RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Bachelor of Engineering (B.E.)
Scheme and Syllabus of VII& VIII Semesters

2018 SCHEME

BIOTECHNOLOGY

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

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2018 SCHEME

BIOTECHNOLOGY

DEPARTMENT VISION

A Premier Department in Biotechnology Education, Research and Innovation with a Focus on Sustainable Technologies for the Benefit of Society and Environment.

DEPARTMENT MISSION

- Create state-of-the-art infrastructure for research and training in Biotechnology
- Develop graduates who are ethically and socially concerned
- Promoting collaboration with academia, industries and research organizations at national and international level
- Contribute to socioeconomic development through sustainable and inclusive technologies

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Have a strong foundation in scientific and engineering principles, develop oral and written communication skills and team work that prepare them for a successful career in Biotechnology and allied industries.
PEO2: Function at a technically competent level in formulating and solving problems in Biotechnology and to develop an outlook for higher education and lifelong learning.
PEO3: Organize and utilize the knowledge to develop biological processes and products, exhibit professionalism, ethical attitude to become an entrepreneur.

PROGRAM SPECIFIC OUTCOMES (PSOS)

PSO	Description
PSO1	Gain knowledge in Basic sciences, Mathematics and Biology to understand the Engineering problems related to Biotechnology and Bioinformatics.
PSO2	Develop the skills in the area of Biotechnology, Chemical Engineering and Informatics to solve complex Biological problems.
PSO3	Acquire technical knowledge to design, analyse, optimize and scale up Bio processes to develop value added products.
PSO4	Develop intellectual, personal and professional abilities through experiential learning and interdisciplinary projects.

Lead Society: American Society of Agricultural and Biological Engineers

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	PE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics

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RV COLLEGE OF ENGINEERING®
(Autonomous Institution Affiliated to VTU, Belagavi)
BIOTECHNOLOGY
SEVENTH SEMESTER CREDIT SCHEME

SEVENTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			**Total Credits**
				L	T	P	
1	18HS71	Constitution of India and Professional Ethics	HSS	3	0	0	3
2	18BT72	Downstream Process and Product Recovery (Theory and Practice)	BT	4	0	1	5
3	18BT73	Genomics, Proteomics and Nanotechnology	BT	4	1	0	5
4	18BT74	Internship / Course	BT	0	0	2	2
5	18BT7FX	Elective F (PE)	BT	3	0	0	3
6	18BT7GX	Elective G (PE)	BT	3	0	0	3
7	18G7HXX	Elective H (OE)*	Res. BOS	3	0	0	3
Total Number of Credits				**20**	**1**	**3**	**24**
Total number of Hours/Week				**20**	**2**	**7.5**	

Note: * Internship (6 weeks) is to be carried during the vacation after 6th semester and evaluation shall be conducted during 7th semester for 2 credits.

** Students should take other department Global Elective courses.

EIGHT SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			**Total Credits**
				L	T	P	
1.	18BTP81	Major Project	BT	0	0	16	16
Total Number of Credits				**0**	**0**	**16**	**16**
Total number of Hours/Week						**32**	

VII Semester			
PROFESSIONAL ELECTIVES (GROUP F)			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1	18BT7F1	Nanobiotechnology	3
2	18BT7F2	Sustainable and Precision Agriculture	3
3	18BT7F3	Equipment Design & Drawing	3
4	18BT7F4	Artificial Intelligence	3

VII Semester			
PROFESSIONAL ELECTIVES (GROUP G)			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1	18BT7G1	Forensic Sciences	3
2	18BT7G2	Metabolites and Bioprospecting	3
3	18BT7G3	Alternative Energy	3
4	18BT7G4	Next Generation Sequencing Informatics	3

VII Semester				
OPEN ELECTIVES (GROUP H)				
Sl. No.	**Course Code**	**Host**	**Course Title**	**Credits**
1	18XX7H1	AS	Unmanned Aerial Vehicles	3
2	18XX7H2	BT	Bioinformatics	3
3	18XX7H3	CH	Industrial safety and Risk management	3
4	18XX7H4	CS	Web programming	3
5	18XX7H5	CV	Solid waste management and statutory regulations	3
6	18XX7H6	EC	Image processing and machine learning	3
7	18XX7H7	EE	Renewable energy sources and storage	3
8	18XX7H8	EI	Mems & applications	3
9	18XX7H9	ET	Project management	3
10	18XX7H10	IM	Cyber forensics and digital investigations	3
11	18XX7H11	IS	Robotics and automation	3
12	18XX7H12	ME	Space technology and applications	3
13	18XX7H13	PY	Introduction to astrophysics	3
14	18XX7H14	CY	Materials for advanced technology and spectroscopic characterization	3
15	18XX7H15	MA	Applied psychology for engineers	3
16	18XX7H16	HSS	Advance course in entrepreneurship	3

VIII Semester			
Sl. No.	**Course Code**	**Course Title**	**Page No.**
1.	18BTP81	Major Project	

Semester: VII						
CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS **(Theory)** **(Common to All Programs)**						
Course Code	**:**	**18HS71**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**36L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Apply the knowledge of constitutional literacy to become aware of the fundamental rights and duties in their role as Engineers.
2	Understanding of ethical and legal aspects of advertising, consumer problems and their redressal mechanism related to product and service standards.
3	Discuss the knowledge of substantive Labor law and to develop skills for legal reasoning and statutory interpretations.
4	Evaluate individual role, responsibilities and emphasize on professional/ engineering ethics in shaping professions.

Unit - I	**10 Hrs**
Indian Constitution- Salient features of Indian Constitution ,Preamble to the Constitution of India; Provisions Relating to Citizenship in India- at the Commencement of the Constitution and Later with latest amendments, Modes of Acquisition and Termination of Citizenship of India. Scope & Extent of Fundamental Rights-Articles 14-32 with case studies; Right to Information Act, 2005 with Case studies.	
Unit – II	**10 Hrs**
Directive Principles of State Policy- Significance of Directive Principles of State Policy, Fundamental Duties in the Constitution of India; Union Executive- President and State Executive- Governor; Parliament & State Legislature; Council of Ministers; Anti-defection law; Union and State Judiciary; Emergency provisions; Elections, Administrative tribunals. Human Rights & Human Rights Commission.	
Unit –III	**06 Hrs**
Consumer Protection Law - Definition and Need of Consumer Protection; Consumer Rights under the Consumer Protection Act, 2019; Unfair Trade Practice, Defect in goods, Deficiency in services; Product liability and Penal Consequences, False and Misleading Advertisement, E-Commerce**,** Alternate dispute Redress mechanism**;** Redresses Mechanisms under the Consumer Protection Act, 2019. **An overview of Indian Penal Code 1860 (Law Of Crimes)**	
Unit – IV	**06 Hrs**
Introduction to Labour Legislations - Industrial Relation, Labour Problem and Labour Policy in India; Labour Welfare and Social Security- Factories Act, 1948, Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013; the Child Labour (Prohibition and Regulation) Act, 1986, Maternity Benefit (Amendment) Act, 2017; Industrial Dispute Act, 1947, Reference of Disputes to Boards, Courts or Tribunals.	
Unit –V	**07 Hrs**
Scope and aims of engineering ethics (NSPE Code of Ethics), Responsibility of Engineers, Impediments to responsibility. Honesty, Integrity and reliability, Risks, Safety and Liability in Engineering. Corporate Social Responsibility. Statutory Provision regarding prohibition and prevention of Ragging.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Demonstrate the citizen's fundamental Rights, duties & consumer responsibility capability and to take affirmative action as a responsible citizen.
CO2	Identify the conflict management in legal perspective and judicial systems pertaining to professional environment, strengthen the ability to contribute to the resolve of human rights & Ragging issues and problems through investigative and analytical skills.
CO3	Understanding process of ethical and moral analysis in decision making scenarios and inculcate ethical behavior as a trait for professional development.
CO4:	Apply the knowledge to solve practical problems with regard to personal issues & business Enterprises.

Reference Books	
1	Dr. J. N Pandey, Constitutional Law of India, Central Law Agency, 2020 edition
2	Avtar Singh: Law of Consumer Protection: Principles and Practice, Eastern Book Company, 5th Edition, 2015, ISBN -13:978-9351452461
3	S.C. Srivastava: Industrial Relation and Labour Laws, Vikas Publishing House, 6th Edition, 2012, ISBN: 9789325955400
4	Jr. Charles E Harris, Michael. S. Pritchard and Michael J Rabins, Engineering Ethics, Wadsworth Cengage Learning, 5th Edition, 2009, ISBN-978-0495502791

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2 : Low-1

Semester: VII						
Downstream Process and Product Recovery (Theory and Practice)						
Course Code	**:**	**18BT72**		**CIE**	**:**	**100+50=150 Marks**
Credits: L:T:P	**:**	**4:0:1**		**SEE**	**:**	**100+50=150 Marks**
Total Hours	**:**	**52L**		**SEE Duration(Theory)**	**:**	**3.00 Hours**
				SEE Duration (Practicals)	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the importance of purification technology of biological products at industrial scale.
2	Comprehend various primary purification techniques for bioproducts.
3	Learn Purification techniques for isolation of products from complex biological mixtures
4	Impart membrane technology application to lab scale and process scale techniques for handling crude broth and purification techniques.
5	Apply the knowledge towards secondary and advanced separation techniques for lab and process scale purification of biological products

Unit-I	**08 Hrs**
Introduction to Downstream processing: Overview of upstream and downstream processing, Basic concepts of bio separation technology, Economic importance of downstream processing in biotechnology, properties of biological materials. Characteristics of biological molecules, Separation characteristics of recombinant proteins, enzymes, Vaccines and monoclonal antibodies.	
Unit – II	**08 Hrs**
Biomass removal and disruption: Cell disruption by Mechanical and non- mechanical methods, Chemical lysis, Enzymatic lysis, physical methods, Sonication, High pressure Homogenizer, Flocculation methods and its applications. Centrifugation and ultracentrifugation. Simple Numerical on cell disruption and centrifugation	
Unit –III	**12 Hrs**
Filtration: Separation of products by filtration: dead end filtration, depth filtration, concept of filter medium resistance, Rotary Vacuum Filtration, scale up of filtration systems, different modes of operation. **Extraction:** Principles of solid-liquid extraction, Liquid - Liquid extractions, multistage and counter current multistage extraction. Selection of solvent, Extraction equipment: working of Bollman, Mixer-settler and York-Scheibel extractors. Precipitation (salt, pH, organic solvent, high molecular weight polymer).Numerical problems on filtration and extraction.	
Unit –IV	**12 Hrs**
Membrane Based Separation: Structure and characteristics of membranes, types of membranes, membrane equipment, Phenomenon of concentration polarization, membrane fouling and its consequences. Membrane based purification: Microfiltration, Ultrafiltration, Nanofiltration and Diafiltration. Biotechnological applications of membrane based separations. **Industrial bioproducts processing**: Baker's yeast, cheese, alpha amylase, HFCS production, Biopolymers, Hepatitis B. Numerical on membrane based bioseperation	
Unit –V	**12 Hrs**
Advanced Separation Techniques: Chromatography:- general theory; separation based on Size, Charge, Hydrophobicity and Affinity: Gel filtration, Ion exchange chromatography, Affinity chromatography, and hydrophobic interaction chromatography (HIC). Polishing of Bio products by Crystallization, Drying equipment- Tray Drier, Rotary Drier and Freeze Drier.	

Case studies: Large scale separation and purification of Recombinant human Insulin, Monoclonal Antibodies, Biodiesel and Biobutanol production
LAB EXPERIMENTS
1. Cell disruption techniques- physical method 2. Solid-liquid separation methods: sedimentation by flocculating agents. 3. Solid-liquid separation methods: Membrane filtration. 4. Solid-liquid separation methods: Centrifugation 5. Product enrichment operation: ammonium sulphate precipitation of proteins. 6. Product enrichment operation: aqueous two phase extraction (single stage). 7. Separation of amino acids/vitamins/pigments by adsorption Chromatography. 8. Efficiency of centrifugation on the citric acid broth separation. 9. Product drying technique-vacuum tray drier. 10. Crystallization Technique for bioactive compound.

Note: Each student has to perform 10 experiments in a semester. 10 Experiments are guided experiments

Course Outcomes: After completing the course, the students will be able to	
CO1:	Highlight the importance of downstream processing of biological products.
CO2:	Interpret the techniques for various intracellular and extracellular products from complex biological mixtures.
CO3:	Apply techniques to concentrate and purify biological products
CO4:	Initiate different processes for separation and purification of biological products

Reference Books	
1	Filtration and Purification in the Biopharmaceutical Industry, Uwe Gottschalk, 3rd Edition, 2019, CRC Press, ISBN:9781315164953.
2	Principles of Bioseparation Engineering, Ghosh R, 1st edition, 2006, World Scientific Publishing. ISBN: 9812568921.
3	Bio separations Science and Engineering, Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, 2nd Edition 2015, Oxford University Press., ISBN: 0195391810.
4	Downstream Process Technology: A New Horizon In Biotechnology, Krishnaprasad N, Eastern Economy Edition, 2010, PHI Learning India ltd., ISBN: 9788120340404.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	2	1	-	-	1
CO2	2	3	-	3	-	-	-	2	-	-	1	-
CO3	3	2	1	2	-	-	-	1	-	-	-	-
CO4	3	2	2	1	-	-	-	1	-	-	-	2

High-3: Medium-2: Low-1

Semester: VII						
GENOMICS PROTEOMICS AND NANOTECHNOLOGY						
Course Code	**:**	**18BT73**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**4:0:1**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**52L**		**SEE Duration(Theory)**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Understand the molecular aspects of the genome.
2	Develop the concepts and principles underlying the human genome project and other genome program.
3	Differentiate between the different structures and functions of the proteome. Identify genetic markers for breeding purposes.
4	Apply the methods of synthesis, fabricate and characterize the materials to nanoform.

