Syllabus for Seventh Semester UG degree in

B.Tech.Biotechnology

Submitted to

RTMNU, Nagpur

By

Board of B.Tech. Biotechnology

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Science and Technology,
R.T.M. Nagpur University, Nagpur.
Syllabus for B.Tech. Biotechnology
(Seventh Semester)

Subject: Intellectual Property Rights (IPR) & Regulatory (BT-PC-701 T)

Total credits: 02
Teaching Scheme:
Lectures: 2 Hours/Week
Tutorial: Nil

Examination Scheme:
Duration of Paper: 02 Hours
University Assessment: 35 Marks
College Assessment: 15 Marks

Course Objective(s): To disseminate knowledge on patents, patent regime in India and abroad and registration aspects. To make students aware about current trends in IPR and Govt. supports in promoting IPR. To classify the role of regulatory committees in controlling the risk.

Course Contents:

Unit 1: Intellectual Property Rights: Introduction and the need for intellectual property right (IPR)-Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication.

Unit 2: Trade Secret-IPR in India: Genesis and development, IPR in abroad, Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention,1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994 India`s New National IP Policy, 2016. Govt. of India step towards promoting IPR, Govt. Schemes in IPR, Career Opportunities in IPR, IPR in current scenario with case studies.

Unit 3: Public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalization and development divide. Ethical dimensions of IPR, technology transfer and other global biotech issues.

Unit 4: Regulations on ethical principles in biomedical/ biotechnological practice: Nuremberg code, declaration of Helsinki; the Belmont report, co-operational guidelines, WHO, guidelines of DBT (India), Guidelines of an informed consent Rights/ protection, infringement or violation, remedies against infringement, civil and criminal. Biosafety regulations in the handling of

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recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad.

Text Books/References:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3. V Sreekrishna, 2017. Bioethics and Biosafety in Biotechnology by New Age International publishers.

E-resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. World Intellectual Property Organization. (2004). WIPO Intellectual Property Handbook. (https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf)

Course Outcomes:

CO 1: The students shall get an adequate knowledge on patent and copyright. This provide further way for developing their idea or innovations.
CO 2: The students shall identify the role of regulatory committees in controlling the risk.
CO 3: Students should get enough information on ethical issues linked to Biotechnology sector.
CO4: Students shall apply the knowledge of regulations on ethical principles in biotechnological practices and bio-safety measures.

Dr. S.G. Suke

Subject: Data analysis and Simulations (BT-PC-702 T)

Total credits: 04
Teaching Scheme:
Lectures: 3 Hours/Week
Tutorial: 1 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): To facilitate the learner to introduce to process modelling fundamentals and solve simultaneous linear and non linear algebraic equations, fit the experimental data in standard function and obtain solutions to Ordinary Differential Equations and Partial Differential Equations to analyze the experimental data.

Course Contents:

Unit 1: Introduction to Process modeling: Attributes of mathematical model, Basic Principles of Modelling, Concept of mass balance and energy balance, Mathematical formulation of process.

Unit 2: Solutions to simultaneous linear and nonlinear algebraic equations: Newton Raphson Method, Bisection Method, Secant Method, Regula Falsi Method, Matrix methods, Gauss Seidel Method, Gauss Elimination Method, Gauss Jordon method.

Unit 3: Curve Fitting Techniques: To compute constants and regression coefficient for function (straight line function, exponential function, Logarithmic function, polynomial function and hyperbolic function) developed for various processes.

Unit 4: Solutions to Ordinary Differential Equations and Partial Differential Equations: Euler method, Runge Kutta Method and Heun Method used for solving Initial value problem and Methods like shooting method, crank Nicholson method and finite difference method used for solving Boundary Value Problem.

Unit 5: Data Analysis: To compute mean, median, variance and standard deviation, Statistical analysis, Hypothesis testing, Significance of p-value, chi-square, T-test.

Text Books/References:

Text Books:

1) J. D. Hofman, Numerical Methods for Engineers and Scientists, McGraw-Hill, New York, 1992.
2) Applied Mathematics for Chemical Engineers, H.S. Mickley, T. K. Sherwood, C.E. Reed, and McGraw Hill.

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3) Introductory numerical methods of numerical analysis. S. S. Shastri, Prentice Hall.
4) Mathematical Methods in Chemical Engineering, V.G. Jenson & G. V. Jeffrey, Academic Press.
5) Data Visualization – A Practical Introduction by Kieran Healy, Princeton University Press 2019.

Reference Books:

1) Deep Learning – Rajiv Chopra, Khanna Publishing House, 2019.
2) Deep Learning by Ian Goodfellow, Yoshua Bengio, MIT Press 2017.

Course Outcomes: After completion of the course, students will be able to:

CO 1: Acquire fundamental knowledge of process modeling.

CO 2: Solve linear and non linear algebraic equations.

CO 3: Fit the experimental data in standard functions and find regression coefficient.

CO4: Solve ordinary and partial differential equations having initial and boundary conditions.

CO 5: Test the hypothesis and analyze the data.

Dr. S.G. Sukre

Subject: Gene Expression and Transgenic (BT-PE-703i T)
[Professional Elective-III]

Total credits: 04
Teaching Scheme:
Lectures: 3 Hours/Week
Tutorial: 1 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): The course will provide the technical details and use of different gene expression systems for over expression of recombinant proteins and model organisms for protein expression. The course will also provide details about the strategies, methodologies and screening of transgenic. The course will teach about the generation of transgenic animals and plants for research and societal application.

Course Contents:

Unit 1: Overview of recombinant protein expression vectors and promoters, Vectors with tags His, GST, MBP, GFP, Vectors fortag free protein expressions. Cleavable tag and non-cleavable tags, Purification of tagged and tag-free proteins.

Unit 2: Gene expression analysis in selected model systems (Zebra fish, *Drosophila melanogaster*, *Bacillus subtilis, Arabidopsis thaliana)* Over expression in *E. coli*, *B. subtilis*, Corynebacterium, *Pseudomonas fluorescens*, yeasts like *S. cerevisiae* and *Pichia pastoris.*

Unit 3: Mammalian cell line like Chinese Hamster ovary (CHO) and Human embryonic kidney (HEK), Methods for creation of transgenic animals-DNA microinjection, Embryonic stem cell-mediated gene transfer, Retrovirus-mediated gene transfer.

