

## BMS COLLEGE OF ENGINEERING, BENGALURU

VISION	MISSION
PROMOTING PROSPERITY OF MANKIND BY AUGMENTING HUMAN RESOURCE CAPITAL THROUGH QUALITY TECHNICAL EDUCATION & TRAINING	ACCOMPLISH EXCELLENCE IN THE FIELD OF TECHNICAL EDUCATION THROUGH EDUCATION, RESEARCH AND SERVICE NEEDS OF SOCIETY

### DEPARTMENT OF BIOTECHNOLOGY

Established in 2002, the Department of Biotechnology, BMSCE, aims to impart quality education with distinctive proficiency of merging engineering principles with biological systems. The department offers Undergraduate program with an intake of 40.

### DEPARTMENT VISION

To be a Centre of excellence in the field of biotechnology equipped to create graduates who endeavor for the welfare of mankind

### DEPARTMENT MISSION

1. To impart quality education for lifelong professional growth and opportunities in a wide range of careers.
2. To create awareness towards socio-ethical implications of potentials of biotechnology .

### PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

**PEO1:** Graduates will be successful professionals in Biotechnology and allied fields with proficiency of working in a multidisciplinary team.

**PEO2:** Graduates will pursue higher education with synergistic combination of the skills of biologists & engineers.

**PEO3:** Graduates will inculcate ethical and social values for the well-being of mankind and environment.

### PROGRAM SPECIFIC OUTCOMES (PSOs)

**PSO1:** Apply knowledge of basic sciences and biotechnological techniques to manipulate living organisms.

**PSO2:** Design, optimize, analyze and scale up a bioprocess to develop value added products.

**PSO3:** Generate, analyze and interpret Biological data using Insilco approaches.

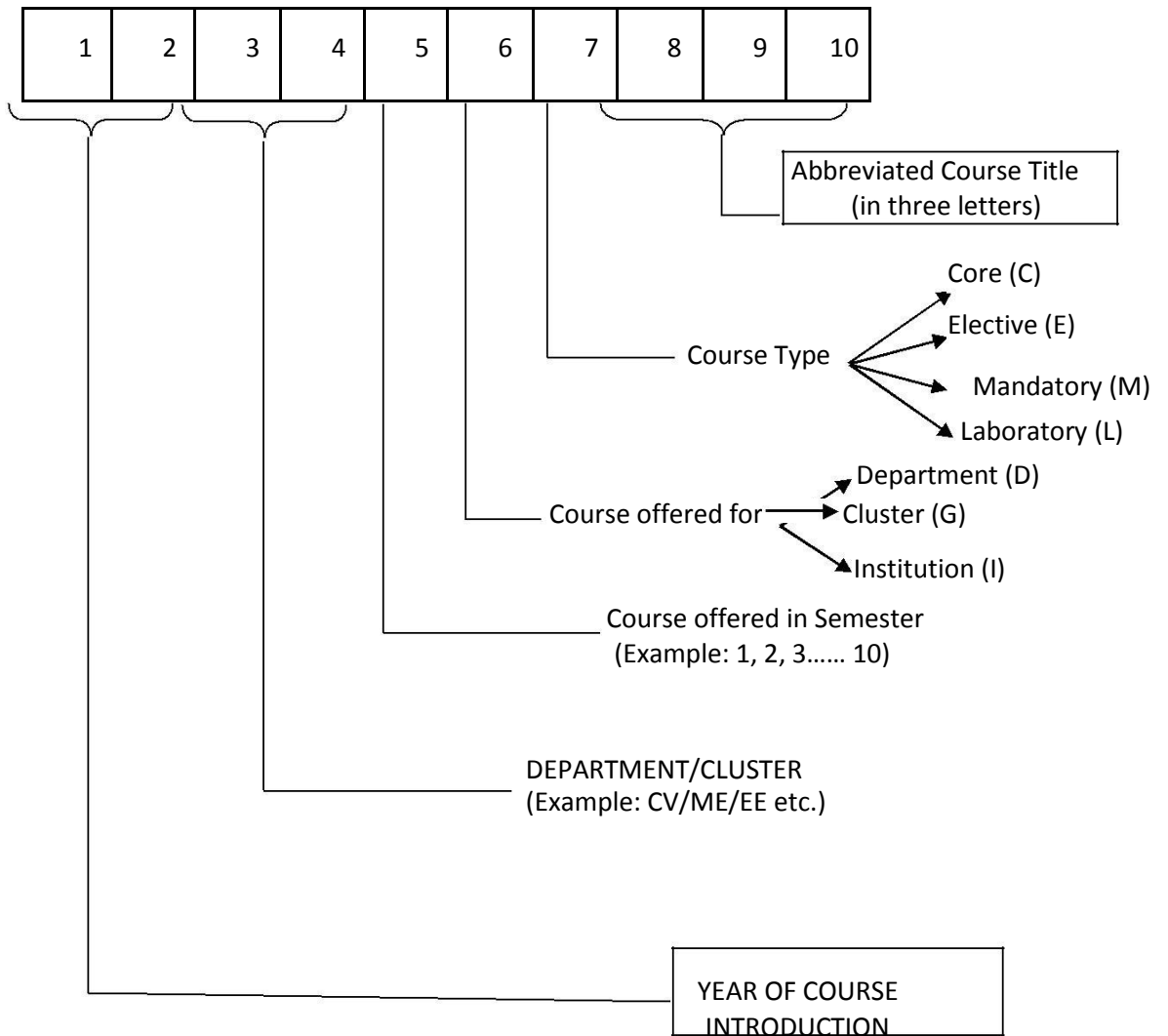
## PROGRAM OUTCOMES (POs)

<b>PO 1</b>	Graduates will <b>apply knowledge of Mathematics, Science and Engineering concepts</b> to solve problems pertinent to Biotechnology.
<b>PO 2</b>	Graduates will be able to <b>identify problems related to biotechnology, analyze and derive valid conclusions</b> with fundamental knowledge in biology, Engineering and computation.
<b>PO 3</b>	Graduates will be able to <b>design solution to problems by applying suitable components and processes</b> within the safety constraints for environmental & societal needs.
<b>PO 4</b>	Graduates will be able to <b>design, conduct experiments, analyze and interpret data</b> for <b>investigating problems</b> in BT and allied fields.
<b>PO 5</b>	Graduates will be able to <b>select and apply appropriate tools and techniques</b> in biological manipulation, Process engineering and data interpretation.
<b>PO 6</b>	Graduates will be able to <b>apply reasoning to assess societal, health, safety and legal issues</b> and understand <b>his responsibilities in biotechnological engineering practices</b> .
<b>PO 7</b>	Graduates will be able to <b>understand the potentials, and impact of biotechnological solutions</b> on environment and societal context and <b>need for sustainable solution</b> .
<b>PO 8</b>	Graduates will have understanding of regulatory <b>norms and ethics</b> in BT product/processes development.
<b>PO 9</b>	Graduates will be able <b>to work individually and as a team</b> in a multidisciplinary environment.
<b>PO 10</b>	Graduates will possess <b>oral and written communication</b> skills.
<b>PO 11</b>	Graduates will <b>demonstrate knowledge of engineering and management principles</b> .
<b>PO 12</b>	Graduates will have <b>contemporary knowledge in BT</b> and will have the ability to engage in <b>lifelong learning</b> .

## NOTATIONS

AY	Academic Year
AAT	Alternative Assessment Tools
BOE	Board of Examiners
BOS	Board of Studies
CBCS	Choice Based Credit System
CGPA	Cumulative Grade Point Averages
CIE	Continuous Internal Evaluation
CO	Course Outcomes
DC	Departmental Core
GC	Group Core
HSS	Humanity and Social Science courses
IC	Institutional Core
IE	Institutional Elective
IL	Institutional Lab
LTPS	Lecture-Tutorial-Practical-Selfstudy
NFTE	Not Fit for Technical Education
PCC	Professional Core Courses
PEO	Programme Educational Objective
PO	Programme Outcomes
PEC	Professional Elective Courses
SEE	Semester End Examination
SGPA	Semester Grade Point Average
ST	Studio

## NOMENCLATURE FOR THE COURSE CODE



Example:

☐ Code for Engineering Mathematics-II Course in 2<sup>st</sup> Semester is  
**1 4 M A 2 I C M A T**

☐ Code for Material Science and Metallurgy Course in 3<sup>rd</sup> Semester is  
**1 5 M E 3 D C M S M**

☐ Code for Concrete Technology Course in 4<sup>th</sup> Semester is  
**1 5 C V 4 D C C O N**