Unit-I	**12Hrs**
Introduction to Eukaryotic genes and Polymorphisms: Organization of eukaryotic (microbial, plant and animal genomes) within nucleus, Central dogma and Inheritance pattern. Mitochondrial and chloroplast genome. Polymorphism. C-Values of eukaryotic genomes. **Sequencing and genome projects:** Early sequencing efforts, Methods of preparing genomic DNA for sequencing, **Sequencing strategies**: shot-gun approach, clone contig approach, **DNA sequencing methods:** Gilbert and Maxim, Sanger Dideoxy method, Fluorescence method, High throughput sequencing. Major genome sequencing projects.	
Unit – II	**10 Hrs**
Genomics: Expressed sequenced tags (ESTs), Single Nucleotide Polymorphisms (SNPs). **Functional genomics:** Finding genes in the genome, assigning functions to the gene. **Genotyping** – DNA chips and diagnostics assays, RT-PCR, SAGE& DD-PCR. Importance of noncoding sequences – miRNA and RNAi. Molecular markers in genome analysis, Telomerase as molecular markers, FISH-DNA amplification markers. Types of mapping and their usefulness to plant and animal breeding.	
Unit -III	**10Hrs**
An introduction to proteomics: Basics of protein structure and function, Evolution from protein chemistry to proteomics; Abundance-based proteomics: Sample preparation and prefractionation steps, Gel-based proteomics - two-dimensional gel electrophoresis (2-DE), two dimensional fluorescence difference in-gel electrophoresis (DIGE), Staining techniques, Image analysis of 2DE gels. Central role of mass spectrometry: ionization sources, mass analyzers, different types of mass spectrometers	
Unit –IV	**10 Hrs**
Quantitative proteomics - Stable isotope labelling by amino acids in cell culture (SILAC), isotope-coded affinity tag (ICAT), isobaric tagging for relative and absolute quantitation (iTRAQ); Interactomics - techniques to study protein-protein interactions, yeast two-hybrid, immunoprecipitation, protein microarrays, Label-free nanotechnologies in proteomics, Surface Plasmon Resonance (SPR); Modificomics: understanding post-translational modifications; Structural proteomics; Bioinformatics in proteomics; Challenges and future prospects of proteomics research.	
Unit –V	**10 Hrs**
Introduction to nanomaterials: History, Types of nanomaterials: Fullerenes (Grephene, Bucky ball, Nano tubes, Nanoshells, Quntum dots, Dendrimers, Nanocarriers. **Nanosynthesis.** Ball milling, CVD, Sol gel, Plasma arching. **Top-Down and Bottom-up** approaches, methods of nanofabrication: soft- and hard-lithography. **Characterization of Nanomaterials:**	

Spectroscopic methods: UV-VIS, FTIR and Raman. **Microscopic method:** Scanning Electron Microscopy, Transmission Electron Microscopy, **Scanning probe methods**: Atomic Force Microscopy, Scanning & Tunneling Microscopy,

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand and remember the concepts of various genes and their expression.
CO2:	Apply various large scale sequencing methods for sequencing various organisms genome.
CO3:	Acquire and evaluate the methods involved in analysis of genome and proteome.
CO4:	Develop or create a diagnostic tool for plant, animal and human diseases using the knowledge of nanotechnology.

Reference Books	
1	Genome analysis and Genomics- S.B Primrose and R M Tayman, 3rd Ed.,2002 Wiley-Blackwell ISBN: 978-1-4051-0120.
2	Genomics and Proteomics: Principles, Technologies, and Applications, Devarajan Thangadurai and Jeyabalan Sangeetha, 1st Edn, 2021, Apple Academic Press, ISBN 9781774635377.
3	Introduction To Genomics, 2Nd Edn by Lesk, Oxford University Press, 2015, Paperback, 9780198745891
4	Nanotechnology Trends and Future Applications, Tahir, Muhammad Bilal, Rafique, Muhammad, Sagir, Muhammad, 2021, Springer, (Eds.), ISBN 978-981-15-9437-3.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	2	2	1	2	-	-	-	-
CO2	1	3	3	2	1	2	2	2	1	-	2	2
CO3	3	3	3	1	3	2	2	3	2	-	2	2
CO4	1	3	3	1	3	3	2	3	2	-	2	2

High-3 : Medium-2 : Low-1

SEMESTER : VII						
INTERNSHIP						
Course Code	**:**	**18BT74**		**CIE Marks**	**:**	**50**
Credit L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50**
Hours/week	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. The duration of the internship shall be for a period of 6/8 weeks on full time basis after IV semester final exams and before the commencement of VII semester.
2. The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3. Internship must be related to the field of specialization of the respective UG programme in which the student has enrolled.
4. Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5. Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
6. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for UG circuit Programs and Light Blue for Non-Circuit Programs.
7. The broad format of the internship final report shall be as follows

- Cover Page
- Certificate from College
- Certificate from Industry / Organization
- Acknowledgement
- Synopsis
- Table of Contents
- Chapter 1 - Profile of the Organization: Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
- Chapter 2 - Activities of the Department
- Chapter 3 - Tasks Performed: summaries the tasks performed during 8-week period
- Chapter 4 – Reflections: Highlight specific technical and soft skills that you acquired during internship
- References & Annexure

Course Outcomes:

After going through the internship the student will be able to:

CO1: Apply engineering and management principles

CO2: Analyze real-time problems and suggest alternate solutions

CO3: Communicate effectively and work in teams

CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments,	45%
Review-II	Importance of resource management, environment and sustainability presentation skills and report writing	55%

Scheme for Semester End Evaluation (SEE):

The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

Professional Elective F

Semester: VII						
NANOBIOTECHNOLOGY						
Course Code	**:**	**18BT7F1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 Hrs**		**SEE Duration(Theory)**	**:**	**3.00 Hours**

Course Learning Objectives:

1	To understand the fundamentals of nanomaterials, their structures and applications in various field.
2	To Describe methods by which nanoscale manufacturing and production can be enabled and characterization techniques for them.
3	To have awareness about Micro & Nano Electromechanical systems and Microfluidics.
4	To learn about Nano sensors and nano biosensors; nanoscale product and their applications in medical field.
5	To study about the nanosensors used in diagnostic and therapeutic and their applications in medical field.

Unit-I	**07 Hrs**
Introduction to nanomaterials and Fundamentals of Nanotechnology and Nanoengineering: History, Types of nanomaterials: Fullerenes (Grephene, Bucky ball, Nano tubes, Diamond like carbon, DLC), Nanoshells, Quntum dots, Dendrimers, Nanocarriers. Nanowires. **Nanobiomaterials:** DNA and Protein based Nano structures, array nanostructures. Function and application of DNA and protein based nanostructures.	
Unit – II	**08 Hrs**
Nanomaterials, Synthesis and Characterization: Approaches of Fabrication: Top-Down and Bottom-up methods of nanofabrication and Nanosynthesis: Ball milling, CVD, Sol gel, Plasma arching. Biosynthesis of Nanoparticles. Nanolithography: hard (Optical, UV, EUV, X-ray) and soft lithography. Characterization of nanomaterials using spectroscopic (UV-VIS, FTIR and Raman) and microscopic methods Atomic Force Microscopy, Scanning & Tunneling Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy (AFM, STM, SEM and TEM).	
Unit –III	**07 Hrs**
Micro & Nano Electromechanical systems **and Microfluidics**: MEMS/NEMS: Nanotransducers: Nano- mechanical, electrical, electronic, Magnetic and Chemical Transducers. Nano sensors and Nano Actuators: types of actuators. Microfludics: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps.	
Unit –IV	**07** Hrs
Nanosensors and Nanobiosensors: Overview of nanosensors, prospects and market. Types of Nanosensors and their applications. Electromagnetic nanosensors: Magnetic nanosensors. Mechanical nanosensors. Types of nanobiosensors: Cantilever, nanotube, nanowire and nanoparticle based sensor, Nanosensors, Mechanics of CNTs, Biosensors in modern medicine.	
Unit –V	**10 Hrs**
Medical Nano Technology: Diagnostics, therapeutics, drug delivery, Nano Surgery and Tissue Engineering. Diagnostics: Resonance Light Scattering (RLS) Technology, Nano chips, gene and protein chips. Therapeutic: Drug delivery: Bioavailability, Drug Delivery Applications, Bioavailability, Sustained and targeted release. Benefits of Nano drug delivery system. Use of	

Microneedles and nanoparticles for targeted and highly controlled drug delivery. Nano robots in drug delivery and cleaning system. Design of nanoparticles for oral delivery of peptide drugs, Tissue Engineering.. Nanotoxicity assessment: In-vitro laboratory tests on the interaction of nanoparticles with cells. Body on a chip and lab on a chip.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Remember, understand and apply knowledge about nanomaterials and their uses. Interpret and apply the techniques of manufacturing and characterization processes.
CO2:	Understand the Micro & Nano Electromechanical systems and Microfluidics Interpret and apply the techniques and processes.
CO3:	Understand and apply knowledge of nanosensors and nanobiosensors applications like electronics, mechanical, chemical, and biological systems
CO4:	Apply knowledge of nanosensors and nanobiosensors to create and evaluate nano-design, devices and systems applicable to various medical disciplines.

Reference Books	
1	Textbook of Nanosciences and Nanotechnology, B.S. Murty, P. Shankar, B. Raj, B. B. Rath and J. Murday, 2013, Springer, Co-publication with University Press (India) Pvt. Ltd. VCH, XII. ISBN- 978-3-642-28030-6.
2	Springer Handbook of Nanotechnology**,** Editors: Bhushan, Bharat (Ed.), 2017, Springer, ISBN 978-3-662-54357-3.
3	Nanotechnology and Nanomaterial Applications in Food, Health, and Biomedical Sciences (Innovations in Agricultural & Biological Engineering), Deepak Kumar Verma, Megh R. Goya, Hafiz Anasr Rasul Suleria, 2019, Apple Academic Press, CRC Press, Taylor & Francis Group**,** ISBN-10 1771887648.
4	Nanotechnology Trends and Future Applications, Tahir, Muhammad Bilal, Rafique, Muhammad, Sagir, Muhammad, 2021, Springer, (Eds.), ISBN 978-981-15-9437-3.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	3	1	3	2	2	1	2	1	1	2
CO2	2	3	3	2	3	2	-	2	2	1	2	1
CO3	3	3	2	2	3	3	2	2	2	1	2	2
CO4	3	3	2	3	3	3	2	**-2**	2	1	2	1

High-3 : Medium-2 : Low-1

Semester: VII						
SUSTAINABLE AND PRECISION AGRICULTURE (Theory)						
Course Code	**:**	**18BT7F2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able	
1	Understand basic concepts of Precision Agriculture, including: a. soil and crop spatial variability; precision integrated crop management.
2	Comprehend the use spatial information for improved soil and crop management. environmental, socio-economical, and e-marketing aspects.
3	Develop a better understanding and retention of material through hands-on modules, group discussions, problem solving, and group projects
4	Appreciate value of precision agriculture from on-farm and agribusiness visits
5	Realize the potentials and limitations of applying the concept of Precision Agriculture to global level

Unit-I	**8 Hrs**
Concept of Sustainable and Precision Agriculture: Introduction to Precision, Prescriptive and Digital Agriculture: Scope, Definition, Historic Perspectives and Applications. Organic Farming: Concepts and principles of organic farming. Key indicators of sustainable agriculture, organic farming and climate change Input management. Digital Agriculture – IoT and Future Digital Tools, Ponics: Aero and Hydro; Perspective and application. Precision Farming; Economics and Adoption, The Human Side of Adopting Precision Technologies.	
Unit – II	**8 Hrs**
Agriculture Precision and Analysis: Precision Soil Sampling and Yield Monitoring, Telematics: ISOBUS Concept and Technology, Geographic Information Systems, and Remote Sensing Coordinate Systems: Components of GIS: Capture, Storage, Editing, Analysis, Display and Output. Map Scales, Spatial and Temporal Analysis. Farm Management Information Systems & Data Management Platforms, Data Analysis: Experimental Design, Data Quality, Mining, Analysis, Compatibility, Interpretation and Correlation.	
Unit – III	**8 Hrs**
Sensing and Imaging: Global Positioning Systems (GPS) and DGPS: Overview, GNSS, Factors Influencing GPS, Manual Guidance Systems, Auto guidance Systems Module. Sensors: Sensing Platforms—Satellite, UAV, Aerial, Proximal, Active vs. Passive Remote Sensing, Spectral, Spatial, and Temporal Resolution, Precision Irrigation Systems. Precision Drainage Systems. Nutrient Spatial Variability: Sampling in Space and Time, Grid and Zone Soil Sampling, Crop Spatial Variability Soil Sensors, Crop Sensors, Quality Sensors—Protein, Oil, etc. Pest Spatial Variability.	
Unit – IV	**7 Hrs**
Advanced Agricultural Technologies: Difference between traditional and modern agricultural practices; Internet of Things (IoT), Online Marketing of agro-based products, Phenomics – Principle and mechanism, Agricultural Drones & Robotics, Artificial Intelligence (AI) based farming.	
Unit – V	**8 Hrs**
Sustainability and Agriculture: Sustainable agriculture and sustainable food systems: concept, perspective, scope and application, Soil health, crop Production, Pest & disease management, Weed management, Livestock care & planning, Farm Business Design, Marketing, Labour management, Global Change and Sustainable Agriculture, sustainable strategies and food security, Issues in sustainable agriculture	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recognize the scientific, social and economic implications in Sustainable and precision agriculture
CO2:	Analyse the perspective of sensing and imaging in technology for the better yield
CO3:	Evaluate various tools, techniques and advances for better formulation and productivity
CO4:	Formulate the proof of concept for sustenance and precision agriculture for global outreach

Reference Books	
1	Organic Farming for Sustainable Agriculture, Nandwani,Dilip, 2016, Springer publishers, ISBN 978-3- 319-26803-3
2	Precision Agriculture Basics. D. Kent Shannon David E. ClayNewell R. Kitchen. 2018. John Wiley & Sons, Inc.ISBN:9780891183662
3	Precision Agriculture Technologies for Food Security and Sustainability. Sherine M. Abd El-Kader, Basma M. Mohammad El-Basioni.2021.IGI Global publisher. ISBN: 978179985000
4	Precision Agriculture: Technology and Economic Perspectives. Pedersen, Søren Marcus, Lind, Kim Martin. 2017. Springer International Publishing. ISBN 978-3-319-68713-1

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	3	2	1	1	1	-	1	3	2
CO2	2	2	2	1	1	-	2	-	-	2	1	1
CO3	1	3	2	2	-	2	3	2	-	1	1	3
CO4	2	3	3	3	1	-	3	-	2	2	2	2

High-3: Medium-2 : Low-1

Semester: VII						
EQUIPMENT DESIGN AND DRAWING (Elective - F) **(Theory and practice)** **(Group F: Professional Elective)**						
Course Code	**:**	**18BT7F3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**2:0:2:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**50 L**		**SEE Duration**	**:**	**4.00 Hours**

Course Learning Objectives: The students will be able to	
1	Learn the basics of design using Code book and Perry Hand book
2	Explore the abilities of sectional front view and top view of the biochemical equipment accessories.
3	Study mechanical design of equipment's involved in biological reactions as per IS2825 unfired pressured vessels code book.
4	Study the process design of equipment involved in biological reactions as per Perry Hand book.