Unit 4: Plant single cell. Chloroplast transformation and protein expression in chloroplasts. Strategies and methodologies of screening, selection, verification and characterization of transformed tissues of plants, regulation of gene expression and gene silencing in plants.

Unit 5: Transgenic farm animals, poultry birds and fishes for vaccine development, production of growth hormones and other commercial products; improving the nutritional quality of milk and meat by transgenic approach. Transgenic mammals for gene therapy, silencing of specific endogenous gene and concept of gene targeting.

Dr. S. G. Suke

Text Books/References:

1. Gene Expression Systems, Using Nature for the Art of Expression. Edited by Joseph M. Fernandez and James P. Hoeffler.
2. Regulation of Gene Expression, By Perdew, Gary H., Vanden Heuvel, Jack P., Peters, Jeffrey M. Springer.
3. Prokaryotic Gene Expression. Edited by Simon Baumberg. Oxford Press.
4. Transgenic Animal Technology,3rd Edition, A Laboratory Handbook by Carl Pinkert. Elsevier.
5. Ethical Use of Transgenic Animals (English, Paperback, Shah Krunal V). Lambert publication.
6. Transgenic Animals as Model Systems for Human Diseases. Edited E. F. Wagner F. Theuring. Springer.

Course Outcomes: At the end of this course the students will able to:

CO1: Illustrate the various vector and system used for protein expression and purification of protein.
CO2: Apply the knowledge of appropriate model organism for gene expression.
CO3: Acquire the knowledge of the cell line and various methods to create animal transgenic.
CO4: Illustrate the construction of plant transgenic by understanding different strategies.
CO5: Evaluate the different applications of transgenic.

Dr. S.G. Sukre

Subject: Bioprocess Equipment Design (BT-PE -703iiT)
[Professional Elective-III]

Total credits: 04
Teaching Scheme:
Lectures: 03 Hours/Week
Tutorial: 01 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): To acquire basic understanding and knowledge of design parameter& design procedures for commonly used bioprocess equipment and their attachments and also economic consideration for process development

Course Contents:

Unit 1: Design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate contactors and plate hydraulic design.

Unit 2: Design principles of bioreactors, Geometric configuration, flanges, nozzles, gaskets, supports, piping, jackets and coils etc.

Unit 3: Design of Accessories for bioreactors: agitators, aerators, air filters, stabilizers. Power requirement.

Unit 4: Heat Exchangers: Codes and standards for heat exchangers, materials of construction, baffles and tie rods, tube joining methods, Design of shell and tube heat exchangers. Design of heat exchange equipments such as evaporator, plate type heat exchanger, bayonet heat exchanger.

Unit 5: Scale up of bioreactors, safety measures in bioreactors. Material for construction of bioreactors and selection criteria. Cost estimation methods and economic evaluation of projects.

Text Books/References:

1. Handbook of Chemical Engineering. J. H. Perry, Section 25 on Process Economics-1974.
2. Fundamentals of Cost Engineering – M. C. Bourman
3. Chemical Economics – Happel and Jourdon.
4. Applied Project Management – Ludwig.
5. Plant Design and Economics for Chemical Enginers Peters and Timmermans.
6. Process Economics –Schwayer.

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7. Khanna, O. P., "Industrial Engineering and Management", Khanna Publishers.

Course Outcomes: At the end of this course the students will able to:

CO 1: Demonstrate the various design variables in distillation, design methods for binary system.

CO 2: Acquire the knowledge of basics design of bioreactors.

CO 3: To design Accessories for bioreactors

CO 4: Design the heat exchanger equipments and internal accessories.

CO 5: Evaluate scale up of bioreactor and its economic evaluation.

Dr. S.G. Suke

Subject: Animal Tissue culture Technology (BT-PE-703iii T)
[Professional Elective-III]

Total credits: 04
Teaching Scheme:
Lectures: 03 Hours/Week
Tutorial: 01 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): To impart the knowledge of the various Animal Cell culture techniques, bioreactor design for mammalian cell culture & induce the latest developments in animal cell culture Technology.

Course Contents:

Unit 1: Introduction to the balanced salt solutions and simple growth medium. Serum & protein free defined media and their application, Medium Optimization. Measurements of cell death. Biology and characterization of the cultured cells: measuring parameters of growth, Cell Synchronization, Senescence and apoptosis, Measurement of viability and cytotoxicity.

Unit 2: Basic techniques of mammalian cell culture: disaggregation of tissue and primary culture, maintenance of cell culture, Scale-up (Scale-up of anchorage dependent cells: Roller Bottles and microcarriers, Scale-up of anchorage dependent cells: hollow fibre technology, Scale-up of suspension cultures: Spinner flasks and stirred tank bioreactors).

Unit 3: Mass transfer in mammalian cell culture, Cell cloning and micromanipulation, Cell transformation, stem cell isolation and cultures, cryopreservation and transport of germplasm. FISH & application of animal cell culture.

Unit 4: Embryo transfer and transgenic animals: Artificial insemination, Superovulation, Embryo transfer, *In vitro* fertilization-Pregnancy diagnosis-Sexing of embryos, Embryo splitting; Cryopreservation of embryo; Animal as bioreactors. Discussion about current developments in animal biotechnology.

Unit 5: Animal farming, Organ Culture, Regenerative Medicine, Stem Cell research, Manipulation of Growth hormone, Ethical issues in animal biotechnology.

Dr. S. G. Syke

Text Books/References:

1. Culture of Animal Cells, (3rd Edition), F1. Ian Freshney. Wiley-Liss.
2. Animal Cell Culture – Practical Approach, Ed. John R.W. Masters, OXFORD.
3. Animal Cell Culture Methods- Leslie Wilson, Paul T. Matsudaira, Jennie P. Mather, David Barnes. Academic Press, 1998
4. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
5. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P. Mather and David Barnes. Academic Press.
6. Cell Growth and Division: A Practical Approach. Ed. R. Basega, IRL Press.

Course Outcomes: At the end of this course the students will able to:

CO 1: Learn about the various Animal Cell culture techniques

CO 2: Impart the knowledge of bioreactor design for mammalian cell culture.