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**SCHEME OF INSTRUCTION**

Department/Cluster: BIOTECHNOLOGY/CHEMICAL

Program: BE

Semester: VII

Course Code										Course Title	Credit hours / week					Contact Hrs/wk	Marks		
											L	T	P	S	Total		CIE	SEE	Total
1	6	B	T	7	O	I	E	L	1	Institutional Elective-I	3	0	0	0	3	3	50	50	100
1	6	B	T	7	D	C	E	Q	D	Bioprocess Equipment Design and CAED	2	1	1	0	4	6	50	50	100
1	6	B	T	7	D	C	P	P	E	Process Plant design & Economics	2	1	0	0	3	4	50	50	100
1	6	B	T	7	D	C	B	I	P	Bioethics, Biosafety and IPR	3	0	0	2	5	3	50	50	100
1	6	B	T	7	D	C	M	P	R	Mini project	0	0	4	0	4	4	50	50	100
1	6	B	T	7	D	E	E	L	C	Elective-C	3	0	0	0	3	3	50	50	100
1	6	B	T	7	D	C	B	F	S	Biotechnology for society	1	0	0	2	3	1	50	50	100
<b>Total</b>										<b>14</b>	<b>2</b>	<b>5</b>	<b>4</b>	<b>25</b>	<b>24</b>	<b>350</b>	<b>350</b>	<b>700</b>	

**Elective C**

Course Code										Course Title	Credit Hours/Week					Contact Hrs/wk	Marks		
											L	T	P	S	Total		CIE	SEE	Total
1	6	B	T	7	D	E	I	B	T	Industrial Biotechnology	3	0	0	0	3	3	50	50	100
1	6	B	T	7	D	E	A	M	T	Aqua & Marine BT	3	0	0	0	3	3	50	50	100
1	6	B	T	7	D	E	B	T	E	Biomaterials & Tissue Engineering	3	0	0	0	3	3	50	50	100
1	6	B	T	7	D	E	C	D	M	Clinical Data Management	3	0	0	0	3	3	50	50	100

L-Lecture Hours/week, T-Tutorial Lecture Hours/week, P-Practical Lecture hours/week, S-self study

CIE-Continuous Internal Evaluation, SEE-Semester End Examination (of 3 Hours duration)

## SCHEME OF INSTRUCTION

Department/Cluster: BIOTECHNOLOGY/CHEMICAL

Program: BE

Semester: VIII

Course Code										Course Title	Credits/ hours per wk				Contact Hrs/ wk	Marks			
											L	T	P	S		Total	CIE	SEE	Total
1	6	B	T	8	O	I	E	L	2	Institutional Elective-II	3	0	0	0	3	3	50	50	100
1	6	B	T	8	D	C	P	M	F	Project management and Finance (HSS Core)	3	0	0	0	3	3	50	50	100
1	6	B	T	8	D	E	E	L	D	Elective D	3	0	0	0	3	3	50	50	100
1	6	B	T	8	D	C	P	R	W	Project work	0	0	10	0	10	10	50	50	100
*1	6	H	S	8	I	E	L	S	X	16HS8 IE LS1 Yoga 16HS8 IE LS2 NCC 16HS8 IE LS3 NSS 16HS8 IE LS4 Sports 16HS8 IE LS5 Cultural Activities 16HS8 IE LS6 Internship with NGO	0	0	1	0	1	1	---	---	---
1	6	H	S	8	D	C	M	M	E	Management & Entrepreneurship	3	0	0	0	3	3	50	50	100
1	6	B	T	8	D	C	I	R	S	Internship/Industrial Training/ technical seminar	0	0	2	0	2	2	50	50	100
<b>Total</b>										<b>12</b>	<b>0</b>	<b>13</b>	<b>0</b>	<b>25</b>	<b>25</b>	<b>300</b>	<b>300</b>	<b>600</b>	

\*CIE & SEE needs to be decided

### Elective D

Course Code										Course Title	Credit Hours/Week				Contact Hrs/wk	Marks			
											L	T	P	S		Total	CIE	SEE	Total
1	6	B	T	8	D	E	T	R	P	Transport Phenomena	3	0	0	0	3	3	50	50	100
1	6	B	T	8	D	E	N	B	T	Nano-Biotechnology	3	0	0	0	3	3	50	50	100
1	6	B	T	8	D	E	D	A	N	Data Analytics	3	0	0	0	3	3	50	50	100
1	6	B	T	8	D	E	A	P	G	Advanced Programming	3	0	0	0	3	3	50	50	100

L-Lecture Hours/week; T-Tutorial Lecture Hours/week, P-Practical Lecture Hours/week, S- Self Study.

CIE-Continuous Internal Evaluation; SEE-Semester End Examination (of 3 Hours duration)

<b>Course Title</b>	<b>BIOPROCESS EQUIPMENT DESIGN AND CAED</b>										<b>Credits</b>	<b>4</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>7</b>	<b>D</b>	<b>C</b>	<b>E</b>	<b>Q</b>	<b>D</b>	<b>L-T-P-S</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Unit Operations, Reaction Engineering, Elements of Engineering Drawing and Elements of Mechanical Engineering

**COURSE DESCRIPTION:** The course deals with study of various components used in bioprocess plant. This emphasizes on detail design of major equipment used in bioprocess industry.

**COURSE OBJECTIVES:** The objective of the course is to make students understand the working of various components used in process plant. Students will be able to design the major equipment used in bioprocess industry.

### **PART A: THEORY+TUTORIAL**

#### **UNIT 1**

#### **INTRODUCTION TO BIOPROCESS DESIGN [4L+2T]**

Nature of design, the anatomy of biochemical manufacturing process, organization of biochemical engineering project, codes and standards, factors of safety, degrees of freedom & design variables, optimization, basic considerations in design, piping and instrumentation, material of construction, symbols of equipment used in process flow diagram

#### **UNIT 2**

#### **BIOPROCESS COMPONENTS [4L+3T]**

Welding Joints, pipe fittings, Flanged pipe joint, Gland & Stuffing box expansion joint Ball valve, Gate valve, Non- return valve, Diaphragm valve, Centrifugal pump, Peristaltic pump, Bioreactors, types, Filtration units: Normal flow and tangential flow (TFF) filtration systems

#### **UNIT 3**

#### **PROCESS EQUIPMENT DESIGN AND CAED [20L+6T]**

Detailed process and mechanical design of the following equipment

- I. Shell and tube exchangers
- II. Fermenter
- III. Distillation column-Packed bed IV. Extractor

### **PART B: LABORATORY**

CAD of

1. Flanged pipe joint
2. Gland & Stuffing box expansion joint
3. Ball valve
4. Gate valve
5. Non- return valve
6. Diaphragm valve
7. Centrifugal pump



8. Peristaltic pump
9. Shell and tube exchangers
10. Fermenter
11. Distillation column-Packed bed
12. Extractor

### COURSE OUTCOMES

1. Comprehend the importance of parameters required to design process equipment
2. Identify the various symbols used in process flow diagrams
3. Draw the sketches of pipe joints, stuffing box, valves, pumps and bioprocess vessels using CAED
4. Design shell & tube heat exchanger, distillation column and Fermenter for given parameters

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1		2			1						
CO2	1		2									
CO3	1		2									
CO4		3	3									

### PRIMARY REFERENCES

1. **Process equipment design** by M V Joshi., V.V Mahajani
2. **Chemical Engineering** by Coulson and Richardson, Vol. 6, 1993.
3. **Principles of fermentation Technology** by P.F. Stanbury and A. Whitaker, Pergamon Press, 1984.

### SECONDARY REFERENCES

1. **Process Equipment Design** by Brownell LE and Young EH, John Wiley and Sons, Inc. 2009 **Fermentation and Biochemical Engineering Handbook** by Celeste C. Todaro and Henry C. Vogel 3<sup>rd</sup> edition, 2014
2. **Bioreactors: Analysis and Design**, by Tapobrata Panda. 1<sup>st</sup> Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011
3. **Perry's Chemical Engineers' Handbook** by Perry, R.H. Green, D.W. McGraw-Hill. Seventh Edition, 1997.
4. **Unfired pressure vessel I S Code 2825**
5. **Shell and tube heat exchanger specifications**, I S Code 4503

### E-BOOKS

1. [http://buc.edu.in/sde\\_book/bio\\_process.pdf](http://buc.edu.in/sde_book/bio_process.pdf)

### MOOCs

1. <http://nptel.ac.in/courses/103103027/>
2. <https://online-learning.tudelft.nl/courses/industrial-biotechnology/>
3. <http://nptel.ac.in/courses/102106022/16>

<b>Course Title</b>	<b>PROCESS PLANT DESIGN AND ECONOMICS</b>										<b>Credits</b>	<b>3</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>7</b>	<b>D</b>	<b>C</b>	<b>P</b>	<b>P</b>	<b>E</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Knowledge of Unit Operations, Enzyme Kinetics and Reaction Engineering and Process control & automation

**COURSE DESCRIPTION:** This course intended to demonstrate the importance of economic considerations in the design of process equipment and plant facilities to the students. This course enables the students to apply economic analytical methods to evaluate plant design options, selection of manufacturing process and site to maximize the profitability.