Unit-I	**10 Hrs**
Batch reactor and Jacketed vessel: Detailed Process Design and mechanical design of the Batch reactor using standard code books. The detailed dimensional drawings shall include sectional front view, Full Top/Side view depending on equipment using CAD.	
Unit-II	**10 Hrs**
Packed bed Distillation Column: Detailed Process Design and mechanical design of the packed bed distillation column using standard code books. The detailed dimensional drawings shall include sectional front view, Full Top/Side view depending on equipment using CAD.	
Unit-III	**10 Hrs**
Shell and Tube Heat Exchanger: Detailed Process Design and mechanical design of the Shell and Tube Heat exchanger using standard code books. The detailed dimensional drawings shall include sectional front view, Full Top/Side view depending on equipment using CAD.	
Unit-IV	**10 Hrs**
Moving Bed Bioreactor (MBBR): Detailed Process Design and mechanical design of the MBBR using standard code books. The detailed dimensional drawings shall include sectional front view, Full Top/Side view depending on equipment using CAD.	
Unit-V	**10 Hrs**
Adsorption column: Detailed Process Design and mechanical design of the Adsorption column using standard code books. The detailed dimensional drawings shall include sectional front view, Full Top/Side view depending on equipment using CAD.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Remember and understand the concepts of design and use of the IS 2825 code book and J H Perry hand book
CO2:	Integrate the standard design parameters to design of bio equipment.
CO3:	Evaluate the various parameters of distillation column, heat exchangers
CO4:	Generate drawings of distillation column, heat exchanger and bioreactors using CAD.

Reference Books	
1	Chemical Engineers Handbook, Robert H Perry. & D.W. Green, 9th Edition, 2018, McGraw Hill; ISBN: 9780071834087
2	IS 2825: Code for Unfired pressure vessels, 2005, Bureau of Indian Standards, New Delhi; UDC 66.023 : 621.642.
3	Design of Process Equipment Design, M.V. Joshi and V.V. Mahajan, 2009, 4th Edition, McMillan India; ISBN: 978-0230638105.
4	Chemical Engineering Design, J.M. Coulson & J.F. Richardson, 2005, Pregman Press; ISBN 07506 65386.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The 10 marks component is for Equipment drawing/Assignment/Presentation/Project.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks executed by means of an examination. The Question paper for the course contains two main questions with internal choice; each main question carries 100 marks (60 Marks for design and 40 Marks for drawing in CAD). Each main question may have sub questions covering entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	-	-	2	2	1	1	-	-	2
CO2	2	2	-	3	3	1	-	-	1	-	-	1
CO3	3	2	1	-	-	2	2	-	1	-	-	2
CO4	2	3	2	2	2	2	-	-	-	-	-	1

High-3: Medium-2: Low-1

Semester - VII						
Artificial Intelligence (Theory)						
Course Code	**:**	**18BT7F4**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 hrs**

Course Learning Objectives (CLO): Graduates shall be able to

1. Understand the basic concepts of Artificial Intelligence
2. Learn the applications of artificial intelligence in bioinformatics
3. Learn some basic search algorithms for problem solving; knowledge representation and reasoning; pattern recognition; fuzzy logic; and neural networks.
4. Understand the advancements of designing the intelligent systems that can solve general purpose problems, represent and process knowledge, plan and act, reason under uncertainty.

Unit – I	**10 Hrs**
Introduction to Artificial Intelligence: Introduction to Artificial Intelligence, Problems, Approaches and tools for Artificial Intelligence. Introduction to search, Search algorithms, Heuristic search methods, Optimal search strategies. Use of graphs in Bioinformatics. Grammers, Languages and Automata. Current Techniques of Artificial Intelligence: Probabilistic approaches: Introduction to probability, Bayes' theorem, Bayesian networks and Markov networks.	
Unit – II	**10 Hrs**
Classification methods: Linear Classifiers & Logistic Regression ,Linear Classifiers, Overfitting & Regularization in Logistic Regression, Decision Trees, Preventing Overfitting in Decision Trees, Handling Missing Data, Clustering and retrieval of data, Nearest Neighbor Search, Clustering with k-means, Hierarchical Clustering.	
Unit – III	**10 Hrs**
Supervised learning - parametric/non-parametric algorithms, support vector machines, kernels, neural networks, Unsupervised learning - clustering, dimensionality reduction, recommender systems, deep learning, Best practices in machine learning (bias/variance theory; innovation process in machine learning and AI, Support vector machines (SVMs), case studies and applications.	
Unit – IV	**10 Hrs**
Genetic programming – Method, Applications, Guidelines and Bioinformatics applications. Boolean Networks, Bayesian Networks and Fuzzy Neural Networks with case studies. Learning from observation - Inductive learning – Decision trees – Explanation based learning – Statistical Learning methods - Reinforcement Learning	
Unit – V	**10 Hrs**
Deep and Reinforcement Learning - Introduction to deep learning. Deep earning in lexical processing, syntactic processing, semantic processing. Convolution and recurrent neural networks. Reinforcement and deep learning. Applications of deep and reinforcement learning – Building chatbots with rasa, Gesture recognition, face recognition, speech recognition.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Learn about concepts of artificial intelligence and their applications in Bioinformatics
CO2:	Understand the basic ideas and techniques underlying the design of intelligent computer systems
CO3:	Use the knowledge acquired for both problem solving and for reasoning
CO4:	Focus on problems, the ethical, legal and social issues involved in the field of AI and use the Techniques and algorithms to address those problems.

Reference Books	
1	Statistical Modelling and Machine Learning Principles for Bioinformatics Techniques, Tools, and Applications by K. G. Srinivasa, G. M. Siddesh, S. R. Manisekhar, published by Springer Nature, 2020. ISBN: 9789811524455.
2	Artificial Intelligence: A Modern Approach by Stuart Jonathan Russell and Peter Norvig. Prentice Hall, 2016. ISBN 9781537600314
3	Machine Learning Approaches to Bioinformatics by Zheng Rong Yang. World Scientific Publishing Co. Pte. Ltd, 2010.ISBN 981-4287-30-X.
4	An Introduction to Deep Reinforcement Learning by Vincent François-Lavet, Peter Henderson, Riashat Islam published by Now Publishers, 2019. ISBN: 9781680835380.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	2	2	1	-	1	-	1	3	3
CO2	2	-	2	1	1	-	2	-	-	2	1	1
CO3	1	3	2	2	-	2	3	2	-	1	1	3
CO4	3	3	2	3	1	-	3	-	1	2	3	3

High-3: Medium-2: Low-1

Professional Elective G

Semester: VII						
FORENSIC SCIENCE (Theory)						
Course Code	**:**	**18BT7G1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able	
1	To understand the broadest definition of forensic science and application of criminal and civil laws.
2	To acquire forensic evidence in a reliable, professional manner with appropriate regard to scientific, statistical, ethical and legal issues.
3	To develop critical analytical skills and apply them in case-study situations relevant to current forensic science.
4	To realize the significance of the forensic experts and its labs and its functions
5	To validate toxicology, imaging, processing the crime scene for better indulgent of forensic

Unit-I	**8 Hrs**
Introduction: Introduction to Forensics, Definition and scopes of forensics, History and chronology of the events in forensics, and important milestones in the forensics, importance and significance of court in forensics; procedure and protocol: Inquest and medical examiners systems, powers of courts, documentary evidences and witness, (Doctors guide to court), application of the forensics: Forensic anthropology, Forensic entomology, Forensic psychiatry, Forensic odontology. Forensic pathology: Rigor mortis, livor mortis, algor mortis.	
Unit – II	**8 Hrs**
Crime Lab and Forensic Analysis: Organization of crime lab at various levels in India (Center and State), facilities offered by various laboratories. Services of the crime lab, basic services of the crime lab, optional services. Crime scene- Identification (Race, Sex, Age), Preservation and record, methodic search for evidence. Analysis of the physical evidences- definition, importance and source of evidence, type, collection and preservation, expert unit men, handling, package and sealing of physical evidence, FRYE standard and DAUBERT criteria.	
Unit –III	**8 Hrs**
Forensic Digital Imaging, Statistics and engineering: Digital imaging, acquisition of digital evidences, forensic imaging, maintaining chain of control with digital images, basic approach and process, digital videos, scanners, presenting pictures in the courtrooms, detecting compression and forgeries and maintaining records, analysis and recovery, advantages and disadvantages of digital imaging. Probability, populations and samples, weight of evidence and the Bayesian likelihood ratio. Transfer evidence, application of statistics of forensic science. Forensic engineering DNA analysis, dactyloscopy- Definition, various events and its significance, fingerprints its classification and patterns (concept of LAW).	
Unit –IV	**8 Hrs**
Cyber Forensic: Introduction, history of computer forensics, Basics of computers, Media, Computer Forensic Lab, Forensic Computers, Mobile Units, Data Storage, collecting evidence from a single system, common mistakes in evidence collection, storing and retrieving data, processing the electronic crime scene, analysis of electronic data, forensic analysis of internet data, forensic investigation of internet communications, E-Mail analysis, mobile forensics. Corporate fraud,	

Unit –V	7 Hrs
Toxicology and ethics in Forensic Science: Forensic toxicology, General Materials, Custodial Deaths, General Toxicology, Corrosive Poisons, Vegetable Alkaloid Poisons, Irritant Poisons, Non–Metallic& Metallic poisons, Inebriant Poisons Irrespirable Gases, Drug & Insecticides, Food Poisoning. Science and professional ethics: significance and limitations, code of conduct and code of ethics for forensics and their application, ethical requirement, ethical dilemmas and their resolutions.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recognize the scientific, ethical and legal implications in the collection, storage and dispatch of forensic evidence.
CO2:	Comprehend the role of forensic scientist in the collection and interpretation of evidence and the presentation of expert testimony, and its importance to assurance of judicial equity
CO3:	Evaluate the crime lab and their functionality along with the engineering and statistics
CO4:	Analyse the forensics in cyber for retention of security and impact of toxicology in forensics to submissive in ethics and moral values

Reference Books	
1	Criminalistics: An Introduction to Forensic Science; R Saferstein; Prentice Hall; 9st ed; 2007. ISBN: 0-13-221655-8
2	Forensic Science in Crime Investigation, B.S.Nabar; Asia Law House; 3rd edition; 2002;ISBN: 81861969944
3	Hacking Exposed™ Computer Forensics, Aaron Philipp David Cowen Chris Davis, 2nd edn. The McGraw-Hill Companies, 2010 ISBN: 978-0-07-162678-1
4	The essentials of Forensic Medicine and Toxicology; K.S.Narayana Reddy; 23rd edition; 2004; ISBN: 8139427131
5	Forensic science : from the crime scene to the crime lab, Saferstein, Richard, 2nd ed. 2009, ISBN 0-13-139187-9 (978-0-13-139187-1)

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	3	-	1	-	-	-	1	3	1
CO2	2	2	2	1	1	-	2	-	-	1	-	1
CO3	1	3	2	2	-	2	-	2	-	1	1	1
CO4	1	3	3	3	-	-	3	-	2	1	-	1

High-3: Medium-2 : Low-1

Semester: VII						
METABOLITES AND BIOPROSPECTING (Theory)						
Course Code	**:**	**18BT7G2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the concepts of traditional and modern bioprospecting and gain knowledge on the biodiversity of metabolites
2	Apply the concepts of bioprospecting for production of novel products
3	Demonstrate the understanding of value added products, is isolation and characterization techniques
4	Use concepts of Bioprospecting for investigation of bioactive compounds, and increasing the active compounds by precision engineering.
5	Apply knowledge for bioprospecting of novel genes/biomolecules and enzymes for industrial and medicinal uses.

Unit-I	**8 Hrs**
Introduction of Bioprospecting: Basics of Bioprospecting, Potential value of Bioprospecting. status of bioprospecting in India. Approaches to Bioprospecting-: Random search and Algorithm based search (Using indigenous knowledge, Ecological based knowledge, Evolutionary based knowledge) Phylogenetic approach. **Bioprospecting for known and unknown metabolites**-Case studies. **Databases and drug discovery**-NAPRALERT, NCI and CDRI databases.	
Unit – II	**8 Hrs**
Biosynthesis of secondary metabolites and metabolic engineering: secondary metabolite pathways, rate limiting steps. **Over-expression systems**: Bioprospecting for genes involved in the production of bioactive compounds, case studies. GIS based technology to predict species distribution for bioprospecting.	
Unit –III	**8 Hrs**
Strategic plans for bioprospecting with reference to global scenario: Laboratory tools and techniques in bioprospecting., Bioassays. **Chemical profiling**: Chromatographic techniques, molecular characterization using molecular markers. Molecular markers in bioprospecting for known metabolites, microsatellites, AFLP, SNP's etc. *In-vivo* and *in-vitro* protocols for multiplication and production of economically important metabolites-hairy roots, suspension cultures, micropropogation etc.	
Unit –IV	**8 Hrs**
Valuation of biodiversity hotspots for bioprospecting: Bioprospecting, Creating a Value for Biodiversity. Western Ghats, Eastern Himalayas. Valuation techniques. Potential for bioprospecting in India. **Medicinal plant diversity:** indigenous knowledge, human resource. Traditional Knowledge and practice and its role in bioprospecting.	
Unit –V	**7 Hrs**
Bioprospecting of natural bioactive compounds: Natural products from Marine world. Microbial natural products. Bioprospecting of plant-associated microbiomes, Bioprospecting of metagenomes. Role of industry, academic institution collaboration in accelerating research in bioprospecting. IPR issue and trade related issue in Bioprospecting.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the fundamental concepts of Potential value of Bio prospecting, platforms and databases..
CO2:	Analyse the bio prospecting of genes for overexpression studies and for enhancement of metabolites
CO3:	Apply the acquired knowledge to strategize bio prospecting in global scenario and the techniques involved to characterization and understand the IPR and trade related issues
CO4:	Evaluate the hotspots for bioprospecting of natural products

Reference Books	
1	Bioprospecting Success, potential and constraints. Russell Paterson, Nelson Lima., 2017, Springer International Publishing., ISBN – 978-3-319-47935-4
2	Bioprospecting. Yogesh Urdukhe. 2020. Educational Publishers. ISBN-9789390005123
3	Bioprospecting in Life Sciences. Rajendra Kumar Behara , Ekamber Kariali.2019.Narosa publishers. ISBN-9788184876512
4	Plant Metabolites: Methods, Applications and Prospects. Swapna Thacheril, Sukumaran, Shiburaj Sugathan, Sabu Abdulhameed.2020. Springer; ISBN-978-9811551352

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	2	2	1	1	1	1	1	1
CO2	2	2	2	1	1	1	1	-	-	1	1	1
CO3	1	3	2	2	2	2	1	2	1	1	1	1
CO4	1	3	3	3	1	3	1	1	2	1	-	1

High-3: Medium-2 : Low-1

Semester: VII						
ALTERNATIVE ENERGY (Theory)						
Course Code	**:**	**18BT7G3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**3:0:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To appreciate the various renewable and alternative energy sources
2	To recognize biomass resources, types of biofuels and the bio-refinery concept
3	To understand the relationship between mass and energy balances, biomass characterization techniques, unit operations, and thermodynamics in biomass conversion process
4	To utilize the available role of renewable energy engineers to address growing energy needs
5	To understand the role of various treatment techniques in the production of alternative energy