CO 3: Cultivate the knowledge of Cell cloning and micromanipulation

CO 4: Demonstrate the latest developments in various techniques for animal cell culture.

CO 5: Demonstrate the applications of animal culture technology in various fields.

Dr. S.G. Suke

Subject: Precision Medicine & Wellness (BT-PE-704i T)
[Professional Elective-IV]

Total credits: 04
Teaching Scheme:
Lectures: 03 Hours/Week
Tutorial: 01 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): The objective of this course is to provide the students with understanding and use of modern omics techniques and systems biology in providing personalized medicine and preventive health care.

Course Contents:

Unit 1: Use of genomics, transcriptomics, proteomics and metabolomics in understanding disease condition. Biomarker identification and validation of a disease state.

Unit 2: Human Genome project. Cancer genome project. Different types of genetic and nongenetic variations.

Unit 3: Genetic screening and diagnosis: prenatal carrier testing and newborn screening for Mendelian diseases. Pharmacogenomic testing for drug selection, dosingand predicting adverse effects of commonly prescribed drugs,

Unit 4: Tumor profiling, Patient data and clinical decisions. Risk assessment through omics approach.

Unit 5: Ethical, legal, and social implications of health privacy and policy laws for precision medicine. Ayurveda system of *Prakriti* and *Agni*.

Text Books/References:

1. National Institute of General Medical Sciences. The New Genetics. Bethesda, MD: U.S. Department of Health and Human Services.
2. Genomic and Precision Medicine, Geoffrey Ginsburg and Huntington Willard,
3. The Language of Life: DNA and the Revolution in Personalized Medicine, Francis S. Collins.
4. Handbook of Biomarkers and Precision Medicine. Claudio Carini, Mark Fidock, Alain van Gool. Chapman and Hall/CRC; 1st edition

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Course Outcomes: At the end of this course the students will be able to:

CO1: Apply the knowledge of Genomics, Proteomics and different types of diagnostic biomarkers.

CO2: Interpret variation in genome structure and sequence in the context of physiological function and disease and across human populations.

CO3: Explain the recent advances in disease risk prediction, molecular diagnosis and progression of diseases, and targeted therapies.

CO4: Demonstrate the precision medicare and preventive care system using modern omics tools.

CO5: Apply ethical, social, and legal issues related to personalized medicine.

Dr. S.G. Sykes

Subject: Cryogenic Application in Biotechnology (BT-PE-704ii T)
[Professional Elective-IV]

Total credits: 04
Teaching Scheme:
Lectures: 03 Hours/Week
Tutorial: 01 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): To introduce students the fundamentals of Cryogenics and its present areas, basic thermodynamicsapplied to liquefaction and refrigeration process etc. To give detail ideas to the students of cryogenic processes relate to the production and utilization oflow temperatures, production of cryogens and their storage, transport and consumption and to make aware the different applications of cryogenics in biotechnology field such as cryogenics inbiology, medicine, food processing etc.

Course Contents:

Unit 1: Introduction: Historical development and milestones in cryogenic applications. Basic thermodynamics applied to liquefaction and refrigeration process. Low temperature properties of engineering materials: Mechanical properties, thermal properties, electrical and magnetic properties. Properties of cryogenic fluids.

Unit 2: Gas liquefaction systems: production of low temperatures, Joule Thomson expansion process, general liquefaction systems, liquefaction systems for Air, neon, hydrogen, nitrogen, and helium. Critical components of liquefaction systems.

Unit 3: Cryogenic Refrigeration systems: Ideal refrigeration systems, refrigerators using liquids and gases as refrigerants, Adiabatic demagnetization, refrigerators using solids as working media.

Unit 4: Gas separation-principles of rectification, flash calculations. Thermal insulations and their performance at cryogenic temperatures. Cryogenic storage and transfer systems: Cryogenic fluid storage vessels, cryogenic fluid transfer systems.

Unit 5: Effect of ultra-low temperature on plants and animal tissue, microorganism, biomolecules, lyophilization of cells and products. Application of cryogenics: Cryo-pumping, cryobiology, cryogenics in space technology, food processing, cryogenics in biology, medicine Biomedical and Pharmaceutical Fields and recent applications.

Dr. S. G. Sayke

Text Books/References:

1. Barron, Randel F., Cryogenic Systems, Oxford University Press, 1985.
2. Dinnerhaos, Q. D., Cryogenic Engineering, McGraw Hill Book Co., 1987.
3. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press, 1989.
4. Hasdden, G. G. Cryogenic Fundamental, Academic Press, 1971.
5. Martia Donabedian. Survey of Cryogenic Cooling Techniques.
6. Arora C P, "Refrigeration and Air Conditioning", 19th Edition, Tata McGraw Hill, Delhi (1985).
7. Pradad M, "Refrigeration and Air Conditioning", 2nd Edition, New Age International Private Limited, Delhi (2002).
8. Jordan and Prister, "Refrigeration and Air Conditioning", Prentice Hall of India (1998).

Course Outcomes: On completion of the course the students will be able to:

CO 1: Apply thermodynamics principles and to assess the low temperature properties of engineering materials.

CO 2: Analyze and compare different gas liquefaction systems for various gases and the critical components involved.

CO 3: Apply the knowledge of the cryogenic refrigerators using liquids and gases as refrigerants and solids as working media.

CO4: Demonstrate the principles of gas separation, thermal insulation, cryogenic storage, and transfer systems.

CO 5: Explore the diverse applications of cryogenics in various fields.

Dr. S.G. Sukre

Subject: Renewable Energy (BT-PE-704iii T)
[Professional Elective-IV]

Total credits: 04
Teaching Scheme:
Lectures: 03 Hours/Week
Tutorial: 01 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): To impart knowledge in the recent developments in Energy Sector with emphasis on Renewable Energy including resource assessment, energy harnessing process for various application including power generation.

Course Contents:

Unit 1: Need of sources of renewable energy: Introduction to different sources of renewable energy, e.g., Solar Energy, Wind Energy, Bio-mass, Geothermal Energy, Ocean energy, Solar Energy and Applications.