**COURSE OBJECTIVES:** To demonstrate the importance of economic considerations in the design of process equipment and plant facilities to the students.

#### UNIT 1

##### **PLANT DESIGN CONCEPTS** [7L]

Introduction, stages of process development, Process Design development. General design considerations, Evaluation of technologies, Feasibility study formats, Plant location and site selection, Plant layout.

#### UNIT 2

##### **PROJECT COSTING** [8L]

Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of fixed capital investments, cost indices, cost factors in capital investment, working capital and its determinants.

#### UNIT 3

##### **PRODUCTION COST** [7L]

Estimation of direct costs of production, fixed charges, plant overhead costs, indirect components of cost of production, total cost of production, Break even analysis.

#### UNIT 4

##### **INTEREST AND DEPRECIATION** [10L]

Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital. Taxes and insurances. Types of depreciation, methods for determining depreciation, single unit and group depreciation.

#### UNIT 5

##### **PROFITABILITY ANALYSIS** [7L]

Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period ,alternative investments, incremental and replacements.

### COURSE OUTCOMES

1. Select suitable site, plant lay out and technologies required for establishment of a process plant
2. Emphasize on the role of process engineer and check the feasibility of process
3. Estimate the cash flow in industrial operations and depreciation charges
4. Select suitable process by estimating the production cost and profitability analysis

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1							3					
CO2							3					
CO3		2					3					
CO4		2			2		3					

### PRIMARY REFERENCES

1. **Plant Design and Economics for Chemical Engineering** by M.S. Peters and K.D.Timmerhaus, Mc Graw Hill, 4th Ed., 1991.

### SECONDARY REFERENCES

1. **Process Engineering Economics** by Schweyer.

### E-BOOKS

1. <http://www.freeengineeringbooks.com/Civil/Engineering-Economics-Books.php>
2. Engineering Economics, Second Edition- Kindle Edition
3. [http://www.cognella.com/pdf/Fundamentals-of-Engineering-Economics\\_sneak\\_preview.pdf](http://www.cognella.com/pdf/Fundamentals-of-Engineering-Economics_sneak_preview.pdf)

### MOOCs

1. <http://nptel.ac.in/courses/103103039/40>
2. <http://www.shortcoursesportal.com/studies/75847/competency-in-chemical-engineering-and-plant-design.html>

<b>Course Title</b>	<b>BIOETHICS, BIOSAFETY and IPR</b>									<b>Credits</b>	<b>5</b>				
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>7</b>	<b>D</b>	<b>C</b>	<b>B</b>	<b>I</b>	<b>P</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>2</b>

**COURSE PRE-REQUISITES:** Knowledge of Constitution of India and Professional Ethics, Microbiology, Genetic engineering, Pharmaceutical BT, Animal BT, plant BT

**COURSE DESCRIPTION:** The course deals with IPR laws and agreements related to biotechnology. The course also includes impact of biotechnology on society, ELSI of biotechnology solutions and biosafety levels.

**COURSE OBJECTIVES:** On completion of the course, students will have fundamental concepts of IP laws and protection, agreements, ELSI and safety issues governing a technology.

### UNIT 1

#### **FUNDAMENTALS OF IP [8L]**

Introduction to IPR, Basic principles of Patent laws: Basis for IP protection. Criteria for patentability: Novelty, Utility, and Inventive step, Non obviousness, Non patentable invention (relevant case studies). WIPO and Patent Cooperation Treaty (PCT), Patents: Definition and objectives, Criteria of patenting, Assignment of Patent rights- compulsory license, TRIPS agreement and compulsory licensing (case studies), Indian law on compulsory licensing. Infringement of patents- Law enforcing and relevant BT case studies in United Kingdom, United States and India (case studies). Infringement defenses with case studies.

### UNIT 2

#### **IPR IN BIOTECHNOLOGY [10L]**

Commercial potential of BT invention, R & D investments, Rationale and applications. Concept of Novelty and Inventive step in BT, Microorganisms and BT inventions, Moral issues in patenting BT invention. Substantiation of Patent laws & international agreements related to pharma, microbial, environmental, and agricultural and informatics sectors via classical case studies. Traditional knowledge(TK) as IP: Introduction to TK, plant variety protection(UPOV 1991), Plant variety protection in India. Justification for geographical indications, Bioprospecting & Biopiracy – ways to tackle, Protectability of traditional knowledge under existing IP framework.

### UNIT 3

#### **ETHICAL ISSUES OF BIOTECHNOLOGY IN SOCIETY [10L]**

BT and social responsibility, public acceptance issues in biotechnology: Issues of access, ownership, monopoly, traditional knowledge, biodiversity and environmental sustainability, public vs. private funding, globalization and development divide. Impact of biotechnology across the world, Impact of Bt cotton and acceptance issues of Bt brinjal in India. Ethical complications of BT: Interference with nature, fear of unknown, unequal distribution of Risks and benefits. Medical ethics and issues of modern BT applications in medicine: Basic principles of medical ethics, Stem cell and gene therapy, Synthetic or artificial cell, HGP and its issues

## UNIT 4

### BIOSAFETY CONCEPTS AND ISSUES

[6L]

Definition of Risk and its classification, relationship between risk, hazard, exposure and safeguards, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. Biosafety levels: Different types and description. Laboratory associated infections and other hazards, Assessment of biological hazards. Biological weapons: - Types and possible role of RDT in production of novel bioweapons. Social, Economic and ethical implications of Bioterrorism.

## UNIT 5

### BIOSAFETY REGULATIONS AND GUIDELINES

[5L]

Biosafety assessment procedures in India and abroad, International dimensions in biosafety: Cartagena protocol on biosafety. CBW. Biosafety regulations (national and international guidelines): Guidelines on rDNA technology, transgenic science, GM crops, Experimental protocol approvals, levels of containment. Guidelines for research in transgenic plants. Biosafety assessment of pharmaceutical products such as drugs/vaccines (products out of RDT),

### COURSE OUTCOMES

1. Understand the basic structure of intellectual property and its relevance to modern biotechnology
2. Adoption of patenting system in day-to-day research for protecting innovative ideas as well as the age-old traditional skills
3. Inculcate ethics and understand the possible societal anticipations of outcomes from potential applications of biotechnology targeting the end-user.
4. Learn and adopt the established guidelines with respect to biosafety practices in research and development sectors

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1						1						
CO2						2						
CO3						3		3				
CO4						3		3				

### PRIMARY REFERENCES

1. **Basic Intellectual property rights**, Paper I, Dr. Ramakrishna, National Law School of India University,
2. **Ownership and enforcement of IPR** by Dr. T. Ramakrishna, NLSIU, Bangalore
3. **Bioethics & Biosafety** by Sateesh MK (2008), IK Publishers.

4. **Biotechnology and Safety Assessment** by Thomas by J.A., Fuch, R.L. (2002), Academic Press.

#### **SECONDARY REFERENCES**

1. **Biotechnologies in developing countries** by Sasson A, UNESCO Publishers, 1993.
2. **Biological safety Principles and practices** by Fleming, D.A., Hunt, D.L., (2000), ASM Press.
3. **Intellectual Property and Criminal Law**, Bangalore by Gopalakrishnan. N S, National Law School of India University, 1994.

#### **E-BOOKS**

1. [https://vufind.carli.illinois.edu/vf-tiu/Record/tiu\\_576971](https://vufind.carli.illinois.edu/vf-tiu/Record/tiu_576971)

#### **MOOCs**

1. <https://www.mooc-list.com/course/bioethics-law-medicine-and-ethics-reproductive-technologies-and-genetics-edx>

<b>Course Title</b>	<b>MINI PROJECT</b>										<b>Credits</b>	<b>4</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>7</b>	<b>D</b>	<b>C</b>	<b>M</b>	<b>P</b>	<b>R</b>	<b>L-T-P-S</b>	<b>0</b>	<b>0</b>	<b>4</b>	<b>0</b>

### COURSE OUTCOMES

1. Comprehend a given problem pertaining to BT
2. Compile, analyse and interpret data from the literature collected and derive valid conclusion
3. Design and conduct preliminary experiments independently toward standardization of protocols within a given period of time.
4. Write effective report and Communicate effectively by oral presentation

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3					2	2	2				
CO2		3										2
CO3			2	3	3				3		2	
CO4										3		

<b>Course Title</b>	<b>BIOTECHNOLOGY FOR SOCIETY</b>										<b>Credits</b>	<b>3</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>7</b>	<b>D</b>	<b>C</b>	<b>B</b>	<b>F</b>	<b>S</b>	<b>L-T-P-S</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>2</b>

**COURSE PRE-REQUISITES:** Basic knowledge in biochemistry, cell biology and genetic engineering. Course description:

**COURSE DESCRIPTION:** This course enables the students to understand the interactions of the biotechnology, its products with society. It also helps students to understand the debates, controversies and fears pertaining to biotechnological applications for the society.