Unit-I	**7 Hrs**
Energy Scenario: Forms of energy, units for energy measurement, classification of energy resources, energy consumption pattern, energy scenario, energy and environment, alternative energy resources - biofuels, economics of biofuels, Clean Development Mechanism (CDM) **Description of Biofuels**: Energy use & efficiency, biofuel production, energy from biochemical pathways - organoheterotrophic, lithotrophic & phototrophic metabolism, biofuel feedstocks - starch, sugar, lignocellulosic, agro & Industrial by-products.	
Unit – II	**8 Hrs**
Production of Bioethanol : Bioethanol production using sugar, feedstocks, selection of micro-organisms, associated unit operations, determination of bioethanol yield, recovery of bioethanol, quality control aspects and properties of fuel standard bioethonol . **Production of Biodiesel:** Chemical, thermodynamic & reaction kinetic aspects of biodiesel production: transesterification and supercritical esterification, saponification and hydrolysis, acid & base catalysis. Sources of oils. Methods of biodiesel production – general procedure and large scale production, quality control aspects, properties of fuel standard biodiesel	
Unit –III	**8 Hrs**
Production of Biohydrogen: Enzymes involved in hydrogen production, photobiological hydrogen production - biophotolysis and photofermentation, hydrogen production by fermentation - biochemical pathway, batch fermentation, factors affecting hydrogen production, carbon sources, process and culture parameters.**Waste to Energy (WtE):** Types, energy content, combustibility assessment, collection- methods, transportation and recovery of recyclables, drying, and densification, incineration, gasification – syngas and producer gas, hydrogenation and Biological digestion – composting and fermentation to hydrogen, methane and alcohol.	
Unit –IV	**8 Hrs**
Microbial Fuel Cells: Biochemical Basis; Fuel Cell Design: Anode & Cathode Compartment, Microbial Cultures, Redox Mediators, Exchange Membrane, Power Density; MFC Performance Methods: Substrate & Biomass Measurements, Basic Power Calculations, MFC Performance: Power Density, Single-Chamber vs Two-Chamber Designs, Wastewater Treatment Effectiveness.	
Unit –V	**8 Hrs**

Microbial Modelling of Biofuel Production: Microbial growth models - unstructured, single limiting nutrient models, inhibition models, models for multiple limiting substrates, yield parameters. Kinetic rate expressions, bioreactor operation and design for biofuel production - batch, CSTR, CSTR with cell recycle, Fed-Batch Systems, Plug Flow Systems. Modelling of glucose utilization and hydrogen production - Batch and CSTR fermentations and simulations.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the technological basis for harnessing alternative energy sources
CO2:	Recognize the effects that current energy systems based on fossil fuels have, over the environment and the society
CO3:	Compare different alternative energy technologies and choose the most appropriate based on local conditions
CO4:	Perform simple techno-economical assessments of alternative energy systems

Reference Books	
1	Biofuels Engineering Process Technology, Caye M. Drapcho, N.P. Nhuan and T. H. Walker, 2020, Mc Graw Hill Publishers,New York, ISBN: 9781259585722.
2	Biofuels – Methods and Protocols (Methods in Molecular Biology Series), Jonathan R.M, 2012, Humana Press, New York, ISBN: 1617796476.
3	Biofuels (Advances in Biochemical Engineering/Biotechnology Series, Lisbeth Olsson, 2010, Springer-Verlag Publishers, Berlin, ISBN:9781412378554.
4	Waste management, L. Juhasz, G. Magesan & R. Naidu, 2019, Science Publishers, ISBN: 9780367446604.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	-	-	-	2	2	1	1	1	-	1
CO2	2	3	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	-	-	2	2	1	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2 : Low-1

Semester: VII						
NEXT GENERATION SEQUENCING INFORMATICS (Elective)						
Course Code	**:**	**18BT7G4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basic concepts of various platforms of NGS analysis
2	Detailed methodology of NGS analysis pipeline and algorithms
3	Practical aspects and implementation of in various other forms of sequencing and analysis.
4	Understand and implement basic coding techniques to handle big data.
5	Use of the next generation techniques to solve problems of clinical genomics

Unit-I	**7 Hrs**
Introduction to next generation sequencing: Sanger sequencing principles - history and landmarks, of Sequencing Technology Platforms, A survey of next-generation sequencing technologies, A review of DNA enrichment technologies, Base calling algorithms, Base quality, phred values, Reads quality checks, Interpretations from quality checks. Adapter and primer contamination. Processing reads using clipping of reads-Advantages and disadvantages of processing of reads	
Unit – II	**8 Hrs**
Tools and Techniques in NGS: Burrows-Wheeler Aligner (BWA) and Bowtie Alignment programs, burrows wheeler algorithm. Reference indexing and Alignment. Building from source, The bowtie aligner, The -n alignment mode, The -v alignment mode, Reporting Modes, Paired-end Alignment, Color space Alignment, Color space reads, Building a color space index, Decoding color space alignments, Paired-end color space alignment, Performance Tuning, SAM and BAM format. Artifacts in alignment programs	
Unit –III	**9 Hrs**
Metagenomic data analysis: MicroRNA Expression Profiling and Discovery, Dissecting Splicing Regulatory Network by Integrative Analysis of CLIP-Sequence Data, Analysis of Metagenomic Data, NGS-based non-invasive prenatal diagnosis, Diagnosis of inherited neuromuscular disorders by NGS Application of NGS in hearing loss diagnosis..	
Unit –IV	**8 Hrs**
Exome sequencing: Exome sequencing as a discovery and a diagnostic tool, Challenges of NGS based molecular diagnostics, NGS-Based Clinical Diagnosis of Genetically Heterogeneous Disorders, Molecular Diagnosis of Congenital Disorders of Glycosylation (CDG), NGS improves the Diagnosis of X-Linked Intellectual Disability (XLID), NGS Analysis of Heterogeneous Retinitis Pigmentosa.	
Unit –V	**7 Hrs**
Role of HPC and big data analysis: Handling Big Data, The use of next-generation sequencing for solving diagnostic dilemmas, Methods used in patient populations to uncover associations between genome variation and common diseases, Predictive tests for common, complex diseases.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the fundamental concepts of properties and representation of graphs, different measures of statistical distribution using central moments.
CO2:	Solve the problems involving characterization and operations on graphs, fitting of a curve for the given data and functions of random variables.
CO3:	Apply the acquired knowledge to solve the problems on different types of graphs,

	correlation, regression and measures of probability distributions.
CO4:	Evaluate the solutions of application problems in graph theory and probability distributions.

Reference Books	
1	Graph-Based Modelling in Science, Technology and Art, Stanisław Zawiślak and Jacek Rysiński ED., 2021, Springer International Publishing, Vol 107, ISBN: 978-3-030-76787-7
2	Next Generation Sequencing and Data Analysis, Kappelmann-Fenzl**,** Melanie ED., 2021, Springer International Publishing, ISBN 978-3-030-62490-3
3	Introduction to Next Generation Sequencing Technologies, Lloyd Low and Martti T. Tammi ED., 2021,Bioinformatics, ISBN 978-981-3144-74-3
4	Probability: Statistics for Engineers; Scientists, Ronald E. Walpole Raymo, nd H. Myers, ED., 2016, Pearson Education, ISBN-13: 978-0134115856. .

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2 : Low-1

Semester: VII						
UNMANNED AERIAL VEHICLES **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H01**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**3:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration:**	**:**	**3Hrs**

Course Learning Objectives: The students will be able to	
1	Get an overview of the history of UAV systems
2	Understand the importance of aerodynamics, propulsion, structures and avionics in the design of UAV
3	Demonstrate ability to address the various mission payloads - on-board & off-board, propulsion systems, integration with manned systems
4	Comprehend the importance of guidance and navigation of a UAV

Unit-I	**07 Hrs**
Overview of Unmanned Aerial Vehicles and Systems: History of UAVs, Need of unmanned aerial systems, Overview of UAV Systems-System Composition, Classification of UAVs based on size, range and endurance, Basic working of fixed, rotary and flapping UAVs, Applications of UAVs.	
Unit – II	**08 Hrs**
Aerodynamics of Unmanned Aerial Vehicles: Airfoil nomenclature and its characteristics, Basic aerodynamics equations, Aircraft polar, Types of drag, Aerodynamics of rotary and flapping wings, Airframe configurations-HTOL, VTOL and Hybrids.	
Unit -III	**08 Hrs**
Structures of UAV: Mechanic loading, Load calculation, Materials used for UAV (general introduction), Selection criteria for structure, Types of structural elements used in UAV their significance and characteristics. **UAV Propulsion Systems:** Thrust Generation, Powered Lift, Sources of Power for UAVs- Piston, Rotary, Gas turbine engines, electric or battery powered UAVs.	
Unit -IV	**08 Hrs**
Payloads of UAVs : Non-dispensable Payloads- Electro-optic Payload Systems, Radar Imaging Payloads, Electronic Warfare Payloads, Dispensable Payloads and other payloads. **Launch and Recovery Systems for UAVs:** UAV Launch Methods for Fixed-Wing Vehicles- Rail Launchers, Pneumatic Launchers, Hydraulic/Pneumatic Launchers, Zero Length RATO Launch of UAVs, UAV Recovery Systems-Conventional Landings, Vertical Net Systems, Parachute Recovery, VTOL UAVs, Mid-Air Retrieval, Shipboard Recovery.	
Unit -V	**08 Hrs**
UAV Navigation and Guidance Systems Navigation, Dead Reckoning, Inertial, Radio Navigation, Satellite–Way point Navigation, UAV Guidance, Types of guidance, UAV communication systems, Ground control station, Telemetry, UAS future.	

Course Outcomes: At the end of this course the student will be able to :	
CO1	Appraise the evolution of UAVs and understand the current potential benefits of UAVs
CO2	Apply the principles of Aerospace Engineering in design and development of UAVs
CO3	Determine and evaluate the performance of UAV designed for various Missions and applications
CO4	Appreciate the guidance and navigation systems for enabling the versatility of UAV systems

Reference Books	
1	Unmanned Aircraft Systems UAV design, development and deployment, Reg Austin, 1st Edition, 2010, Wiley, ISBN 9780470058190.
2	Introduction to UAV Systems, Paul G Fahlstrom, Thomas J Gleason, 4th Edition, 2012, Wiley, ISBN: 978-1-119-97866-4
3	Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Kimon P. Valavanis, 1st Edition,2007, Springer ISBN 9781402061141
4	Flight Stability and Automatic Control, Robert C. Nelson, 2nd Edition, October 1, 1997, McGraw-Hill, Inc, ISBN 978-0070462731.
5	Design of Unmanned Air Vehicle Systems, Dr. Armand J. Chaput, 3rd Edition, 2001, Lockheed Martin Aeronautics Company, ISBN: 978-1-60086-843-6

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	3	2	2	-	-	-	1
CO2	2	3	3	3	1	1	1	1	-	-	-	2
CO3	1		3	3	-	-	-	-	-	-	-	2
CO4	3	3	3	3	-	2	1	2	-	-	-	2

High-3 : Medium-2 : Low-1

Semester: VII						
BIOINFORMATICS (Theory) (Common to all Courses)						
Course Code	**:**	**18G7H02**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Acquire the knowledge of biological database and its role in insilico research
2	Understand the essential algorithms behind the biological data analysis such as Dynamic programming, Dot plotting, Evolutionary and Clustering algorithms along with their implementation.
3	Use various tools and techniques for the prediction of linear & non-linear structures of both macro and micro molecules and study the dynamics of macromolecules and High Throughput Virtual Studies.
4	Perform annotation of unknown DNA and Protein sequences and explore the principles of molecular modelling
5	Apply the knowledge towards analyzing the sequences using programming languages and Drug development

Unit-I	**08 Hrs**
Biomolecules and Introduction to Bioinformatics: Introduction to Biomolecules. Structure, Types and Functions of Carbohydrates, Lipids, Nucleic Acids and Proteins. Genetic code, Codon degeneracy, Genes and Genomes. Introduction to Bioinformatics, Goals, Scope, Applications in biological science and medicine. Biological databases – Sequence, structure, Special Databases and applications - Genome, Microarray.	
Unit – II	**08 Hrs**
Sequence analysis: Introduction, Types of sequence alignments, Pairwise sequence alignment, Multiple sequence alignment, Alignment algorithms Needleman & Wunch, Smith & Waterman and Progressive global alignment, Database Similarity Searching- Scoring matrices – BLOSSUM and PAM, Basic Local Alignment Search Tool (BLAST), and FASTA. Next Generation Sequencing – Alignment and Assembly. **Molecular Phylogenetics:** Introduction, Terminology, Forms of Tree Representation. Phylogenetic Tree Construction Methods - Distance-Based, Character-Based Methods and Phylogenetic Tree evaluation	
Unit –III	**09 Hrs**
Predictive and structural bioinformatics: Gene prediction programs – ab initio and homology based approaches. ORFs for gene prediction. Detection of functional sites and codon bias in the DNA. Predicting RNA secondary structure, Protein structure basics, structure visualization, comparison and classification. Protein structure predictive methods using protein sequence, Protein identity based on composition. Structure prediction - Prediction of secondary structure.	
Unit –IV	**07 Hrs**
PERL: Introduction to Perl, writing and executing a Perl program, Operators, Variables and Special variables. Object Oriented Programming in Perl–Class and object, Polymorphism, inheritance and encapsulation. Data Types – Scalar, Array and Associative array. Regular Expressions (REGEX), Components of REGEX - Operators, Metacharacters and Modifiers.	
Unit –V	**07 Hrs**
BioPERL: Introduction to BioPerl, BioPerl Modules, Applications of BioPerl – Sequence retrieval from Database and submission of sequence to online Database, Indexing and accessing	

local databases, Sequence alignments BioPerl and Sequence Analysis - Pair wise and Multiple sequence alignment, Parsing BLAST and FASTA results.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Demonstrate the knowledge of retrieval of the biological data in the essential formats and its analysis.
CO2:	Analyse the gene, protein and RNA data to find the degree of similarities and identifying the patterns
CO3:	Apply the drug designing methods for screening and inventing the new targets and drugs
CO4:	Predict the structure of a compound and design the molecule.