Unit 2: Bioenergy: Types and availability of biomass resources, various methods of biomass utilisation for energy generation: gasification, briquette, palatization, syn-gas, Anaerobic/Aerobic digestion, types of Bio-gas digesters, Combustion characteristics of biogas and its different utilizations

Unit 3: Ethanol: Ethanol as Biofuel, Process technology for production of ethanol from sugar, starch and Lignocellulosic biomass, Cultivation and Harvesting of dedicated energy crops.

Unit 4: Biodiesel: Biodiesel as fuel, Chemistry of Biodiesel, Process technology and biodisel production, Edible and nonedible source of Biodiesel, Cultivation and harvesting of oil seeds.

Unit 5: Fuel Cells and Hydrogen Energy: Introduction, principle of fuel cells, , types of fuel cells, fuel cell batteries, applications of fuel cells. Hydrogen as a renewable energy source, sources of hydrogen, fuel for vehicles, hydrogen production- direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production.

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Text Books/References:

1. Leon Freris, David Infield, "Renewable Energy in Power Systems", Wiley, 2008.
2. Biofuel Technology Handbook - Dominik Rutz, Rainer Janssen WIP Renewable Energies
3. Tiwari, G. N., & Ghosal, M. K. (2007). Fundamentals of renewable energy sources. Alpha Science International Limited.
4. Mukherjee, D., & Chakrabarti, S. (2004). Fundamentals of renewable energy systems. New Age International.
5. Kothari, D. P., Singal, K. C., & Ranjan, R. (2011). Renewable energy sources and emerging technologies. PHI Learning Pvt. Ltd

Course Outcomes: At the end of this course the students will be able to:

CO1: Explain the basic principles of various renewable energy conversion processes and devices used therein.

CO2: Categorize various bioenergy that influences the performance of renewable energy devices/processes.

CO3: Apply the knowledge of production of ethanol from biomass as biofuel.

CO4: Illustrate produce the biodiesel using fat containing biomass.

CO5: Describe the fuel cells and hydrogen as a renewable energy source.

Dr. S.G. Sulke

Subject: Virtual Reality (BT-OS-705i T)
[Open Subject-III]

Total credits: 03
Teaching Scheme:
Lectures: 03 Hours/Week
Tutorial: Nil

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): The objective of this course is to provide a detailed understanding of the concepts of Virtual Reality and its applications.

Course Contents:

Unit 1: Introduction to Virtual Reality: Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark.3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

Unit 2: Geometric Modelling: Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation. Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection. Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

Unit 3: Virtual Environment: Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape& object in between, free from deformation, particle system.Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Unit 4: VR Hardware and Software: Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML.

Unit 5: VR Applications: Introduction, Engineering, Entertainment, Science, Training. The Future: Virtual environment, modes of interaction.

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Text Books/References:

1. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
2. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
3. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley Inter Science,2nd Edition, 2006.
4. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.

Course Outcomes: On completion of the course, learner will be able to:

CO 1: Comprehend to design of VR technology relates to human perception and cognition.

CO 2: Learn about multimodal virtual displays for conveying and presenting information and techniques for Geometric Modelling.

CO3: Explain the concept of Animating the Virtual Environment with using virtual environment technology.

CO4: Learn the fundamental aspects of designing and implementing rigorous empirical experiments using VR.

CO5: Illustrate the applications of VR to the conduct of scientific research, training, and industrial design.

Dr. S.G. Sulke

Subject: Bioterrorism and National Security (BT-OS-705ii T)
[Open Subject-III]

Total credits: 03
Teaching Scheme:
Lectures: 03 Hours/Week
Tutorial: Nil

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): To Familiarize the issues involved and threats to the society due to bioterrorism and approaches to tackle it effectively.

Course Contents:

Unit 1: Terrorism and Bioterrorism: Definition, Traditional Terrorists, New Terrorists, Nuclear, chemical, and radiological weapons. The psychology of Bioterrorism, Historical perspective.

Unit 2: Microbes and Immune System: Primary classes of Microbes-bacteria, virus, and other Agents. Interaction between microbes and the immune system.

Unit 3: Bioterrorism Weapons and Techniques: Characteristics of microbes and the reasons for their Use, Symptoms, Pathogenicity, Epidemiology, natural and targeted release. The biological, techniques of dispersal, and case studies of Anthrax, Plague-Botulism, Smallpox, and Tularemia and VHF.

Unit 4: Prevention and Control of Bioterrorism: Surveillance and detection, Detection equipment and sensors, Diagnosis, Treatment, Vaccinations, Supplies, Effectiveness Liability Public Resistance, Response First Responders Infectious. Control-Hospital Prevention, Protection Decontamination, Notification-Role of Law Enforcement, Economic impact.

Unit 5: Bioterrorism Management: Ethical issues, personal, national, the need to inform the public without creating fear, cost-benefit Rations. Information Management Government control and industry Support, Microbial forensics.

Text Books/References:

1. Bioterrorism: Guidelines for Medical and Public Health Management, Henderson, Donald, American Medical Association, 1st Edition, 2002.

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2. Biological Weapons: Limiting the Threat (BCSIA Studies in International Security), Lederberg, Joshua (Editor), MIT Press ,1999.
3. Bioterrorism and Infectious Agents: A New Dilemma for the 21st Century (Emerging Infectious Diseases of the 21st Century), I.W. Fong and Kenneth Alibek, Springer, 2005.
4. The Demon in the Freezer: A True Story, Preston, Richard, Fawcett Books, 2003.
5. The Anthrax Letters: A Medical Detective Story, Cole, Leonard A., Joseph Henry Press, 2003.
6. Biotechnology research in an age of terrorism: confronting the dual use dilemma, National Academies of Science, 2003.

Course Outcomes: At the end of the course, the student will be able to:

CO 1: Evaluate different types of biosecurity challenges and identifying effects of the biological, chemical, and nuclear weapons most likely to be employed in bioterrorism.
CO 2: Explain the interaction between microbes and the immune system.
CO 3: Understand the types of Bioterrorism Weapons and Techniques.
CO 4: Evaluate possible strategies and identifying the Prevention and Control of Bioterrorism.
CO 5: Illustrate different biosecurity threats and its management.