**COURSE OBJECTIVES:** Upon completion of the course students should be able to understand the impact of biotechnological process and its products on the society. Students should be able to critically analyse and evaluate the issues and ethical considerations while applying bio technological solutions.

**UNIT 1 [13L]**

What Is Biotechnology? The Long History of Biotechnology. Inventing Genetic Engineering, Recombinant DNA, Biotechnology and Business Patenting. Life, Risk, Regulation, and Our Food. Owning Part of You, Freezing, Banking, Crossing, and Eugenics. The Human Genome Project, Genetic Testing, Disability, and Discrimination, Bioethics and Medicine, From the Pill to IVF, Cloning, Stem Cells, Designer Babies, Drugs and Designer Bodies, Personal Genomics, Biotechnology and Race. Bioprospecting and Biocolonialism, Synthetic Biology and Bioterrorism, Biotechnology and Art, Eternal Life and the Post human Future

**COURSE OUTCOMES**

1. Comprehend the role and impact of Biotechnology on the society .
2. Understand the responsibility of biotechnologist towards society.

<b>Mapping of COs with POs</b>												
<b>PO \ CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO 10</b>	<b>PO 11</b>	<b>PO 12</b>
<b>CO1</b>						3	1					
<b>CO2</b>						3	1					

**PRIMARY REFERENCES**

1. **Biotechnology and society an introduction:** Hallam Stevens. 2016, university of Chicago press.

**SECONDARY REFERENCES**

1. **Book title: New Perspectives on Technology, Values, and Ethics, Part II. Chapter**
2. **Biotechnology, Ethics, and Society:** The Case of Genetic Manipulation. Pages 123-144. 2015. Springer international publishing.  
**Biology Is Technology: The Promise, Peril, and New Business of Engineering Life** by Robert H. Carlson. Harvard University Press. 2010



<b>Course Title</b>	<b>INDUSTRIAL BIOTECHNOLOGY</b>									<b>Credits</b>	<b>3</b>				
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>7</b>	<b>D</b>	<b>E</b>	<b>I</b>	<b>B</b>	<b>T</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Knowledge of Microbiology, Unit Operations-1, Unit operations-2, Biochemistry, Molecular Biology, Genetic Engineering, Bioprocess Technology

**COURSE DESCRIPTION:** The course deals with bioconversion and media design. It also emphasizes on large scale production of different primary and secondary metabolites.

**COURSE OBJECTIVES:** On completion of the course, students will have fundamental concepts of process flow diagrams of important products and processes employed in modern biotechnology industry.

### UNIT 1

#### **INTRODUCTION [4L]**

Introduction, Objectives and Scope; Characteristic and comparison of bioprocessing with chemical processing. Substrates for bioconversion processes and design of media. Metabolic basis for product formation. Cell culture techniques and aseptic transfers.

### UNIT 2

#### **PRODUCTION OF ORGANIC ACIDS, AMINO ACIDS & ENZYMES [10L]**

Organic Acids-Fumaric Acid, Itaconic Acid, Kojic Acid, Bacterial Gluconic and –Ketogulonic with process Flow sheets. Production of amino acids. Enzymes as fermentation Products: Amylases, Proteolytic Enzymes, Pectinases, Invertase.

### UNIT 3

#### **PROCESS TECHNOLOGIES FOR SECONDARY METABOLITES [6L]**

Production of antibiotics with process flow sheet-penicillin and tetracycline, Production of vaccines.

### UNIT 4

#### **PRODUCTION OF ORGANIC SOLVENTS [9L]**

Anaerobic Fermentations-Acetone-Butanol Fermentation, Brewing, Industrial Alcohol. Environmental Control of Metabolic Pathways, Glycerol from yeast, Glycerol from Bacillus subtilis, Genetic Control of Metabolic Pathways, Indirect or dual Fermentation, Direct Fermentation, Microbial Oxidative Transformations of Substrate.

### UNIT 5

#### **PRODUCTION OF FOOD PRODUCTS [10L]**

Hydrocarbon Fermentations, Microbial Cells as Fermentation Products, Baker's yeast, cheese, Food and Feed Yeasts, Bacterial Insecticides, Legume Inoculant, Mushrooms, Algae, Vitamins and Growth Stimulants, Vitamin B12(Cobamide), Riboflavin, Vitamin A, Gibberellins, Steroid Transformation.

**Note:** Emphasis on Process Flow Diagram (PFD), blocked diagram to be given for process description wherever applicable.

### COURSE OUTCOMES

1. Understand the concept of bioconversion and media design.
2. Identify and analyze the metabolic pathways involved in production of different metabolites from living organisms.
3. Distinguish and apply the process technologies for large scale production of industrially important products from living organisms.

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3											
CO2		2										
CO3					2							

### PRIMARY REFERENCES

1. **Industrial Microbiology** by Prescott & Dunn, CBS Publishers, 1987.
2. **Industrial Microbiology** by Casida LE, Willey Eastern Ltd, 1989.

### SECONDARY REFERENCES

1. **Bioprocess Technology-fundamentals and applications** by Enfors SO and Hagstrom LRIT, Stockholm, 1992.
2. **Biotechnology, Economic & social Aspects** by Dasilva EJ, Ratledge C & Sasson. A Cambridge Univ. Press, Cambridge, 1992
3. **Environmental Biotechnology** by Foster CF and John ware DA. Ellis Horwood Limited. 1987.
4. Encyclopedia, Kirk and othmer, 2007
5. **Fuels from waste** by Larry Anderson and David A, TillmanAcademic Press, 1977.
6. **Comprehensive Biotechnology** by Young MY, Pergamon Press, 1985.
7. **Biotechnology: A Text Book of Industrial Microbiology** by Brock TD (1990), Smaeur Associates.

### E-BOOKS

1. <http://www.vitorrentz.co/search/Prescott+and+Dunn%E2%80%99s+Industrial+Microbiology,+4th+E>
2. Kirk-Othmer Encyclopedia of Chemical Technology 5th Edition, Vol. 18 (Volume 18)

### MOOCs

1. <https://www.edx.org/course/industrial-biotechnology-delftx-ib01x-0>
2. <https://online-learning.tudelft.nl/courses/industrial-biotechnology/>

<b>Course Title</b>	<b>AQUA AND MARINE BT</b>										<b>Credits</b>	<b>3</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>7</b>	<b>D</b>	<b>E</b>	<b>A</b>	<b>M</b>	<b>T</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Knowledge of Basic Biology, Cell and molecular Biology, Microbiology, Genetic Engineering, Immunology and Bioprocess Technology.

**COURSE DESCRIPTION:** This is an exclusive elective offered to students in case they would like to pursue their career in industry and academia dealing with Marine BT. The course provides a details theoretical knowledge in all the areas of marine BT.

**COURSE OBJECTIVES:** On completion of the elective, students will have a broad understanding in concept and applications of marine BT.

### UNIT 1

#### **AQUATIC ENVIRONMENT AND AQUACULTURE [9L]**

Major physical and chemical factors (light, temperature, gases, nutrients). Aquatic biota: phytoplankton, zooplankton, benthos, periphyton, macrophytes, fish and other animals. Production & Nutrient dynamics in lakes, rivers, estuaries and wetlands. Eutrophication and water pollution: monitoring and control conservation and management of lakes, rivers and wetlands. Importance of coastal aquaculture - design and construction of aqua farms, Criteria for selecting cultivable species. Culture systems – extensive, semi intensive and intensive culture practices. Classification and Characteristics of Arthropoda. Crustacean characteristic key to Myanmar's Economically Important species of Prawns and Shrimps, General biology, embryology, morphology, anatomy and organ systems of – (a) Shrimp and Prawn, (b) Finfish, (c) Marine and freshwater fish. Preparation, culture and utilization of live food organisms, phytoplankton zooplankton cultures, Biology of brine shrimp Artemia, quality evaluation of Cyst, hatching and utilization, culture and cyst production.

### UNIT 2

#### **PUBLIC HEALTH, FOOD HYGIENE & FOOD PROCESSING [9L]**

The science of public health will be introduced: basic concepts, infectious diseases, auto-immune diseases, life-mode diseases, marine-related diseases, major food poisoning and indicator organisms of concern to public health, and functional foods. Food-related problems based on sanitation law will be elaborated: natural toxins, hazardous substances (e.g. mycotoxins, heavy metals), food additives, parasites, and food allergy. Fundamentals and techniques of food processing (especially seafood) and food safety will be discussed: purpose and types of processing techniques for marine plant and animal products, preservation techniques, microbiological examining methods, packaging, standardisation of processed foods, product value, labelling and quality control.