Reference Books	
1.	Essential Bioinformatics, Jin Xiong, 2006, Cambridge University Press, ISBN: 978-05-216-00828.
2.	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins; D. Andreas Baxevanis and B. F; Francis Ouellette. 2009; Wiley-IEEE; 3rd edn; ISBN: 978-81-265-21920.
3	Bioinformatics: Sequence and Genome Analysis; D W Mount; 2014; CSHL Press; 2nd edn; ISBN: 9780879697129.
4	Computational Systems Biology; A Kriete and R Eils; 2006; Academic Press; Illustrated edn; ISBN: 978-01-208-87866.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

Semester: VII						
INDUSTRIAL SAFETY AND RISK MANAGEMENT (Group H: Global Elective) (Theory)						
Course Code	**:**	**18G7H03**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Select appropriate risk assessment techniques.
2	Analyze public and individual perception of risk.
3	Relate safety, ergonomics and human factors.
4	Carry out risk assessment in process industries

Unit-I	**08 Hrs**
Introduction: Introduction to industrial safety engineering, major industrial accidents, safety and health issues, key concepts and terminologies, Hazard theory, Hazard triangle, Hazard actuation, Actuation transition, Causal factors, Hazard recognition.	
Unit – II	**08 Hrs**
Risk assessment and control: Individual and societal risks, Risk assessment, Risk perception, Acceptable risk, ALARP, Prevention through design. **Hazard Identification Methods:** Preliminary Hazard List (PHL): Overview, methodology, worksheets, case study. Preliminary Hazard Analysis (PHA): Overview, methodology, worksheets, risk index, example.	
Unit –III	**08 Hrs**
Hazard analysis: Hazard and Operability Study (HAZOP): Definition, Process parameters, Guide words, HAZOP matrix, Procedure, Example. Failure Modes and Effects Analysis (FMEA): Introduction, system breakdown concept, methodology, example.	
Unit –IV	**08 Hrs**
Application of Hazard Identification Techniques: Case of pressure tank, system breakdown structure, safety ontology, Accident paths, HAZOP application, risk adjusted discounted rate method, probability distribution, Hiller's model	
Unit –V	**07 Hrs**
Safety in process industries and case studies: Personnel Protection Equipment (PPE): Safety glasses, face shields, welding helmets, absorptive lenses, hard hats, types of hand PPE, types of foot PPE, types of body PPE. Bhopal gas tragedy, Chernobyl nuclear disaster, Chemical plant explosion and fire.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall risk assessment techniques used in process industry.
CO2:	Interpret the various risk assessment tools.
CO3:	Use hazard identification tools for safety management.
CO4:	Analyze tools and safety procedures for protection in process industries.

Reference Books	
1	Functional Safety in the Process Industry: A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North corolina, Lulu publication, ISBN:1291187235

2	Safety Instrumented Systems Verification Practical probabilistic calculations, Goble and William M., 2005, Pensulvania ISA publication, ISBN:155617909X
3	Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition, 2003, The University of alberta press,Canada, ISBN: 0888643942.
4	Industrial Safety, Health and Environment Management Systems, R K Jain, Sunil S Rao, 4th Edition, 2005, Khanna Publishers, New Delhi, ISBN: 8174092102

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	1	-	1	1	1	-	-	1	-
CO2	2	3	1	-	1	1	-	-	-	-	-	-
CO3	3	2	1	1	2	-	1	-	-	1	1	-
CO4	3	-	1	-	-	-	-	-	1	-	1	-

High-3; Medium-2; Low-1

Semester: VII						
WEB PROGRAMMING **(Group B: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H04**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the standard structure of HTML/XHTML and its differences.
2	Adapt HTML and CSS syntax & semantics to build web pages.
3	Learn the definitions and syntax of different web programming tools such as JavaScript, XML and Ajax to design web pages.
4	Design and develop interactive, client-side, server-side executable web applications using different techniques such as CSS, JavaScript, XML and Ajax.

Unit-I	**07 Hrs**
Introduction to Web, HTML and XHTML: Fundamentals of Web(Internet, WWW, Web Browsers and Web Servers, URLs, MIME, HTTP, Security, the Web Programmers Toolbox), XHTML: Basic syntax, Standard structure, Basic text markup, Images, Hypertext Links, Lists, Tables, Forms, Frames. **HTML 5:** Core HTML attributes, headings, paragraphs and breaks, quotations, preformatted text, lists, horizontal rules, block-level elements, text-level elements The audio Element; The video Element; Organization Elements; The time Element, Syntactic Differences between HTML and XHTML.	
Unit – II	**08 Hrs**
CSS (Cascading Style Sheet) Introduction, Levels of style sheets, Style specification formats, Selector forms, Property value forms, Font properties, List properties, Color, Alignment of text, The box model, Background images, The and tags, Conflict resolution. **The Basics of JavaScript:** Overview of JavaScript; Object orientation and JavaScript; General syntactic characteristics; Primitives, operations, and expressions; Screen output and keyboard input; Control statements.	
Unit –III	**09 Hrs**
JavaScript (continued): Object creation and modification; Arrays; Functions; Constructor; Pattern matching using regular expressions; Errors in scripts. **JavaScript and HTML Documents:** The JavaScript execution environment; The Document Object Model; Element access in JavaScript; Events and event handling; Handling events from the Body elements, Button elements, Text box and Password elements; The DOM 2 event model; The navigator object.	
Unit –IV	**08 Hrs**
Dynamic Documents with JavaScript: Introduction to dynamic documents; Positioning elements; Moving elements; Element visibility; Changing colors and fonts; Dynamic content; Stacking elements; Locating the mouse cursor; Reacting to a mouse click; Slow movement of elements; Dragging and dropping elements. **Introduction to PHP:** Origins and uses of PHP; overview of PHP; General syntactic characteristics; Primitives, Operations and Expressions; Output; Control statements; Arrays; Functions; Pattern Matching; Form Handling;Cookies; Session Tracking.	
Unit –V	**07 Hrs**
XML: Introduction; Syntax; Document structure; Document Type definitions; Namespaces; XML schemas; Displaying raw XML documents; Displaying XML documents with CSS; XSLT style sheets. **Ajax:** Overview of Ajax; Basics of Ajax: The Application; The Form Document; The Request Phase; The Response Document; The Receiver Phase.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic syntax and semantics of HTML/XHTML.
CO2:	Apply HTML/XHTML tags for designing static web pages and forms using Cascading Style Sheet.
CO3:	Develop Client-Side Scripts using JavaScript and Server-Side Scripts using PHP and utilize the concepts of XML & Ajax to design dynamic web pages.
CO4:	Develop web based applications using PHP, XML and Ajax.

Reference Books	
1	Programming the World Wide Web – Robert W. Sebesta, 7th Edition, Pearson Education, 2013, ISBN-13:978-0132665810.
2	Web Programming Building Internet Applications – Chris Bates, 3rd Edition, Wiley India, 2006, ISBN: 978-81-265-1290-4.
3	Internet & World Wide Web How to H program – M. Deitel, P.J. Deitel, A. B. Goldberg, 3rd Edition, Pearson Education / PHI, 2004, ISBN-10: 0-130-89550-4
4	The Complete Reference to HTML and XHTML- Thomas A Powell, 4th Edition, Tata McGraw Hill, 2003, ISBN: 978-0-07-222942-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**-**	**2**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**
CO2	**-**	**-**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**
CO4	**-**	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**

High-3: Medium-2: Low-1

Semester: VII						
SOLID WASTE MANAGEMENT AND STATUTORY RULES **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H05**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Impart the knowledge of present methods of solid waste management system and to analyze the drawbacks.
2	Understand various waste management statutory rules for the present system.
3	Analyze different elements of solid waste management and design and develop recycling options for biodegradable waste by composting.
4	Identify hazardous waste, e-waste, plastic waste and bio medical waste and their management systems.

Unit-I	**08 Hrs**
Introduction: Present solid waste disposal methods. Merits and demerits of open dumping, incineration, pyrolysis, composting, sanitary landfill. Scope and importance of solid waste management. Definition and functional elements of solid waste management. **Sources**: Sources of Solid waste, types of solid waste, composition of municipal solid waste, generation rate, Problems. **Collection and transportation of municipal solid waste:** Collection of solid waste- services and systems, Municipal Solid waste (Management and Handling) 2016 rules with amendments. Site visit to collection system.	
Unit – II	**08 Hrs**
Composting Aerobic and anaerobic composting - process description, process microbiology, Vermicomposting, Site visit to compost plant, Numerical problems. **Sanitary land filling**: Definition, advantages and disadvantages, site selection, methods, reaction occurring in landfill- Gas and Leachate movement, Control of gas and leachate movement, Site visit to landfill site.	
Unit –III	**08 Hrs**
Hazardous waste management: Definitions, Identification of hazardous waste, Classification of hazardous waste, onsite storage, collection, transfer and transport, processing, disposal, Hazardous and other wastes (Management and Transboundary Movement) Rules, 2016 with amendments. Site visit to hazardous landfill site	
Unit –IV	**08 Hrs**
Bio medical waste management: Classification of bio medical waste, collection, transportation, disposal of bio medical waste, Biomedical waste management (Management & Handling Rules) 2016 with amendments. Site visit to hospital to observe biomedical waste collection and transportation system and visit to biomedical waste incineration plant.	
Unit –V	**07 Hrs**
E-waste management: Definition, Components, Materials used in manufacturing electronic goads, Recycling and recovery integrated approach. e-waste (Management) Rules 2016 and amendments. Site visit to e- waste treatment plant. **Plastic waste management:** Manufacturing of plastic with norms. Plastic waste management. Plastic manufacture, sale & usage rules 2009 with amendments.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	and the current solid waste management system and statutory rules.
CO2:	Analyse drawbacks in the present system and provide recycling and disposal options for each type of waste in compliance to rules.
CO3:	Distinguish Hazardous waste, Biomedical waste, E waste and to provide scientific management system.
CO4:	Evaluate and monitor the Biomedical waste, Hazardous waste, E waste, Plastic and Municipal waste management as per the rules laid by Ministry of Environment, Forest and Climate change.

Reference Books :	
1	Integrated Solid Waste Management, George.C. Tchobanoglous, International edition ,1993, McGraw hill publication. ISBN 978-0070632370
2	Electronic waste management, R.E. Hester, Roy M Harrison, , Cambridge, UK, 2009, RSC Publication, ISBN 9780854041121
3	Solid Waste Management Rules 2016 , Ministry of Environment, Forest and Climate Change Notification, New Delhi, 8th April 2016
4	Hazardous and other wastes (Management and Transboundary Movement) Rules, 2016, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 04th April, 2016.
5	Biomedical waste management (Management & Handling Rules) 2016,. Ministry of Environment & Forest Notification, New Delhi, amendment on 28th March, 2016.
6	E-waste (Management) Rules 2016, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 23rd March , 2016.
7	Plastic Waste (Management and Handling) Rules, 2011 as amended in 2018, Ministry of Environment, Forest and Climate Change Notification, New Delhi, 27th March , 2018

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	-	-	-	-	2	2	1	-	1	-	2
CO2	2	2	2	2	-	1	2	1	-	-	-	-
CO3	1	-	2	2	-	1	2	1	-	1	-	-
CO4	2	-	-	3	-	1	2	1	-	-	-	1

High-3: Medium-2: Low-1

Semester: VII						
IMAGE PROCESSING AND MACHINE LEARNING (Group H: Global Elective) (Theory)						
Course Code	**:**	**18G7H06**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the major concepts and techniques in image processing and Machine Learning
2	To explore, manipulate and analyze image processing techniques
3	To become familiar with regression methods, classification methods, clustering methods.
4	Demonstrate image processing and Machine Learning knowledge by designing and implementing algorithms to solve practical problems

Unit-I	**08 Hrs**
Introduction to image processing: Introduction to image processing, Applications of image processing, Components of an image processing system, Fundamental steps in image processing, Image formation and representation, Color imagery, basic definitions, Pixels, Image resolution, PPI and DPI, Bitmap images, Lossless and lossy compression, Image file formats, Color spaces, Bezier curve, Ellipsoid, Gamma correction, Examples of zooming and shrinking in image processing Advanced image concepts.	
Unit – II	**08 Hrs**
Basics of Python, Scikit image & Advanced Image Processing using Open CV: Basics of python, variables & data types, data structures, control flow & conditional statements, uploading & viewing an image, Image resolution, gamma correction, determining structural similarities.	
Unit –III	**08 Hrs**
Advanced Image processing using Open CV Blending Two Images, Changing Contrast and Brightness Adding Text to Images Smoothing Images, Median Filter, Gaussian Filter, Bilateral Filter, Changing the Shape of Images, Effecting Image Thresholding, Calculating Gradients, Performing Histogram Equalization	
Unit –IV	**08 Hrs**
Image Processing using Machine Learning Feature mapping using SIFT algorithm, Image registration using the RANSAC algorithm, Image classification using Artificial Neural Networks, Image classification using CNNs, Image classification using machine learning Approaches.	
Unit –V	**08 Hrs**
Real time use CASES Exhaustive vs. Stochastic Search, Shapes, Contours, and Appearance Models. Mean-shift tracking; Contour-based models, finding palm lines, Face Detection / Recognition, Tracking movements.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Gain knowledge about basic concepts of Image Processing
CO2:	Identify machine learning techniques suitable for a given problem
CO3:	Write programs for specific applications in image processing
CO4:	Apply different techniques for various applications using machine learning techniques.

Reference Books	
1	Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods Pearson Education, 3rd Edition, ISBN 978-81-317-2695-2.
2	Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python, Himanshu Singh, 1st Edition, Apress, ISBN:978-1-4842-4149-3
3	Pattern Recognition and Machine Learning, Christopher Bishop, 1st Edition Springer, 2008, ISBN: 978-0387-31073-2
4	Computer Vision: A modern Approach, David Forsyth and Jean Ponce, 2nd Edition, Prentice Hall India 2004, ISBN: 978-0136085928

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for assignment is 20. The total marks of CIE are 100.

Total CIE is 30(Q)+50(T)+20(EL)=100Marks

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**-**	**3**	**-**	**1**	**2**	**-**	**-**	**1**	**2**	**-**	**-**	**1**
CO3	**3**	**-**	**2**	**1**	**3**	**-**	**-**	**1**	**1**	**1**	**-**	**1**
CO4	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**1**	**1**	**1**	**-**	**1**

High-3; Medium-2; Low-1

Semester: VII						
RENEWABLE ENERGY SOURCES AND STORAGE SYSTEM (Group H: Global Elective) (Theory)						
Course Code	**:**	**18G7H07**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand Concepts of nonconventional energy sources and allied technology required for energy conversion.
2	Analyse the Basics of battery working and sizing of battery for a given application.
3	Design aspects of solar and wind power systems.
4	Energy storage techniques

UNIT-I	**08 Hrs**

Basics of Renewable Energy: Energy balance of the earth, Solar radiation, wind energy, geothermal energy.

Geothermal Energy – principles, technical description, heat supply by hydro-geothermal systems, heat supply by deep wells, geothermal generation, economic and environmental analysis.

Biomass Energy: Biomass Production, Energy Plantation, Biomass Gasification, Theory of Gasification, Gasifier and Their Classifications, Updraft, Downdraft and Cross-draft Gasifiers, Applications of Biomass Gasifier.

Tidal Energy: Introduction, Tidal Energy Resource, Tidal Power Basin, Advantages and Disadvantages of Tidal Power.

Unit – II	**08 Hrs**

Photo Voltaic Systems: PV Cell, Module and array; Equivalent electrical circuit, Open –circuit voltage and short circuit current, I-V and P-V curves, Array design, Peak power Tracking, System Components,

Grid Connected Solar PV Power System: Introduction to grid connected PV system, Configuration of Grid-connected solar PV system, Components of Grid –connected solar PV systems, Grid connected PV system Design for small power Applications, Grid- connected PV system design for power plants.