Dr. S.G. Suke

Subject: Data Sciences (BT-OS-705iii T)
[Open Subject-III]

Total credits: 03
Teaching Scheme:
Lectures: 03 Hours/Week
Tutorial: Nil

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): The objective of this course is to impart the necessary knowledge of the mathematical foundations needed for data science and develop programming skills required to build data science applications

Course Contents:

Unit 1: Introduction to Data Science: Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting.

Unit 2: Introduction to Programming Tools for Data Science: Tool kits using Python: Matplotlib, NumPy, Scikit-learn, NLTK. Visualizing Data: Bar Charts, Line Charts, Scatter plots. Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction.

Unit 3: Linear Algebra: Vectors, Matrices. Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation. Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem. Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, PHacking, Bayesian Inference.

Unit 4: Overview of Machine learning concepts: Over fitting and train/test splits, Types of Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks Learning And Generalization, Overview of Deep Learning.

Unit 5: Case Studies of Data Science Application: Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

Dr. S. G. Suke

Text Books/References:

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media
3. Jain V.K., "Data Science & Analytics: Using Python, R and SPSS Programming", Khanna Publishing House, Delhi.
4. Jain V.K., "Big Data and Hadoop", Khanna Publishing House, Delhi.
5. Jeeva Jose, "Introduction to Machine Learning using Python", Khanna Publishing House, Delhi.
6. Chopra Rajiv, "Machine Learning", Khanna Publishing House, Delhi.
7. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press http://www.deeplearningbook.org
8. Jiawei Han and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann Publishers.

Course Outcomes: At the end of this course, the students will be able to:

CO 1: Demonstrate understanding of the mathematical foundations needed for data science.
CO 2: Build data science applications using Python based toolkits.
CO3: Implement models such as k-nearest Neighbors, Naive Bayes, linear and logistic regression, decision trees, neural networks, and clustering.
CO 4: Illustrate the concepts of Machine learning.
CO 5: Apply the knowledge of data science in weather forecasting, stock market prediction, object recognition, real time sentiment analysis.

Dr. S.G. Sake

PRATICALS

Subject: Data analysis and Simulations Laboratory (BT-PC-706 P)

Total credits: 01
Teaching Scheme:
Practical: 2 Hours/Week
Tutorial: Nil

Examination Scheme:
Duration of Paper: 06 Hours
University Assessment: 25 Marks
College Assessment: 25 Marks

List of Experiments: Required to perform minimum 07 practical from the list given below:

1. Plotting graph using MS-Excel.
2. To calculate regression coefficient of data using MS-Excel.
3. To find unknown of simultaneous equations using Gauss Seidel method using MS-Excel/MATLAB.
4. To find unknown of simultaneous equations using Jacobi Iterative method using MS-Excel/MATLAB.
5. To find unknown of simultaneous equations using Newton Raphson method using MS-Excel/MATLAB.
6. To find unknown of simultaneous equations using Bisection method using MS-Excel/MATLAB.
7. To find unknown of simultaneous equations using Regula Falsi method using MS-Excel/MATLAB.
8. To find unknown of simultaneous equations using Secant method using MS-Excel/MATLAB.
9. To Initial Value ordinary differential equation using MS-Excel/MATLAB.

Dr. S.G. Suke

Subject: Project-I (BT-PS-707 P)

Total credits: 03
Teaching Scheme:
Practical: 6 Hours/Week

Examination Scheme:
College Assessment: 100 Marks

Objective(s): To synthesize and apply the knowledge gained over the engineering programme to solve real world problems.

Guidance / Remarks:

Project-I can be done either during the Summer Break between Semester VI and Semester VII or during the Semester VII. It will be evaluated as part of Semester VII. It may either be a complete project related to the field of Biotechnology or it may be an initiation (Phase I) of Project-II present in Semester VIII, provided the "Project Work II" is expected to extend beyond the duration of 6 months.

Subject: Summer Internship (BT-PS-708 P)

Total credits: 03

Examination Scheme:
College Assessment: 100 Marks

Objective: Minimum Two to Four weeks in an Industry preferably in the area of Biotechnology. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report. This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college.

Remarks: Internship needs to be done in Summer Break after Semester-VI and will be considered for evaluation in Semester-VII.

Dr. S.G. Sulke

Syllabus for Eighth Semester UG degree in

B.Tech.Biotechnology

Submitted to

RTMNU, Nagpur

By

Board of B.Tech. Biotechnology

Dr M A Suni

Dr. S. G. Hate

Dr V P Bhonge

Dr. S.G. Suke

Dr. A.P. Kopulwar

Science and Technology,

R.T.M. Nagpur University, Nagpur.

Syllabus for B.Tech. Biotechnology

(Eighth Semester)

Subject: Fermentation Technology (BT-PE-801i T)
[Professional Elective-V]

Total credits: 04
Teaching Scheme:
Lectures: 3 Hours/Week
Tutorial: 1 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): The course is designed to provide a comprehensive understanding of the fermentation technology, with a strong emphasis on correlating theory with applications.

Course Contents:

Unit 1: **Introduction to fermentation technology**: History of fermentation. Introduction to fermentation processes, Microbial culture selection for fermentation processes. Media formulation and process optimization.

Unit 2: Microbial growth kinetics: Study of growth kinetics, substrate utilization, and product formation kinetics in fermentation processes. Isolation, preservation, and improvement of industrially important microorganisms. Design, selection, and optimization of fermentation media.

Unit 3: Fermentation process control: Parameters and factors affecting fermentation, (temperature, pH, oxygen availability, and nutrient requirements). Types of fermenters: Batch, fed-batch, continuous, and immobilized cell fermenters.

Unit 4: Production of Microbial products: Process technology for production of organic solvents such as industrial alcohol, glycerol, acetone, butanol. Production of Vit B12. Brief account of steroid transformation.

Unit 5: Microbial polysaccharides and polyesters: Production of xanthan gum and polyhydroxyalkonoides (PHA), biofertilizers, biopesticies, and biosurfactants.

Text Books/References:

1. Principles of fermentation technology: Stanbury, Whittaker and Hall,2nd Ed. 1997.Aditya Books.
2. Fermentation Microbiology and Biotechnology: -El-Mansi and Bryce,2002
3. Process Biotechnology Fundamental: -Mukhopadhaya
4. Biochemical Engineering and Biotechnology: - Atkinson B and Mavituna F.
5. Industrial Microbiology by Prescott and Dunn.

