>After completion of this course students can able<br>To learn the fundamental concepts of nanosensors and devises<br>To understand the working and circuitry of nanosensors and devices | | |
| Graduate Attributes (as per NBA):<br>• Engineering Knowledge. | | |

- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. KouroushKalantar – Zaheb, Benjamin Fry, Nanotechnology enabled sensors, Springer Verlag, New York, 2007
2. Jerome Schults, MilarMrksich, Sangeeta N. Bhatia, David J. Brady, Antionio J. Ricco, David R. Walt, Charles L. Wilkins,, Biosensing: International Research and Developments, Spinger, 2006
3. Ramon Pallas – Areny, John G. Webster John, Sensors and signal conditioning, 2nd edition, Wiley & Sons, 2001
4. Karl Glosekotter, Nanoelectronics and Nanosystems, Springer, 2004

REFERENCE BOOKS:

1. Handbook of Biosensors and Electronic Noses: Medicine, Food and the Environment: CRC-Press, 1st Edition, 1996
2. D. L. Wise, Biosensors: theory and applications, CRC Press, 1993
3. Rao and Gupta, Principles of Medical Electronics and Biomedical Instrumentation, Orient Longman, 2001
4. H. Fujita, Micromachines as tool for Nanotechnology, Springer, 2003

**Nanomaterials Synthesis and Characterization Techniques**
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2015 -2016)
Course: B.E. / Nano Technology
Semester: V

| | | | |
|---|---|---|---|
| Subject Code | 15NT564 | IA Marks | 20 |
| Number of Lecture Hours Per Week | 03 | Exam Marks | 80 |
| Total Number of Lecture Hours | 40 | Exam Hours | 03 |
| CREDIT – 03 | | | |

Course Objective:
To provide students with the knowledge of techniques used for synthesis and characterization of nanomaterials

| Modules | Teaching | Revised |
|---|---|---|

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM**
**CHOICE BASED CREDIT SYSTEM (CBCS)**
B.E. Nano Technology

| | Hours | Bloom's Taxonomy (RBT) Level |
|---|---|---|
| Module 1:<br>Top Down Approaches<br>Synthesis and nanofabrication, Bottom-Up versus Top-Down; Top-down approach with examples, Ball milling synthesis, Arc discharge, RF-plasma, Plasma arch technique, Inert gas condensation, electric explosion of wires, Ion sputtering method, Laser pyrolysis, Molecular beam epitaxy and electrodeposition. Electro spinning, Physical vapor Deposition (PVD) – Chemical vapour Deposition (CVD) - Atomic layer Deposition (ALD). | 08 | L1, L2 |
| Module 2:<br>Bottom Up Approaches<br>Chemical precipitation methods-co-precipitation, arrested precipitation, sol-gel method, chemical reduction, photochemical synthesis, electrochemical synthesis, Microemulsions or reverse micelles, Sonochemical synthesis, Hydrothermal, solvothermal, supercritical fluid process, solution combustion process, spray pyrolysis method, flame spray pyrolysis, chemical vopour synthesis, gas phase synthesis, gas condensation process, chemical vapour condensation. | 08 | L1, L2, L3 |
| Module 3:<br>Biological Synthesis<br>Biosynthesis of nano particles by bacteria and fungi (intracellular and extracellular synthesis). Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation of nanostructured materials by virus - TMV virus; Synthesis process and application, Role of plants in nanoparticle synthesis – marigold, tulsi and aloevera. | 08 | L1, L2, L3 |
| Module 4:<br>Characterization Techniques - I<br>Introduction, Structural and compositional characterization-principles and applications of X-ray diffraction, X-ray photoelectron spectroscopy, Energy dispersive X-ray analysis, electron diffraction. Optical microscopy- Use of polarized light microscopy – Phase contrast microscopy – Interference Microscopy – hot stage microscopy - surface morphology – Etch pit density and hardness measurements. | 08 | L1, L2, L3, L4 |
| Module 5:<br>Characterization Techniques - II<br>Scanning Electron Microscopy (SEM): Principle, Components, Advantages, Disadvantages and Applications, Transmission Electron Microscopy (TEM): Principle, Components and Applications, Atomic | 08 | L1, L2, L3, L4 |

| | | |
|---|---|---|
| Force Microscopy (AFM): Principle, Components and Applications, Scanning Tunneling Microscopy (STM): Principle, Components and Applications, microstructure studies and analysis. Nano size measurement by light scattering methods. | | |

Course Outcome:

On completion of this course, students should be able to:

- Experiment Top-down approaches: physical techniques used for synthesis and processing of nanomaterials
- Analyze Bottom-Up Approaches: chemical methods used for synthesis and processing of nanomaterials
- Select biological methods used for synthesis and processing of nanomaterials;
- Test Characterization of nanoparticels

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Microbiology by Michael J Pelczar Jr Chan ECS, Noel R Krieg, Tata McGraw Hill Publishing co Ltd
2. Microbiology by Prescott, Harley, Klein, McGraw Hill
3. Lehninger - Principles of Biochemistry by David L. Nelson and Michael M. Cox, 5th Edition, WH Freeman and Company
4. Principles of Biochemistry by LubertStryer, Freeman Int. Edition

REFERENCE BOOKS:

1. T. Pradeep, “NANO The Essential, understanding Nanoscience and Nanotechnology”. Tata McGraw - Hill Publishing Company Limited, 2007
2. C. A. Mirkin and C. M. Niemeyer, Nanobiotechnology - II, More Concepts and Applications, WILEY-VCH, Verlag GmbH & Co, 2007