Unit -III	**08 Hrs**

Wind Power: Introduction, site selection, Advantages and Disadvantages, Wind power installations in the world.

Wind Speed and Energy: Speed and Power Relations, Power Extracted from the wind. Rotor-Swept Area, Air Density, Global Wind Patterns, Wind Speed Distribution, Weibull Probability, Distribution, Mode and Mean Speeds, Root Mean Cube Speed, Mode, Mean, and RMC Speeds, Energy Distribution, Digital Data Processing, Effect of Hub Height, Importance of Reliable Data, Wind Speed Prediction, Wind Energy Resource Maps.

Wind Power Systems: System Components, Tower, Turbine, Blades, Speed Control, Turbine Rating, Power vs Speed and TSR.

Unit –IV	**08 Hrs**

Wind Power Systems: Maximum Energy Capture, Maximum Power Operation Constant-TSR Scheme, Peak-Power-Tracking scheme, System-Design Trade-offs, Turbine Towers and Spacing, Number of Blades, Rotor Upwind or Downwind, Horizontal vs. Vertical Axis.

System Control Requirements: Speed Control, Rate Control.

Environmental Aspects: Audible Noise, Electromagnetic Interference (EMI), Effects on Birds.

Unit –V	**07 Hrs**

Energy storage Batteries: Different types of batteries, Equivalent Electrical Circuit, Battery charging, Battery management, **Flywheels**: Energy Relations, Components, Benefits over battery

Other Storage devices: Superconducting magnetic energy storage, Compressed air, Pumped storage

hydropower, Hydrogen Energy storage

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the concepts of power generation from various renewable sources.
CO2:	Design the Size of the battery required for solar PV applications.
CO3:	Design main components of solar and wind power systems.
CO4:	Execute projects in renewable power generation.

Reference Books	
1	Renewable energy: Technology, Economics and Environment, Martin Kaltschmitt, Wolfgang Streicher Andreas Wiese, Springer Publication, 2007, ISBN 978-3-540-70947-3
2	Solar photo voltaic Technology and systems, Chetan Singh Solanki, third edition(2013), PHI , Learning private limited New Delhi ISBN: 978-81-203-4711-3
3	Wind and solar power system design, Analysis and operation, Mukund R. Patel, 2nd Edition. CRC Group ,Taylor and Francis group, New Delhi ,ISBN 978-0-8493-1570-1
4	Power System Energy Storage Technologies, Paul Breeze, Academic Press, 2018, ISBN 978-0-12-812902-9

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	3	2	-	-	-	-	-	1	-	1
CO2	3	3	2	1	1	2	-	-	-	1	-	1
CO3	3	2	2	2	2	2	2	1	-	1	-	1
CO4	3	3	3	3	2	3	1	1	1	3	1	3

High-3: Medium-2: Low-1

Semester: VII						
MEMS AND APPLICATIONS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H08**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the rudiments of Micro fabrication techniques.
2	Identify and associate the various sensors and actuators to applications.
3	Analyze different materials used for MEMS.
4	Design applications of MEMS to disciplines.

Unit-I	**06 Hrs**
Overview of MEMS & Microsystems: MEMS and Microsystems, Typical MEMS and micro system products, Evolution of micro fabrication, Microsystems and microelectronics, Multidisciplinary nature of Microsystems, Design and manufacture, Applications of Microsystems in automotive, healthcare, aerospace and other industries. **Working Principle of Microsystems**: Biomedical and biosensors. Micro sensors: Acoustic, Chemical, Optical, Pressure, Thermal.	
Unit – II	**09 Hrs**
Micro actuation: Using thermal forces, shape memory alloys, Piezoelectric crystals and electrostatic forces. MEMS with micro actuators: Microgrippers, micromotors, microvalves and micropumps, microaccelerometers, microfluidics**.** **Introduction to Scaling:** Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electrostatic forces, scaling in electromagnetic forces and scaling in fluid mechanics.	
Unit –III	**09 Hrs**
Materials for MEMS and Microsystems: Substrates and wafers, Active substrate materials, Silicon as substrate material, Silicon Compounds, Si-Piezoresistors, GaAs, Quartz, Piezoelectric Crystals, Polymers and packaging materials. Three level of Microsystem packaging, Die level packaging, Device level packaging, System level packaging. Interfaces in microsystem packaging. Essential packaging technologies: die preparation, Surface bonding, Wire bonding, Sealing, 3D packaging.	
Unit –IV	**08 Hrs**
Microsystem Fabrication Process: Introduction to microsystems, Photolithography, Ion Implantation, Diffusion, Oxidation, CVD,PVD-Sputtering, Deposition by Epitaxy, Etching, LIGA process: General description, Materials for substrates and photoresists, Electroplating and SLIGA process.	
Unit –V	**07 Hrs**
Micro Sensors, Actuators, Systems and Smart Materials: An Overview Silicon Capacitive Accelerometer, Piezo resistive Pressure sensor, Fibre-optic sensors, Conductometric Gas Sensor, Electrostatic Comb drive, Magnetic Microrelay, Portable blood analyzer, Piezo electric Inkjet Print head, Micromirror array for Video projection, Micro-PCR Systems, Smart materials and systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the operation of micro devices, micro systems and their applications.
CO2:	Apply the principle of material science to sensor design.

CO3:	Analyze the materials used for sensor designs.
CO4:	Conceptualize and design micro devices, micro systems.

Reference Books	
1	MEMS & Microsystems Design and Manufacture, Tai-Ran Hsu, 2nd Edition, 2002, Tata McGraw Hill Education, New Delhi, ISBN-13:978-0-07-048709-3.
2	Micro and Smart Systems, G.K. Ananthasuresh, K.J .Vinoy, K.N. Bhat, V.K. Aatre, 2015, Wiley Publications, ISBN-:978-81-265-2715-1.
3	Foundations of MEMS, Chang Liu, 2012, Pearson Education Inc., ISBN-13:978-0-13-249736-7.
4	Smart Material Systems and MEMS, Vijay K Varadan, K. J. Vinoy, S. Gopalakrishnan, 2006, Wiley-INDIA, ISBN-978-81-265-3170-7.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-		-	1	-	1
CO3	3	3	2	2	1	-	-		-	1	-	1
CO4	3	3	3	3	1	-	-		1	1	1	1

High-3; Medium-2; Low-1

Semester: VII						
PROJECT MANAGEMENT (Group H: Global Elective)						
Course Code	**:**	18G7H09		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.0 Hours**

Course Learning Objectives: The students will be able to

1	To understand the principles and components of project management.
2	To appreciate the integrated approach to managing projects.
3	To explain different process groups and knowledge areas used to manage project.

Unit-I	**07 Hrs**
Introduction: What is project, what is project management, relationships among portfolio management, program management, project management, and organizational project management, relationship between project management, operations management and organizational strategy, business value, role of the project manager, project management body of knowledge.	
Unit – II	**09 Hrs**
Organizational influences & Project life cycle: Organizational influences on project management, project state holders & governance, project team, project life cycle. **Project Integration Management**: Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase.	
Unit –III	**09 Hrs**
Project Scope Management: Project scope management, collect requirements define scope, create WBS, validate scope, control scope. **Project Time Management**: Plan schedule management, define activities, sequence activities, estimate activity resources, estimate activity durations, develop schedule, control schedule.	
Unit –IV	**07 Hrs**
Project Cost management: Project Cost management, estimate cost, determine budget, control costs. **Project Quality management**: Plan quality management, perform quality assurance, control quality.	
Unit –V	**07 Hrs**
Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk. **Project Procurement Management**: Project Procurement Management, conduct procurements, control procurements, close procurement.	

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

CO1:	Understand the concepts, tools and techniques for managing large projects.
CO2:	Explain various knowledge areas and process groups in the project management framework.
CO3:	Analyze and evaluate risks in large and complex project environments.
CO4:	Develop project plans for various types of organizations.

Reference Books	
1	A Guide to the Project Management Body of Knowledge(PMBOK Guide), Project Management Institute, 5th Edition, 2013, ISBN: 978-1-935589-67-9
2	Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, 7th Edition, 2010, Tata McGraw Hill Publication, ISBN 0-07-007793-2.
3	Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 10th Edition, 2009, CBS Publishers and Distributors, ISBN 047027806.
4	Strategic Project Management Made Simple: Practical Tools for Leaders and Teams, Terry Schmidt, 1st Edition, 2009, John Wiley & Sons, ISBN: 978-0470411582

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2	2		1	1							
CO3							1	1				
CO4	2		3		1							

Low-1 Medium-2 High-3

Semester: VII						
CYBER FORENSICS AND DIGITAL INVESTIGATIONS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H10**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To provide an understanding Computer forensics fundamentals and comprehend the impact of cybercrime and forensics.
2	Describe the motive and remedial measures for cybercrime, detection and handling.
3	Demonstrate and investigate the use of Tools used in cyber forensics.
4	Analyse areas affected by cybercrime and identify Legal Perspectives in cyber security.

Unit-I	**09 Hrs**
Introduction to Cybercrime: Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, Cybercrime Era: Survival Mantra for the Netizens. **Cyber offenses: How Criminals Plan Them**: How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.	
Unit – II	**08 Hrs**
Cybercrime: Mobile And Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for organizations, Organizational Measures for Handling Mobile devices, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	
Unit –III	**07 Hrs**
Tools And Methods Used In Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks. **Phishing and Identity Theft**: Introduction, Phishing, Identity Theft (ID Theft).	
Unit –IV	**08 Hrs**
Understanding Computer Forensics: Introduction, Historical Background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber forensics and Digital Evidence, Forensics Analysis of E-Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation, Setting up a Computer Forensics Laboratory: Understanding the Requirements, Computer Forensics and Steganography, Relevance of the OSI 7 Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, Computer Forensics from Compliance Perspective, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing, Anti-forensics.	
Unit –V	**07 Hrs**
Cybercrime And Cyber Security: The Legal Perspectives-Introduction, Why Do We Need Cyber laws: The Indian Context, The Indian IT Act, Challenges to Indian Law and Cybercrime Scenario in India, Digital Signatures and the Indian IT Act, Amendments to the Indian IT Act, Cybercrime and Punishment.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Interpret the basic concepts of cyber security, cyber law and their roles.
CO2:	Articulate evidence collection and legal challenges.
CO3:	Discuss tool support for detection of various attacks.
CO4:	Demonstrate through use of proper tools knowledge on the cyber security, Cybercrime and

	forensics

Reference Books :	
1	Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives, Sunit Belapure and Nina Godbole, , Wiley India Pvt Ltd, ISBN: 978-81-265-21791, 2013.
2	Introduction to information security and cyber laws, Dr. Surya Prakash Tripathi, Ritendra Goyal, Praveen Kumar Shukla, KLSI. Dreamtech Press, ISBN: 9789351194736, 2015.
3	Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions, Thomas J. Mowbray, Copyright © 2014 by John Wiley & Sons, Inc, ISBN: 978 -1-118 84965 -1
4	Cyber Forensics, Technical Publications, I. A. Dhotre, 1st Edition, 2016, ISBN-13: 978-9333211475

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	3	1	-	-
CO2	1	2	-	2	2	-	-	2	2	3	1	2
CO3	2	3	-	2	2	2	-	2	3	2	-	-
CO4	3	2	3	2	3	1	-	2	3	2	1	1

High-3: Medium-2: Low-1

Semester: VII						
ROBOTICS AND AUTOMATION (Theory)						
Course Code	**:**	**18G7H11**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the concepts of robotics and automation.
2	Impart the knowledge of robotic programming and robotic operation control
3	Selection and analysis of robot configuration and kinematics
4	Importance of automation manufacturing techniques and processing industries
5	Development of automation system for manufacturing and processing industries

Unit-I	**06 Hrs**
Introduction - Basics of kinematics, Anatomy of robot, Robot configuration, Robot joints, Sensors and drive system, Control modes, Specification of robots, Robot programming methods.	
Unit – II	**09 Hrs**
Robot Kinematics - Position and orientation of objects, Objects coordinate frame, Rotation matrix, Euler angles roll, pitch and yaw angles coordinate transformations, Joint variables and position of end effector, Homogeneous transformation. **D-H parameters** and conventions, D-H matrix, Direct kinematic and inverse analysis of planar and 3 DoF robots.	
Unit –III	**10 Hrs**
Trajectory planning - Introduction, Path versus trajectory, Joint-space versus Cartesian-space descriptions, Basics of trajectory planning, Joint-space trajectory planning, Third-order and Fifth-order polynomial trajectory planning. **Automation in Production Systems** - Manufacturing support systems, Automation principles and strategies, Levels of Automation, Production Concepts and Mathematical models, Numericals.	
Unit –IV	**08 Hrs**
Machine Vision - Object recognition by features, Basic features used for object identification, Moments, Template matching, Discrete Fourier descriptors, Computed Tomography (CT), Depth measurement with vision systems, Scene analysis versus mapping, Range detection and Depth analysis, Stereo imaging, Scene analysis with shading and sizes, Specialized lighting, Image data compression, Intraframe spatial domain techniques, Interframe coding, Compression techniques, Colour images, Heuristics, Applications of vision systems	
Unit –V	**06 Hrs**
Flexible Manufacturing Systems - Introduction to FMS - concepts, integration in the data processing systems, FMS scheduling. Case studies. Material Handling systems - Conveyors - AGVs – industrial robots in material handling – Automated Storage and retrieval system. Distributed data processing in FMS - Database Management System and their applications in CAD/CAM and FMS – distributed systems in FMS - Integration of CAD and CAM	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the characteristics and working principle of robots.
CO2:	Apply the related mathematical model to formulate the kinematics and trajectory

	planning of industrial robot.
CO3:	Analyse the machine vision for effective Flexible Manufacturing Systems.
CO4:	Develop model and integrate drives for industrial robots and automation systems.

Reference Books	
1	Mohsen Shahinpoor, "A Robot Engineering Textbook", Harper & Row Publishers, 3rd Edition, New York, ISBN:006045931X
2	John J. Craig, "Introduction to Robotics", Pearson Education International, 3rd Edition, ISBN:109876543, 1-13-123629-6
3	Mikell P Groover, "Automation, Production Systems, and Computer-integrated Manufacturing", Pearson Publishing, 3rd Edition, 2014, ISBN 978 81 203 3418 2
4	Joseph Talavage, "Flexible Manufacturing Systems in Practice Design: Analysis and Simulation", CRC Press, 1987, ISBN 9780824777180

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	1	-	-	1	-	-	-	2	-	2
CO2	3	3	1	3	1	1	-	-	-	2	-	2
CO3	2	-	2	-	1	1	-	-	2	-	-	2
CO4	3	3	2	3	1	1	-	2	3	-	3	2

High-3: Medium-2: Low-1

Semester: VII						
SPACE TECHNOLOGY AND APPLICATIONS (GROUP H: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G7H12**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3 : 0 : 0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Define the earth environment and its behaviour, launching vehicles for satellites and its associated concepts.
2	Analyse satellites in terms of technology, structure and communications.
3	Use satellites for space applications, remote sensing and metrology.
4	Apply the space technology, technology mission and advanced space systems to nation's growth.