Course Outcomes: At the end of the course the student will be able to:

CO 1: Learn the fundamental knowledge of fermentation technology

CO 2: Apply technique of micro-biology to explore the microorganisms to improve industrial fermentation.

CO3: Classify various fermentation techniques and understand the design of various fermenters.

CO4: Comprehend the knowledge of different production strategies for microbial fermentation products.

CO 5: Learn the fermentation of Microbial polysaccharides and polyesters.

Subject: Rational Drug Discovery (BT-PE-801ii T)
[Professional Elective-V]

Total credits: 04
Teaching Scheme:
Lectures: 3 Hours/Week
Tutorial: 1 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): This course is aimed at imparting knowledge and skill to understand the drug discovery process, rational methods to identify and design molecules for new medications greatly shortening the discovery phase of drug development by computational methods.

Course Contents:

Unit 1: Molecular Modelling in Drug Discovery: Stages of drug discovery and development, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identificationand validation, lead optimization and validation, Structure and ligand-based drug design, modelling of target-small molecule interactions, Molecular simulations. Protein Modelling.

Unit 2: Quantum Mechanics and Molecular Mechanics: Introduction to molecular mechanics and quantum mechanics; Bond structure and bending angles–electrostatic, van der Waals and non – bonded interactions, hydrogen bonding inmolecular mechanics; Derivatives of molecular mechanics energy function; Applicationof energy minimization.

Unit 3: Molecular Docking and Informatics in drug design: Types of Molecular Docking, Rigid docking, flexible docking, manual docking, Docking based screening; De novo drug design. Introduction to Bioinformatics, chemoinformatics. ADME databases, chemical, biochemical and pharmaceutical databases.

Unit 4: **Molecular Dynamics simulation methods:** Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

Unit 5: Pharmacophore and QSAR: Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery. History and development of QSAR, Types of physicochemical parameters, experimental and theoretical approaches for the determination of physicochemical parameters such as Partition coefficient, Hammet's substituent constant and Tafts steric constant.

Text Books/References:

1. Computational methods in drug design Fred E. Cohen, Walter Hamilton Moos. Publisher: ESCOM Science, 1993.
2. Molecular Modelling for Beginners - Alan Hinchliffe Publisher: John Wiley & Sons Inc,
   2008. ISBN: 978-0470513149.
3. Combinatorial Library Design and Evaluation: Principles, Software, Tools, Applications in Drug Discovery – Arup Ghose, VellarkadViswanadhan Publisher: CRC Press, 2001. ISBN: 0-8247-0487-8.
4. Molecular Modeling Basics - Jan H. Jensen Publisher: CRC Press, 2010. ISBN 978-1420075267.
5. 3D QSAR in Drug Design: Recent Advances – Hugo Kubinyi, Gerd Folkers, Yvonne C. Martin Publisher: Springer Science & Business Media. ISBN: 0-306-46858-1.
6. Computational Chemistry and Molecular Modeling - K. I. Ramachandran, Gopakumar Deepa, Krishnan Namboori Publisher: Springer – Verlag Berlin Heidelberg. ISBN: 78-3540773023.
7. The Process of New Drug Discovery and Development. Charles G. Smith (Editor), James T. O'Donnell, CRC Press; 2nd edition
8. QSAR in Drug Discovery: rational design to computer assisted technique. Love Kumar Soni and Tamanna Narsinghani. LAMBERT Academic Publishing; 1st edition.

Course Outcomes: At the end of this course the students will be able to:

CO1: Apply the knowledge of molecular modelling in drug discovery.

CO2: Learn the methods of quantum mechanics and molecular mechanics to design and discovery of lead molecules.

CO3: Illustrate the design of new drug molecules using molecular modeling and informatics methods.

CO4: Learn to molecular dynamics simulation methods for rational drug design process.

CO5: Explain the pharmacophore and qualitative structure activity relationship for development of new molecules.

Subject: Nano Biotechnology (BT-PE-801iii T)
[Professional Elective-V]

Total credits: 04
Teaching Scheme:
Lectures: 3 Hours/Week
Tutorial: 1 Hour/Week

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): To familiarize the students about nanomaterial, Biosensors and nanomedicine with advanced research area and application of nanotechnology in biological system.

Course Contents:

Unit 1: Introduction to nanotechnology and nanobiotechnology. Nanomaterial: Carbon nanomaterial, Fullerenes, Nanotube, Nanowire.

Unit 2: Nanobiotechnological devices: Nanoparticles, Dendrimers, Nanorobots, Nubot, Nanoshell. **Biosensors:** DNA, Protein-based, Antibodies and its application. Detection in Biosensors: fluorescence, absorption, electrochemical methods. Techniques used for microfabrication. Future direction in biosensor research.

Unit 3: Biopolymer: synthesis of polymer nanofibers and their biomedical applications. **Polymer nanocomposite:** Types and application.

Unit 4: Nanomedicine as a drug delivery system. Implications of nanotechnology in the society. Positive and negative aspects of nanotechnology.

Unit 5: Application of Nanotechnology: Nanotechnology for waste reduction and Improved energy efficiency, nanotechnology-based water treatment strategies and Environmental remediation. Case studies and Regulatory needs.

Text Books/References:

1. Biosensors and Nanotechnology, (Editors; Zeynep Altintas) John Wiley & Sons Inc, 2017, ISBN: 9781119065159, 9781119065159

2. Biosensors and Bioelectronics: D. Dharaneeshwara Reddy, O.M Hussain, DVR. Sai Gopal, Muralidhara Rao, and K.S Sastry. I. K International Publishing House Pvt. Ltd, New Delhi. 2013. ISBN 978-93-82332-19-0

3. C. M. Niemeyer, "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley – VCH, 2006

4. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004

5. Understanding Nanomedicine: An Introductory Textbook, Rob Burgess, Publisher: Pan Stanford Publishing; 2012. ISBN-13: 978-9814316385

6. Introduction to Nanoscience, S.M. Lindsay, Oxford universal Press, First Edition, 2010 Nanotechnology: Understanding small system, Ben Rogers, SumitaPennathur and Jesse Adams, CRC Press, Second edition, 2011

7. Nanobiotechnology: Bioinspired Devices and Material of Future by Oded Shoseyov and Ilan levy, Human Press, First edition, 2007. The Nanobiotechnology Handbook (Editor; Yubing Xie) CRC press

8) Biosensors: Fundamentals and applications, Oxford, U.K: Oxford University Press by Turner, A.P.F., Karube, I. & Wilson, GS. Oxford university Press.