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
B.E. Nano Technology

| Nano Materials Synthesis Lab<br>[As per Choice Based Credit System (CBCS) scheme]<br>(Effective from the academic year 2015 -2016)<br>Course: B.E. / Nano Technology<br>Semester: V | | | |
|---|---|---|---|
| Laboratory Code | 15NTL57 | IA Marks | 20 |
| Number of Lecture Hours/Week | 01Hr Tutorial + 02 Hrs Laboratory | Exam Marks | 80 |
| | | Exam Hours | 03 |
| CREDIT – 02 | | | |
| Course Objective:<br>• To understand the chemical approach to synthesize nano particles.<br>• To synthesize nano materials by various chemical methods. | | | |
| List of Experiments | | | Revised Bloom's Taxonomy (RBT) Level |
| 1. Synthesis of Ferro fluids by chemical method | | | L2,L4,L5 |
| 2. Synthesis of Ag metal nano particles by Chemical reduction method | | | L2,L3,L4 |
| 3. Synthesis of $TiO_2$nano particles by Solvothermal method. | | | L2,L3,L4 |
| 4. Synthesis of $Fe_2O_3$ nano particles by Co-precipitation method | | | L5,L6 |
| 5. Synthesis of $Mn_3O_4$ nano particles by Co-precipitation method | | | L5,L6 |
| 6. Synthesis of Au metal nano particles by Chemical reduction method | | | L2,L3,L4 |
| 7. Synthesis of ZnS/MoSnano particles by microwave Solvothermal method | | | L5,L6 |
| 8. Synthesis of $Fe_3O_4$ nano particles by chemical reduction method | | | L2,L3,L4 |
| 9. Synthesis of CuOnano particles by reverse microemulsion method | | | L2,L3,L4 |
| 10. Synthesis of $MoS_2$ nano particles by ultra-sonication method. | | | L5,L6 |
| 11. Synthesis of monodisperse copper nano particles by chemical reduction method. | | | L5,L6 |
| 12. Synthesis of CdS by chemical method | | | L2,L3,L4 |
| 13. Synthesis of nano crystalline AgS | | | L2,L3,L4 |
| 14. Synthesis of ZnO by chemical method | | | L2,L3,L4 |
| 15. Green synthesis of Ag nano particles | | | L2,L3,L4 |
| Course Outcome:<br>Students can able to learn the different techniques to synthesis nano materials. | | | |
| Graduate Attributes (as per NBA):<br>• Engineering Knowledge.<br>• Problem Analysis.<br>• Design / development of solutions (partly). | | | |

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| • Interpretation of data. |
| Question paper pattern:<br>• The question paper will have ten questions.<br>• Each full Question consisting of 16 marks<br>• There will be 2 full questions (with a maximum of four sub questions) from each module.<br>• Each full question will have sub questions covering all the topics under a module.<br>• The students will have to answer 5 full questions, selecting one full question from each module. |
| REFERENCE BOOKS:<br>1. Lab manual |

| Characterization and Measurement Lab<br>[As per Choice Based Credit System (CBCS) scheme]<br>(Effective from the academic year 2015 -2016)<br>Course: B.E. / Nano Technology<br>Semester: V | | | |
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| Laboratory Code | 15NTL58 | IA Marks | 20 |
| Number of Lecture Hours/Week | 01Hr Tutorial + 02 Hrs Laboratory | Exam Marks | 80 |
| | | Exam Hours | 03 |
| CREDIT - 02 | | | |
| Course Objective:<br>• To understand the mechanical, optical, magnetic, thermal, ionic and electromagnetic properties of materials and semiconductors when they experience external fields like electric field and magnetic field.<br>• To determine the thickness of thin films, working of a solar cell and also to identify the unknown materials. | | | |
| List of Experiments | | | Revised Bloom's Taxonomy (RBT) Level |
| 1. Determination of electromagnetic properties of N-type and P-type semiconductors. | | | L2,L4,L5 |
| 2. Determination of ionic conductivity of a given sample. | | | L2,L3,L4 |
| 3. Determination of thermal conductivity of thin films. | | | L2,L3,L4 |
| 4. Determination of optical properties of a given sample. | | | L5,L6 |
| 5. Measurement of mechanical properties of a given sample. | | | L5,L6 |
| 6. Determination of magnetic properties of a given liquid sample. | | | L2,L3,L4 |
| 7. Determination of efficiency of a given solar cell. | | | L5,L6 |
| 8. Determination of ultrasonic sound velocity of given liquid | | | L2,L3,L4 |

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| samples. | |
| 9. Identification of unknown sample by arc spectrum method. | L2,L3,L4 |
| 10. Resistivity determination for a semiconductor wafer using Four probe method. | L5,L6 |
| 11. To trace the hysteresis loop for a magnetic material. | L5,L6 |
| 12. Determination of wavelength of the given LED. | L2,L3,L4 |
| 13. Measurement of thickness of a given thin film by air wedge method. | L2,L3,L4 |

Course Outcome:

• Students can able to understand the materials behaviour like mechanical, optical, electrical, thermal, ionic and electromagnetic properties at micro scale level.

• Students can also learn effect of temperature, electric field and magnetic fields on the different types of materials.

• Students can also learn the materials behaviour with respect to the change in voltage and magnetic field.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Lab manual