### UNIT 3

#### **TECHNIQUES [6L]**

Chromosome manipulation in aquaculture - hybridization, ploidy induction, gynogenesis, androgenesis and sex reversal in commercially important fishes. Application of microbial

biotechnology in culture ponds, bioaugmentation, bioremediation, nutrient cycling, and bio-fertilization. Probiotics – Immunostimulants. Tools for disease diagnosis in cultivable organisms - Enzyme immuno assays - Dot immunobinding assay - Western blotting - Latex agglutination test - Monoclonal antibodies - DNA based diagnosis. Cryopreservation techniques.

#### UNIT 4

#### **MARINE BIOTECHNOLOGY [8L]**

Physical, Chemical and Biological aspects of marine life. Air – Sea interaction – Greenhouse gases (CO<sub>2</sub> and Methane). Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial). Biological indicators and accumulators: Protein as biomarkers, Biosensors and biochips. Biodegradation and Bioremediation. Separation, purification and bioremoval of pollutants. Biofouling - Biofilm formation Antifouling and Anti boring treatments. Corrosion Process and control of marine structures. Biosafety - special characteristics of marine environment that bear on biosafety. Ethical and moral issues - food health, and environmental safety concerns. Biotechnological applications in aquaculture (expression of the eucaryotic gene, genes cloned from fish, introduction of the heterologous gene in fish, gene therapy) and safety evaluations of applications in aquaculture

#### UNIT 5

#### **MARINE PHARMACOLOGY [7L]**

Terms and definitions. Medicinal compounds from marine flora and fauna - marine toxins – antiviral, antimicrobial. Extraction of crude drugs, screening, isolation, purification and structural characterization of bioactive compounds. Formulation of drugs and Drug designing: Pharmacological evaluation – routes of drug administration – absorption, distribution, metabolism and excretion of drugs.

#### **COURSE OBJECTIVES**

1. Understand the biology of marine micro-macro flora and fauna.
2. Apply the techniques for detection of marine organism and bio-augmentation.
3. Comprehend on the marine food processing, product and safety.
4. Screening & purification of bioactive compounds from marine flora & fauna.

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	2											
CO2					3		2					2
CO3						2		1				
CO4					2							

### **PRIMARY REFERENCES**

1. **Recent advances in Marine Biotechnology**. Vol. 4. Fingerman, M.
2. **Marine Biotechnology** by David J. Attaway et al.,

### **SECONDARY REFERENCES**

1. **Aquaculture**, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. **Aquatic Microbiology**, Rheinemer, G., 1980. John Wiley & Sons, pp. 235.

### **MOOCs**

1. Marine and Antarctic Science (Open2Study), Link: <https://www.mooc-list.com/course/marine-and-antarctic-science-open2study?static=true>

<b>Course Title</b>	<b>BIOMATERIALS AND TISSUE ENGINEERING</b>										<b>Credits</b>	<b>3</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>7</b>	<b>D</b>	<b>E</b>	<b>B</b>	<b>T</b>	<b>E</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Knowledge of basic cell and molecular biology, Human physiology, Chemistry, Basics of Biomolecules

**COURSE DESCRIPTION:** This course deals on functional biomaterials used in drug delivery and therapeutics, artificial implants, organs that are being used.

**COURSE OBJECTIVES:** The goal of this course is to enable students to understand the biological and physical principles of the biomaterials, to understand how they functions and various applications of biomaterials that under current use.

### UNIT 1

#### **CHARACTERIATICS OF BIOMATERIALS [6L]**

Introduction to Materials Science: mechanical properties, Strength and ductility, viscoelasticity. Classification of bio-materials (inert, bioactive and biodegradable) organic functional groups needed for biomaterials, Nucleophilic and Electrophilic groups, pKa of important biomolecules, Transition states, and intramolecular reactions. Degradation of biomaterials, Protein adsorption to materials.

### UNIT 2

#### **IMPLANT MATERIALS & BIOCOMPATIBILITY [7L]**

Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite, carbon fiber reinforced glass and glass-ceramics, polymers, dental materials, wound-healing process and body response to implants, Tissue and blood compatibility.

### UNIT 3

#### **ARTIFICIAL ORGANS AND IN VIVO SYNTHESIS OF TISSUES [6L]**

Artificial Heart, Prosthetic Cardiac Valves, Limb prosthesis, Externally Powered limb Prosthesis, Dental Implants. In vivo synthesis of skin, peripheral nerves. Rules for in vivo synthesis. Regulatory aspects related to tissues, blood products and tissue Engineering.

### UNIT 4

#### **HUMAN TISSUE AND ORGANS [10L]**

Introduction to human tissues and tissue development: stem cells; morphology of human tissues and organs: muscle tissue, adipose tissue, connective tissue, nervous tissue and epithelial tissues.

Organs: heart, liver, kidney, pancreas, bone & bone marrow and ECM. Tissue homeostasis and importance of cellular signaling in tissue engineering.

## UNIT 5

### SCAFFOLDING

[10L]

Architectural, biological, and mechanical features of scaffolds, Biological scaffolds (collagen, lamin, glycosamino glycans, elastin, fibroin). Natural polysaccharides (alginate, dextran, Chitosan, cellulose). Scaffold design fabrication, Tissue biomechanics, drugs, growth factors and regulatory molecules. Hydrogels, polymer microspheres, 3D printing.

### COURSE OUTCOMES

1. Compare and distinguish various biomaterials
2. Justify the use of suitable biomaterials for various applications
3. Understand the role of implants in artificial organs
4. Identify the suitable use of implants in tissue replacement

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1	3										
CO2	1	3										
CO3	1	3		1								
CO4		2										

### PRIMARY REFERENCES

1. **Introduction to Biomaterials** by Joon Park and RS Lakes.
2. **Biomaterials** by SV Bhat, Springer's publication.

### SECONDARY REFERENCES

1. **Handbook of Materials** for Medical Devices by J R Davis.
2. **Biomaterials Science and Engineering** by Park JV, Plenum Press, 1984.
3. **Catalysis in Chemistry** by William Jenck.
4. **Bioconjugate Techniques** by Greg Hermanson.
5. **Biomaterials and regenerative medicine in ophthalmology** by T V Chirila, Queensland Eye Institute.

## **E-BOOKS**

1. Cells and Biomaterials in Regenerative Medicine  
(<http://www.intechopen.com/books/cells-and-biomaterials-in-regenerative-medicine>)
2. <http://genome.tugraz.at/biomaterials.shtml>

## **MOOCs**

1. <http://nptel.ac.in/syllabus/syllabus.php?subjectId=113104009>
2. <http://nptel.ac.in/syllabus/syllabus.php?subjectId=102106036>
3. <https://www.class-central.com/mooc/494/coursera-introduction-to-tissue-engineering>
4. <http://oyc.yale.edu/biomedical-engineering/beng-100/lecture-22>



<b>Course Title</b>	<b>CLINICAL DATA MANAGEMENT</b>										<b>Credits</b>	<b>3</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>7</b>	<b>D</b>	<b>E</b>	<b>C</b>	<b>D</b>	<b>M</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Pharmaceutical Biotechnology, Biostatistics

**COURSE DESCRIPTION:** This course emphasizes on clinical trials and data management. It also portrays the role of CRC and CRA in clinical trials for effective data management in clinical research.

**COURSE OBJECTIVES:** This course is designed to impart good knowledge in principles and practices of clinical research. Further students will inculcate these for clinical trials design, project management, resource management and data handling to develop a quality data management system

### UNIT 1

#### INTRODUCTION

[9L]

Introduction to Clinical Trials: scope of clinical trial, clinical trials Phases, Phase I studies; Phase II studies; Phase III/IV studies Introduction to ethics of Clinical Trials. Study Population: Definition of study population, Issues on generalization. History of clinical trials, Basic principles, Clinical trial, designing clinical trial: Planning steps (Develop a hypothesis for research, Define the objectives and Establishment, Define the variables needed, Define the study population, finalize the objective into testable hypothesis Predict error and bias, Selection of appropriate study design, Determination of sample size), Execution steps: Data collection process, Data entry and management and Publication.

### UNIT 2

#### DATA REVIEW AND VALIDATION

[8L]

Point by Point Checks, Missing Data or blank field Checks, Data consistency Checks Laboratory Data and range Checks, Discrete value group dispensary Checks, Header Inconsistency Checks, Missing page Checks and CRF tracking, Protocol validation Checks, continuity Data Checks, coding Checks, external Data Checks, textual Data Checks, SAE Reconciliation Checks. Discrepancy Management (brief), Database closure, Quality assurance, Data storage and archival and recent advances in CDM.

### **UNIT 3**

#### **INFORMED CONSENT PROCESS**

**[6L]**

Introduction, the history of informed consent and the system of subject protection, Basic principles; autonomy, beneficence, justice. Informed consent process, preparing the informed consent document, checklist, ensuring readability of the informed sheet and the consent form, special considerations.