Course Outcomes: At the end of this course the students will be able to:

CO 1: Comprehend the basics of nanobiotechnology, nanomaterials and nanoparticles.

CO2: Acquire the concepts of biopolymer, nanocomposite their construction and applications

CO 3: Understand the general concepts of biosensors and their construction and design and applications

CO4: Demonstrate the application of nanobiotechnology in various fields such as medicine, drug encapsulation and drug delivery.

CO5: Apply the Knowledge of Nanotechnology for waste management and environmental remediation.

Subject: Food and Nutrition Technology (BT-OS-802i T)
[Open Subject-IV]

Total credits: 03
Teaching Scheme:
Lectures: 3 Hours/Week
Tutorial: Nil

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): To facilitate the learner to introduce to basic concepts of nutrition, food spoilage and food preservation techniques to minimize spoilage. To elucidate process of production of industrially important microbial metabolites, compute energy value of foods and understand body's need for energy and realize the role of different constituents of carbohydrates and lipids in human nutrition.

Course Contents:

Unit 1: Food Microbiology: Micro-organisms associated with food, factors affecting growth of micro-organisms in food, food spoilage. Enzymatic and nonenzymatic changes in food spoilage.

Unit 2: Food Preservation Techniques: Principles of different modes of food preservation; Preservation methods with emphasis on inactivation, inhibition, and avoiding recontamination.

Unit 3: Production of Primary and Secondary Metabolites: The process of production of some commercially important organic acids: citric acid, lactic acid, acidic acid, gluconic acid, amino acids and alcohol.

Unit 4: Food composition and nutrients present in foods: Nutrition terminologies, Food pyramid, energy value of food, factors affecting and calorie needs for Basal Metabolic Energy, physical activity and diet induced thermogenesis; energy imbalance and body weight regulation.

Unit 5: Human Nutrition: Role of carbohydrate, lipids and protein in human nutrition, Effect of food processing, preservation, and storage on nutritional quality of foods, Fortification: chemical & biofortification.

Text Books/References:

Text Books:

1) Fundamental Food Microbiology (3rd Edition) – by Bibek Ray. CRC Press: ISBN - 0-8493-1610-3

2) Toledo, R.T. Fundamentals of Food Process Engineering, Chapman and Hall; 2000

3) Shakuntala, N., & Many, O. Food: Facts and Principles, New Age International; 2001.

4) Food, Nutrition and Diet Therapy by Krause and Mahan 1996, Publisher- W.B.Saunders, ISBN: 0721658350

5) Nutritive Value of Indian Foods by C. Gopalan, B. V. Rama Sastri, S. C.Balasubramanian Published by National Institute of Nutrition, Indian Council ofMedical Research, 1989.
6) Introduction to Human Nutrition by Gibney, Lahnam-New, Cassidy and Vorster, 2009, Nutrition Society Textbook Series, Second Edition, Wiley Blackwell Publisher.

Reference Books:

1) Modern Food Microbiology (Seventh Edition) – by James M. Jay, Martin J. Loessner and David A. Golden. Springer-Food Science Text Series ISBN 0·387·23180-3
2) Rahman, M.S. Handbook of food preservation, CRC Press; 2007
3) Cullen, P.J., Brijesh, K.T., Vasilis, Valdramidis, P. Novel Thermal and Non-Thermal Technologies for Fluid Foods, Elsevier Academic Press; 2012.
4) Principles of Human Nutrition by M. Eastwood, 2003, Blackwell Science. ISBN 0-632-05811-0

Course Outcomes: After completion of the course, students will be able to:

CO 1: Acquire fundamental knowledge of microbes associated with food and factors responsible for food spoilage.

CO 2: Apply the principle of food preservation techniques.

CO 3: Explain process of production of industrially important microbial metabolites.

CO 4: Describe the concepts of nutrition and compute energy value of foods for body's energy needs.

CO 5: Illustrate the role of different constituents of carbohydrates, protein and lipids in human nutrition.

Subject: Research Methodology & Scientific Writing (BT-OS-802ii T)
[Open Subject-IV]

Total credits: 03
Teaching Scheme:
Lectures: 3 Hours/Week
Tutorial: Nil

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): To introduce the basic concepts of research methodology in Engineering, discuss the techniques and tools to be employed in completing research project, enable the students to prepare report writing and framing Research proposals.

Course Contents:

Unit 1: Introduction and Design of research: Meaning, objectives and significance of research, types and parameters of research, research process, definition of construct and variables, pure and applied research design, exploratory and descriptive design methodology, qualitative vs. quantitative research methodology, field studies, field experiments vs. laboratory experiments, research design in social and physical sciences, research ethics.

Unit 2: Problem Identification & Formulation: Definition and formulating the research problem. Literature survey: primary and secondary; web sources; critical literature review. Research Question - Investigation Question - Hypothesis testing - Qualities of a good hypothesis - Null hypothesis & Alternative Hypothesis

Unit 3: Data and Methods of Data Collection: Survey, assessment and analysis: data collection, primary and secondary sources of data, Collection of primary data through questionnaire and schedules. Collection of secondary data, processing and analysis of data. Sample survey, simple random sampling, stratified random sampling, systematic sampling, cluster sampling, area sampling and multistage sampling. Pilot survey, scaling techniques, validity & reliability.

Unit 4: Data Analysis: Procedure for testing of hypothesis, the null hypothesis, determining levels of significance, type I and II errors, grouped data distribution, measures of central tendency, measures of spread/dispersion, normal distribution.

Unit 5: Scientific work presentation: Research Topics and Preliminary Writing. types of report: technical report, popular report, report writing – layout of research report, mechanics of writing a research report. How to Write a Literature Review. Definition and How to Write a Framework of Thinking. How to select methods according to the research

topic. Writing Results and Discussion. Scientific Presentation Techniques. Writing Conclusions, Writing bibliography and references. Suggestions, and Attachments. Manuscript Preparation Techniques for Journals. Practice of Proposal Seminar Presentations.