UNIT-I	**08 Hrs**
Earth's environment: Atmosphere, ionosphere, Magnetosphere, Van Allen Radiation belts, Interplanetary medium, Solar wind, Solar- Earth Weather Relations. **Launch Vehicles:** Rocketry, Propellants, Propulsion, Combustion, Solid, Liquid and Cryogenic engines, Control and Guidance system, Ion propulsion and Nuclear Propulsion.	
UNIT-II	**07 Hrs**
Satellite Technology: Structural, Mechanical, Thermal, Power control, Telemetry, Telecomm and Quality and Reliability, Payloads, Classification of satellites. **Satellite structure:** Satellite Communications, Transponders, Satellite antennas.	
UNIT-III	**08 Hrs**
Satellite Communications: LEO, MEO and GEO orbits, Altitude and orbit controls, Multiple Access Techniques. **Space applications:** Telephony, V-SAT, DBS system, Satellite Radio and TV, Tele-Education, Tele-medicine, Satellite navigation, GPS.	
UNIT-IV	**08 Hrs**
Remote Sensing: Visual bands, Agricultural, Crop vegetation, Forestry, water Resources, Land use, Land mapping, geology, Urban development resource Management, and image processing techniques. **Metrology:** Weather forecast (Long term and Short term), weather modelling, Cyclone predictions, Disaster and flood warning, rainfall predictions using satellites.	
UNIT-V	**08Hrs**
Space Missions: Technology missions, deep space planetary missions, Lunar missions, zero gravity experiments, space biology and International space Missions. **Advanced space systems:** Remote sensing cameras, planetary payloads, space shuttle, space station, Inter-space communication systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain different types of satellites, orbit and associated subsystems.
CO2	Apply the basics of launching vehicles, satellites and sub systems for space applications.
CO3	Analyze the applications of satellite in the area of communication, remote sensing, metrology etc.
CO4	Study technology trends, satellite missions and advanced space systems.

Reference Books	
1	Atmosphere, weather and climate, R G Barry, Routledge publications, 2009, ISBN- 10 :0415465702.
2	Fundamentals of Satellite Communication, K N Raja Rao, PHI, 2012, ISBN: 9788120324015.
3	Satellite Communication, Timothy pratt, John Wiley, 1986 ISBN: 978-0- 471- 37007 -9, ISBN 10: 047137007X.
4	Remote sensing and applications, B C Panda, VIVA books Pvt. Ltd., 2009, ISBN: 108176496308.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	-	-	-	-	-	-	1	-
CO2	2	2	1	1	-	-	-	-	-	-	1	-
CO3	2	2	1	-	-	-	-	-	-	-	1	-
CO4	2	2	1	-	-	-	-	-	-	-	1	-

High-3: Medium-2: Low-1

Semester: VII						
INTRODUCTION TO ASTROPHYSICS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H13**		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Familiarize with the various celestial bodies and the laws governing their behavior
2	Understand the fundamental concepts of relativity and establish the relation between light and matter
3	Study the methods used to identify and investigate the nature of different stellar bodies
4	Determine the characteristic features of any star by understanding its spectral properties
5	Contemplate the complex system of the milky way galaxy and its components

Unit-I	**07 Hrs**
Fundamental concepts in Astronomy: Origin of the Universe, Major constituents of the universe, Cosmic Microwave Radiation (CMR) background, Geocentric Universe, Retrograde Motion of planets, Brief introduction to the Copernican Revolution, Positions of the Celestial Sphere: Altitude-Azimuth Coordinate System, Equatorial Coordinate System, Solar System, Planets - laws of motion of planets, inner planets, outer planets,	
Unit – II	**08 Hrs**
Theory of Special Relativity: Galilean Transformations, Failure of Galilean Transformations, Lorentz Transformations, Derivation, Time & Space in Special Relativity, Momentum & Energy in Relativity, Doppler Effect for light (Red & Blue Shift), The equivalence principle, the principle of minimal gravitational coupling, Schwarzschild spacetime, Past-Present-Future (Light Cone diagram).	
Unit –III	**08 Hrs**
Stellar Astrophysics: Blackbody radiation, Connection between Color and Temperature, Stellar Parallax, Magnitude Scale, Life cycle of stars (Birth, Life & Death), Hertzsprung-Russel Diagram, Classification of Binary Stars, Mass Determination using Visual Binaries, Eclipsing Spectroscopic Binaries, Formation of Spectral Lines, Schrodinger's time-dependent and independent equations, Boltzmann-Saha Equation, Chandrashekar's Limit, black holes (qualitatively).	
Unit –IV	**08 Hrs**
Light and Matter: Dispersion of light (Prism & Grating), Spectral Lines, de-Broglie's Wavelength and Frequency, Heisenberg's Uncertainty Principle, Broadening of Spectral lines **Spectral Characterization of Stars:** Description of the Radiation Field, Stellar Opacity, Transfer Equation, Profile of Spectral Lines, Optical Telescopes, Radio Telescopes (Case Studies)	
Unit –V	**08 Hrs**
Galaxy Astronomy: The Milky way Galaxy, Counting the Stars, Historical Models, Differential & Integrated Star Counts, Extrasolar planets, Methods of detection of extrasolar planets, Distance to the Galactic Centre, Galactic Coordinate System, Classification of Galaxies, Introduction to Elliptical galaxies, Irregular galaxies, Dwarf galaxies.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Contemplate the nature of our universe by identifying and studying the behavior of celestial bodies.
CO2:	Explain the usefulness of the theory of relativity, light and matter in establishing the fundamental behavior of stellar bodies.

CO3:	Utilize various techniques to discover the components of our universe and conclude their celestial properties.
CO4:	Interpret the spectral properties of any astronomical body to illustrate its properties.
CO5:	Inspect the milky way galaxy to identify the proponents and their characteristic features.

Reference Books	
1	Carroll Bradley W, and Dale A Ostlie, An Introduction to Modern Astrophysics. Reading, 2nd Edition, 1995, MA: Addison-Wesley Pub, ISBN: 9780201547306.
2	Padmanabhan, T, Theoretical Astrophysics, Vols.1-3, 2005, Cambridge University Press, ISBN-9780521016278.
3	Shu F, The Physical Universe, New Edition, 1982, University of California, ISBN- 978-0935702057.
4	Harwit M, Astrophysical Concepts, 3rd Edition, 2000, Springer-verlag, ISBN- 978-0387949437.
5	Shapiro, Stuart L, and Saul A Teukolsky, Black Holes, White Dwarfs, and Neutron Stars, 1st Edition, 1983, Wiley, ISBN: 9780471873167.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Assignment/Presentation/Project 20.

Total CIE is 30(Q) +50(T) +20(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	2	-	-	1	-	1	-	-	2
CO2	3	2	2	2	-	-	1	-	1	-	-	2
CO3	2	3	1	2	2	1	1	-	2	1	-	2
CO4	3	3	1	2	2	1	2	-	3	3	-	2

High-3, Medium-2, Low-1

Semester: VII						
MATERIALS FOR ADVANCED TECHNOLOGY AND SPECTROSCOPIC CHARACTERIZATION **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**18G7H14**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Apply the basic concepts of Chemistry to develop futuristic materials for high-tech applications in the area of Engineering.
2	Impart sound knowledge in the different fields of material chemistry so as to apply it to the problems in engineering field.
3	Develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems.

Unit-I	**08 Hrs**

Coating and packaging materials

Surface Coating materials:

Synthesis and applications of Polymer coating materials: Teflon, Silicone films Polyvinyl chloride & its copolymers, Poly vinyl acetate, Poly ethylene-HDPE, LDPE, Polyurethane.

Properties required in a pigment and extenders.

Inorganic pigments-titanium dioxide, zinc oxide, carbon black, chromate pigments, molybdate orange, chrome green, ultramarine blue, iron blue, cadmium red.

Corrosion inhibiting pigments- zinc phosphate, zinc and barium chromate pigments, ceramic pigments, metal flake pigments, extenders.

Developments in new polymers such as dendrimers, biopolymers & biodegradable polymers.

Packaging materials:

Food products: Cellulosic and Polymeric packaging materials and their properties – including barrier properties, strength properties, optical properties. Glass, aluminum, tin, paper, plastics, composites.

Pharmaceutical products: Injectables and tablet packaging materials.

Unit – II	**08 Hrs**

Adhesives

Introduction-Classification of Adhesives-Natural adhesives, synthetic adhesives-drying adhesives, pressure sensitive adhesives, contact adhesives, hot adhesives. One-part adhesives, multi part adhesives. Adhesive Action. Development of Adhesive strength- Physical factors influencing Adhesive Action-surface tension, surface smoothness, thickness of adhesive film, elasticity and tensile strength. Chemical Factors Influencing Adhesive action - presence of polar groups, degree of polymerization, complexity of the adhesive molecules, effect of pH. Adhesive action- specific adhesive action, mechanical adhesive action, fusion adhesion. Development of adhesive strength- adsorption theory and diffusion theory. Preparation, curing and bonding Processes by adhesives-with reference to Epoxy, phenolics, Silicone, Polyurethane, Acrylic adhesives, Poly vinyl alcohol, Polyvinyl acetate.

Unit –III	**08 Hrs**

Optical fibre materials

Fiber Optics, Advantages of optical fiber communication over analog communication, Classification based on refractive index of the core- step index and graded index optical fibres, Classification based on core radius-single mode and multimode optical fibres, Fibre fabrication. -Methods to manufacture optical glass fibres. Double crucible method and preform methods. Manufacture of perform- Chemical Vapour Deposition (CVD), Modified vapour deposition (MCVD) Plasma activated vapour deposition (PCVD), Outside vapour deposition (OVD)-Vapour-phase axial deposition (VAD). Drawing the fibres from perform, coating and jacketing process.

Ion exchange resins and membranes

Ion exchange resins-Introduction, Types-cation and anion exchange resins, examples, physical properties,

chemical properties-capacity, swelling, kinetics, stability, ion exchange equilibrium, regeneration. Applications of ion exchange resins-softening of water, demineralization of water, advantages and disadvantages of ion exchange resins-calcium sulphate fouling, iron fouling, adsorption of organic matter, bacterial contamination. Ion exchange membranes, Types-anion and cation exchange membranes. Classification of ion exchange membranes based on connection way between charged groups and polymeric matrix-homogeneous and heterogeneous ion exchange membranes, examples. Fabrication of ion exchange cottons- anion exchange cotton and cation exchange cotton. Application of ion exchange membranes in purification of water by electro dialysis method.

Unit –IV	**08 Hrs**

Spectroscopic Characterization of materials:

Electromagnetic radiation, interaction of materials with electromagnetic radiation.

UV- visible spectrophotometry**: Introduction**-Electronic transitions- factors influencing position and intensity of absorption bands-absorption spectra of dienes, polyene and α,β-unsaturated carbonyl compounds, Working of UV-Vis spectrophotometer, Theoretical calculation of λ_{max} by using Woodward-Fieser rules- for cyclic and α,β-unsaturated carbonyl compounds.

IR Spectroscopy: Introduction, principle, molecular vibrations, vibrational frequency, number of fundamental vibrations, factors influencing fundamental vibrations, instrumentation of IR spectrophotometer, sampling techniques, application of IR spectroscopy in characterization of functional groups.

Unit –V	**08 Hrs**

NMR spectroscopy:

H^1 NMR Spectroscopy: Basic concepts- relaxation process. NMR spectrometer-FT NMR-Solvents used in NMR, internal standards-Chemical equivalence -Integrals and Integrations- chemical shift-Factors affecting chemical shifts- shielding and deshielding effects – chemical and magnetic equivalent – magnetic anisotropy-spin-spin splitting rules- Application of NMR on various compounds such as alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, amines, aldehydes, ketones, carboxylic acids, esters, amides & mono substituted aromatic compounds. Problems on prediction of structure of compounds. Application of NMR in magnetic resonance imaging (MRI).

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify sustainable engineering materials and understand their properties.
CO2:	Apply the basic concepts of chemistry to develop futuristic materials for high-tech applications in different areas of engineering.
CO3:	Analyze and evaluate the specific application of materials.
CO4:	Design the route for synthesis of material and its characterization.

Reference Books	
1	Materials Science by G.K.Narula, K.S.Narula & V.K.Gupta. 38th Edtion, Tata McGraw-Hill Publishing Company Limited-2015, ISBN: 9780074517963
2	Solar Lighting by Ramachandra Pode and Boucar Diouf, Springer e-book, 2011, ISBN: 978-1-4471-2133-6 (Print) 978-1-4471-2134-3 (Online).
3	Spectroscopy of organic compounds by P.S.Kalsi, New Age International (P) ltd, Publisher, 2005, ISBN 13: 9788122415438
4	Food Packaging Materials. Mahadeviah M & Gowramma RV, Tata McGraw Hill Publishing Company Limited, 1996, ISBN :0074622382 9780074622384.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	2	2	-	-	1	-	-
CO3	-	3	-	2	-	-	-	-	-	-	-	-
CO4	-	-	3	-	-	1	1	-	-	-	-	1

High-3: Medium-2: Low-1

Semester: VII						
APPLIED PSYCHOLOGY FOR ENGINEERS **(Group H: Global Elective) (Theory)**						
Course Code	**:**	**18G7H15**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To appreciate human behavior and human mind in the context of learner's immediate society and environment.
2	To understand the importance of lifelong learning and personal flexibility to sustain personal and Professional development as the nature of work evolves.
3	To provide students with knowledge and skills for building firm foundation for the suitable engineering professions.
4	To prepare students to function as effective Engineering Psychologists in an Industrial, Governmental or consulting organization.
5	To enable students to use psychological knowledge, skills, and values in occupational pursuits in a variety of settings that meet personal goals and societal needs.

Unit-I	**07 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit – II	**09 Hrs**
Intelligence and Aptitude: Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence.	
Unit –III	**09 Hrs**
Personality: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio- Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment. Psychological Stress: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress. Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control	
Unit –IV	**07 Hrs**
Application of Psychology in Working Environment: The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. Distance learning, Psychological consequences of recent developments in Information Technology. Type A and Type B Psychological Counseling - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling.	
Unit –V	**07 Hrs**
Learning: Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive –	

Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment.
CO2:	Define learning and compare and contrast the factors that cognitive, behavioral, and Humanistic theorists believe influence the learning process.
CO3:	Develop understanding of psychological attributes such as intelligence, aptitude, creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement.
CO4:	Apply the theories into their own and others' lives in order to better understand their personalities and experiences.