### **UNIT 4**

#### **ROLE OF CRC AND CRA IN CLINICAL TRIALS**

**[9L]**

The clinical research associate and coordinator, who can be a CRC/CRA, the sites where CRC/CRA works, responsibilities; general responsibilities; capacity building, trial related responsibilities; site identification, pre-trial documentation, IRB, regulatory, financial, administrative, training of the site staff, informed consent forms, site initiation visit, investigators meeting screening and recruitment, scheduling of visit, accountability, laboratory, monitoring. Skills of being a good CRC/CRA; watch, listen, document and report. Documentation of informed consent), plan for administrative support (budget; personnel, equipment, facilities and suppliers, resources and environment, personnel; qualifications, time commitment, job descriptions, consultant

### **UNIT 5**

#### **DATA MANAGEMENT IN CLINICAL RESEARCH AND LITERATURE SURVEY [7L]**

Introduction: Overview of Clinical Data Management (CDM), Kinds of Data, Data Management plan, Data capture and collection: Paper CRF based studied based study, Data Privacy. CRF Design: Paper based and electronic based CRF process, CRF login and inventory. Clinical Database. Data entry: double entry, single entry. Library sources; search engines, databases, search strategies, limiting the search using logical operators, broadening the search, sensitivity and specificity of literature searches, finding references for evidence- based practice, review and abstracts for evidence- based practice.

#### **COURSE OUTCOMES**

1. Apply principle steps in drug discovery
2. Outline the pertinent issues involved in undertaking of clinical research and recruitment of subjects for study
3. Distinguish the roles of CRC, CRA for effective data management in clinical research.

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3											
CO2						1						
CO3								2				

**PRIMARY REFERENCES**

1. **Basic Principles of Clinical Research and Methodology.** S.K Gupta, 1<sup>st</sup> edition, Medical Publishers (P) Ltd, 2007.
2. **Foundations of Clinical Research: Applications to Practice.** Leslie Gross Portney, Mary P. Watkins , 3rd edition, Amazon Publications.
3. **Principles and Practices of Clinical Research.** Leslie Gross Portney, Mary P Watkins, Academic Press

**SECONDARY REFERENCES**

1. **Design and Analysis of Clinical Trials : Concepts and Methodologies-** Shein-Chung Chow, Jen-Pei, Liu Wiley Series in Probability and Statistics.

**E-BOOKS**

1. [http://landingbook.co/practical\\_guide\\_for\\_clinical\\_data\\_management.pdf](http://landingbook.co/practical_guide_for_clinical_data_management.pdf)

**MOOCs**

1. <https://www.coursera.org/learn/clinical-data-management>
2. <https://news.vanderbilt.edu/2013/09/18/coursera-data-management/>

<b>Course Title</b>	<b>PROJECT MANAGEMENT AND FINANCE</b>										<b>Credits</b>	<b>3</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>8</b>	<b>H</b>	<b>S</b>	<b>P</b>	<b>M</b>	<b>F</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Process Plant Design and Economics

**COURSE DESCRIPTION:** This course deals with planning, scheduling, organizing, and managing projects and information systems, Primary emphasis is on the project management process and tools used by professional management organizations serving process and IT industry. Specifically, the focus is on the nine project management areas as defined by the Project Management Institute. These include project integration, scope, time, cost & cost controls, tradeoffs, quality, human resources, communications, risk, and procurement management.

**COURSE OBJECTIVES:** This course enables students to follow a structured approach for managing the projects

### UNIT 1

#### **PROJECT IDENTIFICATION & FORMULATION [7L]**

Characterization of project, Functional management, Project Life cycle & its phases, defining the project scope, establishing project, project feasibility, Roles and responsibility of project manager, tools and techniques project management, project management objectives.

### UNIT 2

#### **PROJECT PLANNING, SCHEDULING & FINANCING [10L]**

Work breakdown structure, Bar chart, GAN II chart, developing project schedule: scheduling techniques, terminologies in networking and networking convention: PERT, CPM, procurement schedule, Sources of finance, role of financial institution in project financing, financial analysis of projects.

### UNIT 3

#### **PROJECT EXECUTION, CO-ORDINATION & CONTROL [10L]**

Communication in a project, Management Information system (MIS), project co-ordination, cost control, crashing of network, controlling project costs: Project cost Vs project completion time, normal time and crash time, time and cost tradeoffs, resource allocation, balance sheet, budget.

## UNIT 4

### CONTACT AND HUMAN RESOURCE MANAGEMENT

[7L]

Types of contracts, sub-contract, tendering procedures, types of payments to contractors, project organization structure project teams, project leadership, project risk management.

## UNIT 5

### PROJECT PERFORMANCE MEASUREMENT & EVALUATION

[5L]

Termination & closeout responsibilities, performance indicators, project evaluation objectives, evaluation methods, post audit: phases & types, audits and audit reports, agencies for post audit.

### COURSE OUTCOMES

1. Identify the characteristics of project and role of project manager.
2. Check the feasibility of project and categorize its life cycle
3. Apply scheduling and financing techniques for given project
4. Develop cost control strategies for project
5. Communicate with team and measure the performance of project

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1											3	
CO2											3	
CO3							2				3	
CO4							2				3	
CO5											3	

### PRIMARY REFERENCES

1. **Project Management:** S.Chodhary, Tata McGraw Hill Publication.
2. **Project Management:** K.Nagarajan, Sixth edition, New Age International Publishers.

### SECONDARY REFERENCES

1. **Project Management Planning and Control Techniques:** Rory Burke, Fifth Edition, Wiley India edition.

2. **Project Management The Managerial Process:** Clifford F Gray and Erik W Larson, Fifth Edition, McGraw Hill publication.
3. **Project Management for Business, Engineering and Technology:** John.M.Nicholas and Herman Steyn, Third edition, Elsevier publication.

#### **E-BOOKS**

1. [http://www.free-management-ebooks.com/Principles of project management-Powl Newton & Helon Bristol](http://www.free-management-ebooks.com/Principles_of_project_management-Powl_Newton_&Helon_Bristol)

#### **MOOCs**

1. Fundamentals of Project Planning and Management (Coursera)
2. Financial Decision Rules for Project Evaluation (edX)

<b>Course Title</b>	<b>PROJECT WORK</b>										<b>Credits</b>	<b>10</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>8</b>	<b>D</b>	<b>C</b>	<b>P</b>	<b>R</b>	<b>W</b>	<b>L-T-P-S</b>	<b>0</b>	<b>0</b>	<b>10</b>	<b>0</b>

### COURSE OUTCOMES

1. Identify the problem and survey literature pertaining to the problem.
2. Explore for sustainable solutions and reason the impact of BT solutions to the problem chosen.
3. Understand the need for good experimental design and scientific research practices
4. Select an appropriate protocol and conduct the experiments
5. Analyse, interpret data and derive valid conclusions.
6. Write effective report and Communicate scientifically via oral presentation.
7. Execute the project in team within stipulated time period.

Mapping of COs with POs												
PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3											2
CO2							2					
CO3			2			2		2				
CO4				3	3							
CO5		3										
CO6										3		
CO7									2		2	

<b>Course Title</b>	<b>INTERNSHIP</b>										<b>Credits</b>	<b>2</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>8</b>	<b>D</b>	<b>C</b>	<b>I</b>	<b>R</b>	<b>S</b>	<b>L-T-P-S</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>0</b>

### **COURSE OUTCOMES**

1. Survey literature pertaining to given problem
2. Formulate the problem, plan and conduct experiment in a given time period
3. Apply various BT techniques to derive a valid conclusion
4. Write effective report and present effectively by oral communication
5. Ability to work individually or team.

<b>Mapping of COs with POs</b>												
<b>PO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO 10</b>	<b>PO 11</b>	<b>PO 12</b>
<b>CO</b>												
CO1	3											3
CO2		2	3			2					2	
CO3					3							
CO4										3		
CO5									2			



<b>Course Title</b>	<b>TRANSPORT PHENOMENA</b>										<b>Credits</b>	<b>3</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>8</b>	<b>D</b>	<b>E</b>	<b>T</b>	<b>R</b>	<b>P</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Knowledge of Unit operations-1 and Unit operations-2.

**COURSE DESCRIPTION:** This course deals with the study of transport phenomena in molecular motion. The course gives an insight into the concepts of transport process in laminar and turbulent conditions. It also emphasizes on the applications of equation of change. This course describes the analogies between transport processes.

**COURSE OBJECTIVES:** The course objective is to enable students to describe mass, momentum and energy transport at molecular, microscopic and macroscopic level, to determine velocity, temperature and concentration profiles.

### UNIT 1

#### **TRANSPORT PHENOMENA BY MOLECULAR MOTION [7L]**

Importance of transport phenomena; concepts, conservation laws; continuous concept, field, reference frames, substantial derivative and boundary conditions; Phenomenological laws of transport properties Newtonian and non-Newtonian fluids; rheological models; theories of transport properties of gases and liquids; Effect of pressure and temperature.