Text Books/References:

1. Research in education, By J W Best and J V Kahn, Pearson/ Allyn and Bacon.
2. Research Methodology – Methods and Techniques, C K Kothari, New Age International.
3. Design and Analysis of Experiments, D C Montgomery, Wiley.
4. Applied Statistics & Probability for Engineers, D C Montgomery & G C Runger, Wiley.
5. Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education.
6. Research Methodology and Scientific Writing Edition: Second (International Edition) Publisher: Springer. C George Thomas

Course Outcomes: At the end of this course the students will be able to:

CO1: Explain research topic and design research plan by applying research methodology.

CO2: Apply to indentify the research problem, research questions and knowledge to review the literature.

CO3: Illustrate the knowledge of collection data, sample size, preparation of questionnaires, maintains the records.

CO4: Apply various types of methods to analyze the research data by using statistical techniques.

CO5: Summarize the knowledge of writing scientific reports, presentation, manuscript for the journal.

Subject: Design Thinking (BT-OS-802iii T)
[Open Subject-IV]

Total credits: 03
Teaching Scheme:
Lectures: 3 Hours/Week
Tutorial: Nil

Examination Scheme:
Duration of Paper: 03 Hours
University Assessment: 70 Marks
College Assessment: 30 Marks

Course Objective(s): Design Thinking is a problem-solving methodology especially well-suited for investigating ill-defined problems. It uses methods derived from the discipline of design to match people's needs with what is feasible and what a viable organizational strategy can convert into customer/stakeholder value in a financially sustainable way. It was initially proposed as a way for corporations to more quickly, creatively, and effectively develop new offerings but has since been further adapted to address issues in the public and social sectors as well. This course provides an introduction to design thinking.

Course Contents:

Unit 1: Introduction to Design thinking: Importance of design thinking in daily life; Types of innovation in design, Skills required for designing products for end users, need for design thinking in entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Startup & Make in India), Copyright possibilities for design, Various practical applications of design thinking in industry verticals-product, process, research, finance, HR, marketing, operations, etc.

Unit 2: Design thinking process: Scoping–list the requirements for the end users. Identifying insights–spot user pain points in application situations. Establish design criteria–various qualitative and quantitative parameters. Concept development–to meet end user requirements.

Unit 3: Design Strategy: Principles to design and build a prototype–use of computer aided tools for visual depiction. Validation of assumptions & prototypes under simulated user conditions. Re-design and customization to suit requirements. Field survey of the design. Costing & suitability to production requirements–availability of components, sourcing, quality, final build.

Unit 4: Marketing & promoting the design: Identification of customer segments for the designed products & processes, Pitching methods to communicate the design elements. Developing distribution channels–franchising to promote design, Policies, promotion, advertising; Branding and market linkages for "virtual startup company".

Unit 5: Knowledge Centers: Introduction to TED, Stanford India Bio design. Various Indian and global institutions for design thinking support. Tinkering labs in India–fix Atal Tinkering Lab, India STEM foundation. Certifications in designs.

Text Books/References:

1.Jeanne Liedtka and Tim Ogilvie Designing for Growth: A Design Thinking Tool Kit for Managers (Columbia University Press, 2011).

2. Jeanne Liedtka, Tim Ogilvie, and Rachel Brozenske, The Designing for Growth Field Book: A Step-by-Step Project Guide (Columbia University Press, 2014).

3. Human-Centered Design Toolkit (IDEO); https://www.ideo.com/post/design-kit

4. Design Thinking BootCamp Bootleg (Stanford D-School); https://dschool.stanford.edu/resources/the-bootcamp-bootleg

5. Collective Action Toolkit (frogdesign): https://www.frogdesign.com/wpcontent/uploads/2016/03/CAT_2.0_English.pd f

6. Design Thinking for Educators (IDEO):https://designthinkingforeducators.com/

7. Brown, Tim, and Barry Kātz. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation. New York: Harper Business, 2009.

8. Cross, Nigel. Design Thinking: Understanding How Designers Think and Work. Oxford: Berg, 2011.

9. Bennett, Kevin. "Design Thinking: Creating a Better Understanding of Today to Get to a Better Tomorrow." Forbes (2013): n. pag. Web. 6 Apr. 2014. http://www.forbes.com/sites/darden/2013/08/29/design-thinkingcreating-a better-understanding-of-today-to-get-to-a-better-tomorrow/

10. Martin, Roger L. "The innovation catalysts." Harvard Business Review 89(6) (2011): 82-87.

11. "David Kelley: Human-centered design | Talk Video | TED." TED: Ideas worth spreading. N.p., n.d. Web. 4 Mar. 2014. https://www.ted.com/talks/david_kelley_on_human_centered_design?language =en

Course Outcomes: After completion of the course, students will be able to:

CO 1: Apply design thinking principles to identify innovative solutions, develop user-centered products.

CO 2: Establish design criteria, various qualitative and quantitative parameters.

CO 3: Design and build prototypes using computer aided tools, validate assumptions and prototypes in simulated user conditions, and customize designs based on specific requirements.

CO 4: Identify customer segments for designed products and processes, as well as employ pitching methods to communicate design elements.

CO 5: Utilize design thinking methodologies and tools, to ideate, prototype, and create impactful designs, earning certifications in the process.

Subject: Project-II (BT-PS-803 P)

Total credits: 08
Teaching Scheme:
Practical: 16 Hours/Week

Examination Scheme:
College Assessment: 100 Marks
University Assessment: 100 Marks

Objective: To synthesize and apply the knowledge gained over the engineering programme to solve real world problems.

Guidance/Remarks: Project-II has to be done during Semester VIII. It may be initiated in the break between Semester VII & VIII although it is not mandatory to initiate in the break. It will be evaluated as part of Semester VIII. It may either be a complete project related to the field of Biotechnology or it may be an extension (Phase II) of Project-I present in Semester VII, provided the Project in charge and Head of the Department agrees that "Project Work I" is worthy enough to extend across two semesters (i.e. VII & VIII). It may also be a startup in the field related to Biotechnology. In the case of startups, substantial evidence has to be produced for evaluation of the work carried out as part of Project-II.