### UNIT 2

#### **ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) [10L]**

General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical;

### UNIT 3

#### **EQUATIONS OF CHANGE AND THEIR APPLICATIONS [10L]**

Conservation laws and equations of change; Development of equations of continuity motion and energy in single multicomponent systems in rectangular co-ordinates and the forms in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change, scale factors; applications in scale-up.

## UNIT 4

### TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW [7 L]

Turbulent phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface.

## UNIT 5

### ANALOGIES BETWEEN TRANSPORT PROCESSES [5L]

Importance of analogy; development and applications of analogies between momentum and mass transfer; Reynolds, Prandtl, Von Karman and Colburn analogies.

### COURSE OUTCOMES

1. Comprehend one dimensional transport process and its applications in laminar flow and turbulent conditions
3. Identify and Analyze transport process involved in molecular motion.
4. Derive and apply equations for solving momentum, mass and heat transfer problems.

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3											
CO2		2										
CO3		3			2							

### PRIMARY REFERENCES

1. **Transport Phenomena** by R.B. Bird, W.E. Stewart and E.W. Lightfoot, John Wiley, II Edition 2006.
2. **Transport Phenomena A Unified Approach** by Robert, S Brodkey, Harry C. Hershey, Brodkey Publishing 2003.

### SECONDARY REFERENCES

1. **Elements of Transport Phenomena** by L.S.Sissom, and D.R.Pitts, McGraw-Hill, New York, 1972.
2. **Elementary Transport Phenomena** by R.W.Fahien,, McGraw-Hill, New York, 1983.
3. **Fundamentals of Momentum Heat and Mass Transfer** J.R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W, V Edn. John Wiley, New York, 2007.

## **E-BOOKS**

1. <http://www.slideshare.net/Aapandove/bird-stewart-lightfoot-2002-transport-phenomena-2nd-ed>
2. [https://www.academia.edu/5797564/09\\_Transport\\_Phenomena\\_A\\_Unified\\_Approach.\\_Robert\\_S.\\_Brodkey.\\_Harry\\_C.\\_Hershey?auto=download](https://www.academia.edu/5797564/09_Transport_Phenomena_A_Unified_Approach._Robert_S._Brodkey._Harry_C._Hershey?auto=download)

## **MOOCs**

1. <https://www.edx.org/course/basics-transport-phenomena-delftx-tp101x-0>
2. <http://nptel.ac.in/courses/103106068/28>

<b>Course Title</b>	<b>NANO BIOTECHNOLOGY</b>										<b>Credits</b>	<b>3</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>8</b>	<b>D</b>	<b>E</b>	<b>N</b>	<b>B</b>	<b>T</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Chemistry, Physics, Bioanalytical techniques, Biosensors and Bioinstrumentation, Molecular Biology, Basics of Biomolecules

**COURSE DESCRIPTION:** This course aims at teaching the fundamentals of nanotechnology and its applications in biomedical and biological research.

**COURSE OBJECTIVES:** This course will increase the student's competence in using technology applications for control of macromolecules processes.

### UNIT 1

#### INTRODUCTION [7L]

A Brief History; Definition of a nano system; Dimensionality and size dependent phenomena: Surface to volume ratio, Fraction of surface atoms, Surface energy and surface stress-, surface defects; Properties at nanoscale (optical, mechanical, electronic, and magnetic). Structure- property relationships in materials. Biomolecule-surface interactions.

### UNIT 2

#### NANOSTRUCURES [10L]

Types of nano structures: Buckyballs, Nanotubes, Fullerenes, Carriers, Dendrimers, Nanoparticles, Membranes / Matrices, Nano shells, Quantum Dot, Nano crystals, hybrid biological/inorganic devices.

Tools for nano structuring and for characterization of nanostructures: Scanning tunneling microscopy, Atomic force microscopy, X-ray spectroscopy, Surface enhanced Raman spectroscopy, Lithography. Biocompatibility of nanostructures. Interaction of nanoparticles with cells. Assessment of the toxic effects.

### UNIT 3

#### NANODIAGNOSTICS [8L]

Function and application of DNA based nanostructures- DNA microarrays, Nanofabricated devices to separate and interrogate DNA. Nano biosensors. . Interrogation of immune and neuronal cell activities through micro- and nanotechnology based tools and devices.

### UNIT 4

#### NANO THERAPEUTICS [8L]

Drug Discovery Using Nano crystals, Resonance Light Scattering (RLS) and Nano sensors. Benefits of Nano-Imaging Agents, Applications in Drug Delivery - Bioavailability, Sustained and

targeted release, Benefits of Nano-Drug Delivery. Nano robots. Health risks and challenges.

## UNIT 5

### BIOMEMS

[6L]

Introduction and Overview, Biosignal Transduction Mechanisms: Electromagnetic Transducers Mechanical Transducers, Chemical Transducers, Optical Transducers – Sensing and actuating mechanisms.

### COURSE OUTCOMES

1. Identify the Nano biomaterials and understand their properties.
2. Apply the concepts of nanotechnology for Nano analytics and characterize nanomaterial.
3. Comprehend the concept of nanotechnology and their role in a wide range of diagnostic and therapeutic applications

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	1										
CO2					3							2
CO3	1	3										

### PRIMARY REFERENCES

1. **A Textbook of Nanoscience and Nanotechnology**, by Pradeep T ,Tata McGraw Hill Education Pvt. Ltd., 2012.
2. **Nanostructured Materials and Nanotechnology** by Hari Singh Nalwa, Academic Press, 2002.
3. **Nanotechnology – Basic Science & Emerging Technologies**: Chapman & Hall/CRC 2002.

### SECONDARY REFERENCES

1. **Nanobiotechnology Protocols**: Rosenthal, Sandra J and Wright, David W., Humana Press, 2005.
2. **Nanotechnology**: Richard Booker and Earl Boysen (Eds), Wiley dreamtech 2005 edition
3. **Nanobiotechnology: Concepts, Applications and Perspectives** (2004), Christof M.Niemeyer (Editor), ChadA. Mirkin (Editor), Wiley VCH.
4. **Nanotechnology – A gentle Introduction to the Next Big Idea**: Mark Ratner and Daniel Ratner, Pearson Education, 2005.
4. **Nanobiotechnology - II more concepts and applications**.(2007) - Chad A Mirkin and Christof M. Niemeyer (Eds),Wiley VCH.

**E-BOOKS**

1. <https://link.springer.com/book/10.1007%2F978-3-642-02525-9>
2. <https://link.springer.com/book/10.1007%2F978-1-59745-218-2>
3. <http://as.wiley.com/WileyCDA/WileyTitle/productCd-3527306587.html>

**MOOCs**

1. <https://www.mooc-list.com/tags/nanotechnology>
2. <https://www.mooc-list.com/course/nanotechnology-and-nanosensors-part-1-coursera>

<b>Course Title</b>	<b>DATA ANALYTICS</b>									<b>Credits</b>	<b>3</b>				
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>8</b>	<b>D</b>	<b>E</b>	<b>D</b>	<b>A</b>	<b>N</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Basics of computer applications, Bioinformatics, Statistics

**COURSE DESCRIPTION:** This course emphasizes on need of Data Analytics and its applications to analyse the data. It also portrays the fundamentals of Hadoop, Hive and RHIPE software tool for to analyse the data.

**COURSE OBJECTIVES:** This course is designed to impart good operational knowledge on basics of Hadoop, Hive and RHADOOP for data analytics. Further students will inculcate these tools and techniques to critically analyse the data.

### UNIT 1

#### **INTRODUCTION TO DATA ANALYTICS [8L]**

Overview of Data Analytics, Need of Data Analytics, Classification of Data: Structured, Semi-Structured, Unstructured, Characteristics of Data, Big Data Technologies, Big data challenges, Applications of Data Analytics, Modern Data Analytic Tools.

### UNIT 2

#### **ONLINE ANALYTICAL PROCESSING (OLAP) [7L]**

Introduction, Characteristics of OLAP systems, Multidimensional view and Data cube, Data Cube Implementations, Data Cube operations, Implementation of OLAP and overview on OLAP Softwares.

### UNIT 3

#### **HADOOP [7L]**

What is Hadoop? Architecture, HDFS: features, Architecture, operations, MapReduce, hadoop ecosystem, Configuration, Uses, Limitations.

### UNIT 4

#### **HIVE QL [7L]**

Introduction, Data Types and File Formats, Databases in Hive –HiveQL: Data Definition, Data Manipulation, Queries, Views, Indexes, Schema Design

### UNIT 5

#### **DATA ANALYSIS USING R AND HADOOP [10L]**

Features of R language, R and Hadoop Integrated Programming Environment (RHIPE): Introduction, Architecture, and function reference, RHADOOP: Introduction, Architecture, function reference, SQL on HADOOP.

## COURSE OUTCOMES

1. Comprehend the basics of Hadoop, Hive and RHADOOP
2. Apply HADOOP and RHADOOP to analyse the data
3. Design big data applications schema and use HIVE QL to analyse the data.

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3											
CO2					2							
CO3					1							

## PRIMARY REFERENCES

1. **Hadoop in practice**, ALEX HOLMES. Manning Publications, 2012
2. **Programming Hive**, Edward Capriolo, Dean Wampler, and Jason Rutherglen. O'Reilly Media, First Edition.
3. **Big data analytics with R and Hadoop**. Prajapati, V. Packt Publishing Ltd, 2013
4. **Introduction to Data Mining** by Pang-Ning Tan, Michael Steinbach, Vipin Kumar Pearson Education, 2005.

## SECONDARY REFERENCES

1. **An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics**. W. N. Venables, D.M. Smith and the R Development Core Team. Version 3.3.3.
2. **Hadoop: The Definitive Guide** by Tom White Third Edition, O'reilly Media, 2011

## E-BOOKS

1. [https://www.tutorialspoint.com/hadoop/hadoop\\_tutorial.pdf](https://www.tutorialspoint.com/hadoop/hadoop_tutorial.pdf)
2. <http://it-ebooks.info/book/608/>

## MOOCs

1. <https://www.coursera.org/browse/data-science/data-analysis>
2. <https://www.mooc-list.com/tags/data-analysis>



<b>Course Title</b>	<b>ADVANCED PROGRAMMING</b>										<b>Credits</b>	<b>3</b>			
<b>Course Code</b>	<b>1</b>	<b>6</b>	<b>B</b>	<b>T</b>	<b>8</b>	<b>D</b>	<b>E</b>	<b>A</b>	<b>P</b>	<b>G</b>	<b>L-T-P-S</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>

**COURSE PRE-REQUISITES:** Basics of computer applications, Bioinformatics, Genome informatics, Statistics, Genomics and proteomics.

**COURSE DESCRIPTION:** This course emphasizes on basics of R programming and interfacing with statistics to analyse the data. It also portrays the fundamentals of Bioconductor an open source software tool for bioinformatics to analyse and interpret the Biological data.

**COURSE OBJECTIVES:** This course is designed to impart good operational knowledge on basics of R programming and interfacing with statistics for the computational analysis of data. This course also highlights the fundamentals and applications of Bioconductor an open source software tool for bioinformatics. Further students will inculcate these tools to critically analyse the data and derive valid conclusions.

### UNIT 1

#### **R PROGRAMMING BASICS [10L]**

Overview of R programming, Environment setup with R Studio, R Commands, Variables and Data Types, Control Structures, Vectors, Factors, Functions, Matrices, Arrays and Lists.

### UNIT 2

#### **INTERFACING [7L]**

Interfacing R to other languages, Parallel R, Basic Statistics: Linear Model, Generalized Linear models, Non-linear models, Time Series, Autocorrelation and Clustering.

### UNIT 3

#### **INTRODUCTION TO BIOCONDUCTOR FOR SEQUENCE DATA [7L]**

Sequencing Resources, Ranges Infrastructure, DNA /amino acid sequence from FASTA files, Reads from FASTQ files, Aligned Reads from BAM files, Called Variants from VCF files, Genome Annotations from BED, WIG, GTF files

### UNIT 4

#### **BIOLOGICAL DATA ANALYSIS [6L]**

Preparing count matrices, The DESeqDataSet, sample information, and formula design, exploratory analysis and visualization, Differential expression analysis, Plotting results, Annotating and exporting results

### UNIT 5

#### **MASS SPECTROMETRY AND PROTEOMICS DATA ANALYSIS [9L]**

Exploring available infrastructure, Mass spectrometry data, Getting data from proteomics repositories, Handling raw MS data, Handling identification data, MS/MS database search, Analysing search results, Analysis of peptide sequences, Trimming the data, Parent ion mass

error, Filtering criteria, Filter optimisation, High-level data interface, Quantitative proteomics, Importing third-party quantitation data, Data processing and analysis, Raw data processing, Processing and normalisation, Statistical analysis, Machine learning: Classification, Clustering: k-means, Annotation.

## COURSE OUTCOMES

1. Comprehend the basics of R programming and Bioconductor
2. Apply statistical techniques using R Programming for analysis of data.
3. Analyze and interpret the Biological data using the Bioconductor tools to.

Mapping of COs with POs												
PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1											
CO2					2							
CO3					3							

## PRIMARY REFERENCES

1. **An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics.** W. N. Venables, D.M. Smith and the R Development Core Team. Version 3.3.3.
2. **R for Everyone: Advanced Analytics and Graphics:** by Jared P. Lander Addison-Wesley Data & Analytics Series, 2013.

## SECONDARY REFERENCES

1. **The Art of R Programming: A Tour of Statistical Software Design:** by Norman Matloff, No Starch Press, 2011.
2. **A Little Book of R for Bioinformatics:** by Avril Coghlan, Release 0.1

## E-BOOKS

1. <https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf>
2. <https://www.bioconductor.org/>

## MOOCs

1. <https://www.class-central.com/tag/r%20programming>
2. <https://www.edx.org/course/introduction-r-data-science-microsoft-dat2>

## MANAGEMENT AND ENTREPRENEURSHIP (Proposed)

Subject Code: <b>HS03</b>	No. of Credits: 03	No. of lecture hours per week: 03
Exam Duration hours: 03	SEE Marks: 100	Total no. of lecture hours: 39
CIE Marks: 50		

Unit No.	Syllabus Content	No. of Hours
<b>1</b>	<b>MANAGEMENT:</b> Introduction-meaning-nature and characteristics of management, scope and functional area of management, management as a science or art of profession, management and administration roles of management, levels of management, Development of management thought -Early management approaches, Modern management approaches.	<b>08 Hours</b>
<b>2</b>	<b>ENTREPRENEUR:</b> Meaning, evolution of the concept, functions of an Entrepreneur, Characteristics of an Entrepreneur, types of entrepreneur, Intrapreneur – an emerging class. Difference between Entrepreneur, Intrapreneur & Manager, Stages in Entrepreneurial process, Scope of Entrepreneur & Problems of Entrepreneur, Role of Entrepreneurs in economic development, Entrepreneurship-Meaning & Importance of Entrepreneurship in India. Its barriers, Women entrepreneur – Concept & steps to develop Women Entrepreneur.	<b>10 Hours</b>
<b>3</b>	<b>SMALL SCALE INDUSTRY:</b> Ancillary Industry and Tiny Industry , Definition, Characteristics; Objectives, Scope and role of SSI in economic Development, Advantages of SSI, problems of SSI, Steps to start an SSI, Government Policy towards SSI; Introduction to GATT/ WTO/ LPG. Forms of ownership. <b>SUPPORTING AGENCIES OF GOVERNMENT FOR SSI:</b> Meaning, Nature of support; Objectives, functions. <b>INSTITUTIONAL SUPPORT:</b> Different Schemes, TECKSOK, KIADB, KSSIDC, DIC, SISI NSIC, SIDBI, KSFC. Sources of financing an enterprise- long term and short term.	<b>12 Hours</b>
<b>4</b>	<b>PREPARATION OF PROJECT:</b> Meaning, Project identification, Project selection, Project Report - Need of Project, Contents: formulation:, Net work Analysis Errors of project report, Project Appraisal, Feasibility Study-Market Feasibility Study, Technical Feasibility Study, Financial Feasibility Study, Social Feasibility Study.	<b>9 Hours</b>

*Note: One question from each Unit of 20 marks each. Questions from Unit 2 and 4 will have internal choice.*

### RECOMMENDED BOOKS:

1. Entrepreneurship and Management- S Nagendra and V S Manjunath- Pearson Publication 4/e, 2009.
2. Dynamics of Entrepreneurial Development and Management-Vasant Desai-Himalaya Publishing House.
3. Principles of Management – PC Tripathi, and P N Reddy – Tata MacGraw Hill.

### REFERENCE BOOKS:

1. Entrepreneurship Development – Poornima M Charanthimath Pearson Education 2006.
2. Entrepreneurship and management - Shashi k Gupta- Kalyani publishers, Latest edition.

3. Organizational behaviour, Stephen P Robbins, Timothy A. Judge, Neharika Vohra, Pearson, 14/e, 2012.
4. Financial Management- Shashi k Gupta- Kalyani publishers, Latest edition.

**COURSE OUTCOMES:**

After completing the course, the students will be able to

- Gain knowledge on Management concepts & its evolution.
- Learn the application of Managerial skills & attributes.
- Get an in depth knowledge of Entrepreneurial process & will be able to apply the Entrepreneurial skills.
- Compile information & explore the business opportunities.
- Able to prepare the Business plan.