Reference Books	
1	Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill India
2	Psychology Robert A. Baron, III edition (1995) Prentice Hall India.
3	Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3
4	Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2 : Low-1

Semester: VII

Advanced course in Entrepreneurship (Group H: Global Elective) (Theory)						
Course Code	**:**	**18G7H16**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Acquire additional knowledge and skills for developing early customer traction into a repeatable business.
2	Learn the tools and methods for achieving sustainable growth, such as by refining their product or service and business models, building brand strategy, making a sales and financial plan
3	Develop brand strategy and create digital presence, Develop channel strategy for customer outreach.
4	Leverage social media to reach new customers cost effectively, Develop strategies to increase revenues and expand markets

Unit-I	**07 Hrs**
Intro to building Products & Value Proposition: Diagnose: Where are you today on the Product Life Cycle? Assess your Start-up's attractiveness **Competition & testing:** Conduct a Competition Analysis Identify your Competitive Advantage	
Unit – II	**06 Hrs**
Market Validation: Market validation, Customer Usability Interviews, Analyzing Customer feedback **Delivering Value:** Enlist marketing channels, Identify partners for your venture, Create a Sales plan	
Unit –III	**07 Hrs**
Customer acquisition & growth channels: Types of Marketing Channels: Targeting Blogs, Unconventional PR, Search Engine Marketing, Search Engine Optimization, Social ads, display ads and existing platforms, Email Marketing, Viral Marketing, Affiliate programs, Magazines, Newspaper, Radio and TV ads, Offline Ads, Trade Shows	
Unit –IV	**10 Hrs**
Business model: Reiterate and Refine your Business Model Canvas, Choose the right business model for you start-up **Financial Planning:** Forecasting sales and revenue projections, Cash-flow statement	
Unit –V	**09 Hrs**
Pitching: Create your funding plan, Build your pitch deck and compose your pitch.	

Experiential Learning: Student teams will present their practice ventures: business model, business plan, growth achieved, and key learnings to their classmates, faculty, and other entrepreneurs

Course Outcomes: After completing the course, the students will be able to	
CO1:	Develop strategies to increase revenues and expand markets, Explore licensing and franchising for business expansion.
CO2:	Leverage technologies and platforms for growth stage companies, Develop key metrics to track progress.
CO3:	Basics of registering a company, Understanding business regulations and compliances.
CO4:	Advanced concepts of business finance, Financial planning.

Reference Books

1	Running Lean: Iterate from Plan A to a Plan That Works. O'Reilly Media, Maurya, A., 2012.
2	Entrepreneurship. Roy, R., 2012. Oxford University Press
3	Intellectual Property Law in India. Gupta, T. S., 2011. Kluwer Law International
4	Flow: The Psychology of Optimal Experience. Czikszentmihalyi, M., 2008. Harper Perennial Modern Classics

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of tests (T) and Milestones (M). A minimum of four milestone submission have to be submitted and first three milestones (M1, M2, M3) are evaluated for 10 marks adding up to 30 marks and the final milestone (M4) is evaluated for 20 marks. All milestone submissions are online and as per format and portal prescribed by Wadhwani foundations. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(M1, M2 and M3) +50(T) +20(M4) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

Semester VIII

MAJOR PROJECT						
Course Code	**:**	**18BTP81**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**0:0:16:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**32**		**SEE Duration**	**:**	**3.00 Hours**
Course Learning Objectives: The students will be able to						
1.	Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.					
2.	Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both written and oral forms.					
3.	Acquire collaborative skills through working in a team to achieve common goals.					
4.	Self-learn, reflect on their learning and take appropriate action to improve it.					
5.	Prepare schedules and budgets and keep track of the progress and expenditure.					

Major Project Guidelines:

The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the 8th semester.

1. The detailed Synopsis (approved by the department ***Project Review Committee***) has to be submitted during the 1st week after the commencement of 8th semester.

Batch Formation:

- Students are free to choose their project partners from within the program or any other program.
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house / Industry / R & D Institution.
- ***The project work is to be carried out by a team of two to four students , in exceptional cases where a student is placed in a company and offered an internship through the competitive process or student is selected for internship at national or international level through competitive process,*** the student can work independently.
- ***The students are allowed to do either a project for full 5 days in the industry or full 5 days in the college.***
- ***In case the project work is carried out outside Bengaluru, such students must be available during Project Evaluation process scheduled by the respective departments and they must also interact with their guide regularly through Email / Webinar / Skype etc.***

Project Topic Selection:

The topics of the project work must be in the ***field of respective program areas or in line with CoE's(Centre of Excellence) identified by the college*** or **List of project areas as given by industry/Faculty. The projects as far as possible should have societal relevance with focus on sustainability.**

Students can select courses in ***NPTEL*** from the discipline of ***Humanities and Social Sciences, Management, Multidisciplinary and Design Engineering.*** The course chosen could be either of ***4w/8w/12w*** duration. The students need to enrol for a course, register for the exam and submit the e-certificate to the department, as and when it is released by NPTEL. ***The same will be considered as one of the components during project evaluation of phase 2 and phase 5.***

Project Evaluation:

- Continuous monitoring of project work will be carried out and cumulative evaluation will be done.
- The students are required to meet their internal guides once in a week to report their progress in project work.

- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Internal Guide regularly.
- In case of ***Industry project***, during the course of project work, the internal guides will have continuous interaction with external guides and will visit the industry at least twice during the project period.
- For CIE assessment the project groups must give a final seminar with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.
- Before the final evaluations the project group is required to produce a No dues certificate from Industry, Central Library and Department.

Course Outcomes of Major Project:	
1	Apply knowledge of mathematics, science and engineering to solve respective engineering domain problems.
2	Design, develop, present and document innovative/multidisciplinary modules for a complete engineering system.
3	Use modern engineering tools, software and equipment to solve problem and engage in life-long learning to follow technological developments.
4	Function effectively as an individual, or leader in diverse teams, with the understanding of professional ethics and responsibilities.

CIE Assessment:

The following are the weightings given for the various stages of the project.

1. Selection of the topic and formulation of objectives 10%
2. Design and Development of Project methodology 25%
3. Execution of Project 25%
4. Presentation, Demonstration and Results Discussion 30%
5. Report Writing & Publication 10%

SEE Assessment:

The following are the weightages given during Viva Examination.

1. Written presentation of synopsis 10%
2. Presentation/Demonstration of the project 30%
3. Methodology and Experimental Results & Discussion 30%
4. Report 10%
5. Viva Voce 20%

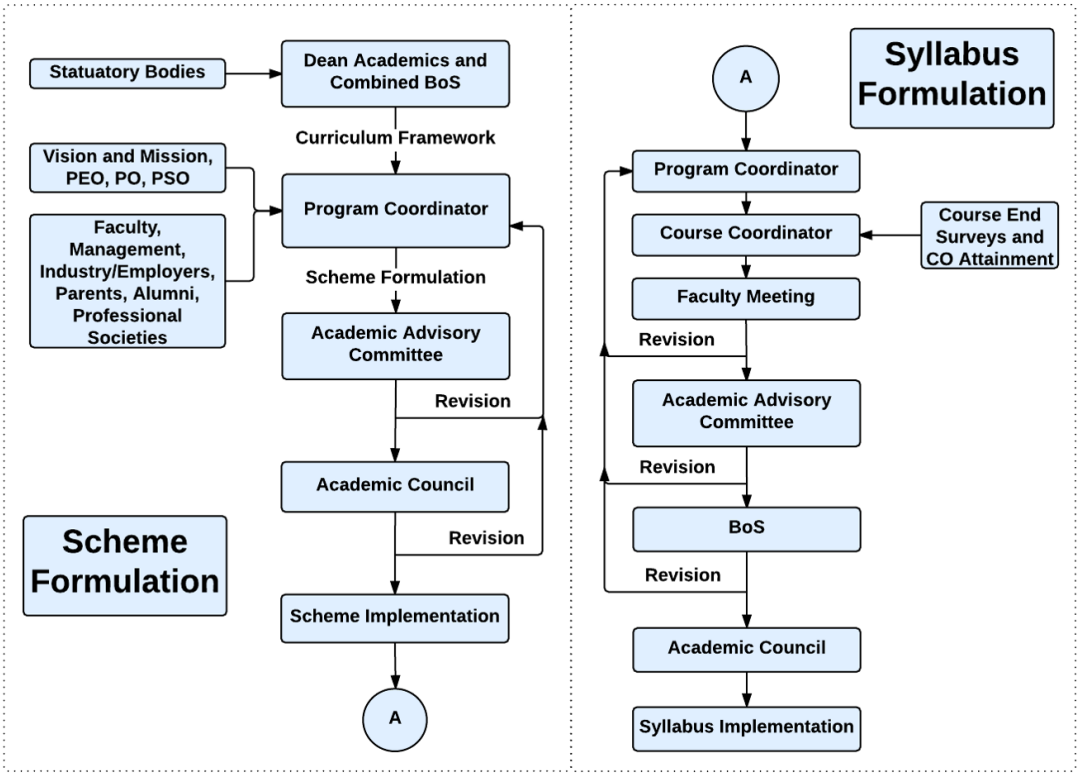
Calendar of Events for the Project Work:

Week	Event
Beginning of 7th Semester	Formation of group and approval by the department committee.
7th Semester	Problem selection and literature survey
Last two weeks of 7th Semester	Finalization of project and guide allotment
II Week of 8th Semester	Synopsis submission and preliminary seminar
III Week	First visit of the internal guides to industry (In case of project being carried out in industry)
III to VI Week	Design and development of project methodology
VII to IX Week	Implementation of the project

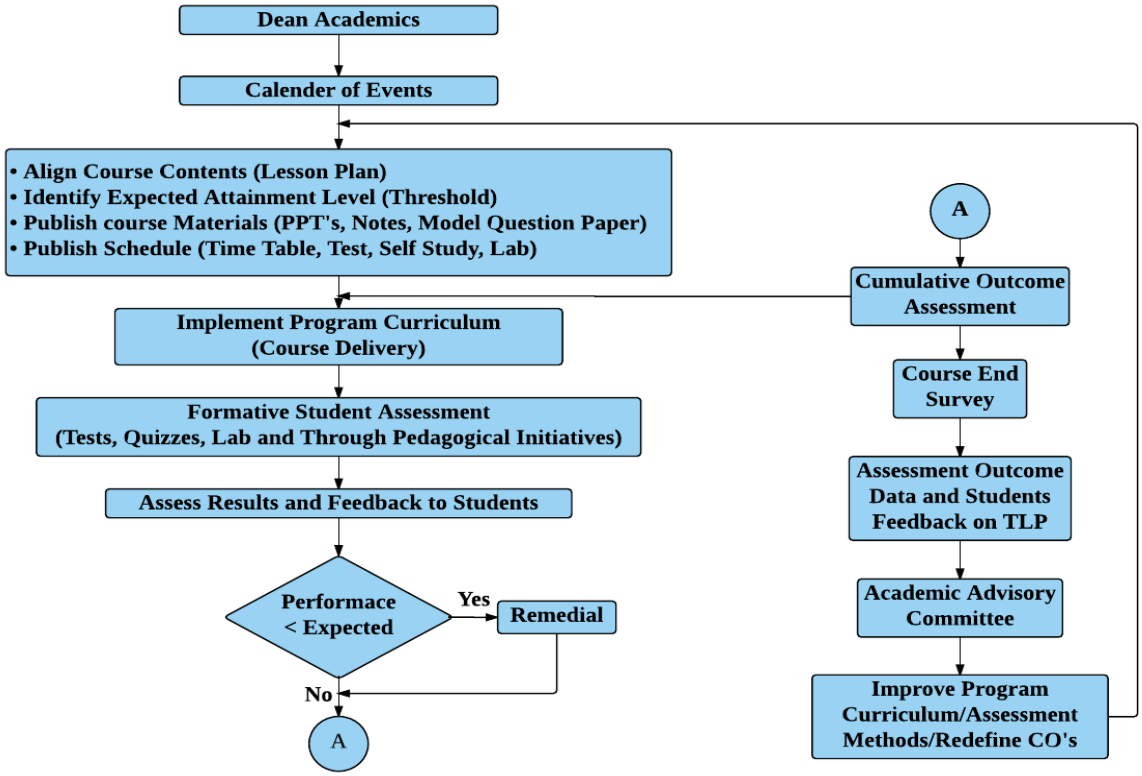
X Week	Submission of draft copy of the project report
XI and XII Week	Second visit by guide to industry for demonstration. Final seminar by Department project Committee and guide for internal assessment. Finalization of CIE.

Evaluation Scheme for CIE and SEE

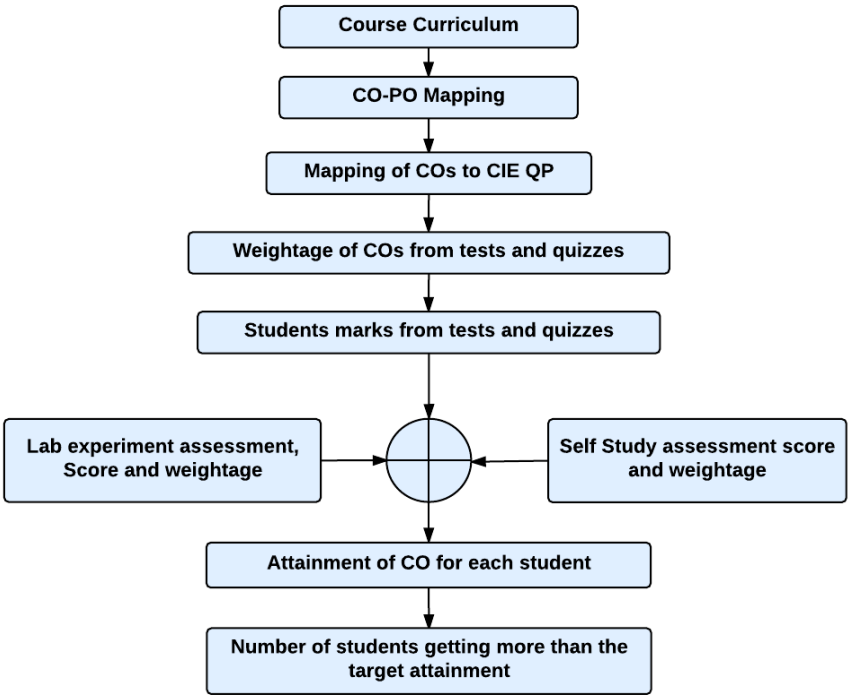
Scheme of Evaluation for CIE		**Scheme of Evaluation for SEE**	
Particulars	**%Marks**	**Particulars**	**%Marks**
Project Evaluation I	10%	Project Synopsis (Initial Write up)	10%
Project Evaluation II	25%	Project Demo / Presentation	30%
Project Evaluation III	25%	Methodology and Results Discussion	30%
Project Evaluation Phase-IV **(**Submission of Draft Project Report for Verification**)**	30%	Project Work Report	10%
Project Evaluation Phase-V **(**Project Final Internal Evaluation**)**	10%	Viva-voce	20%
Total	100	Total	100



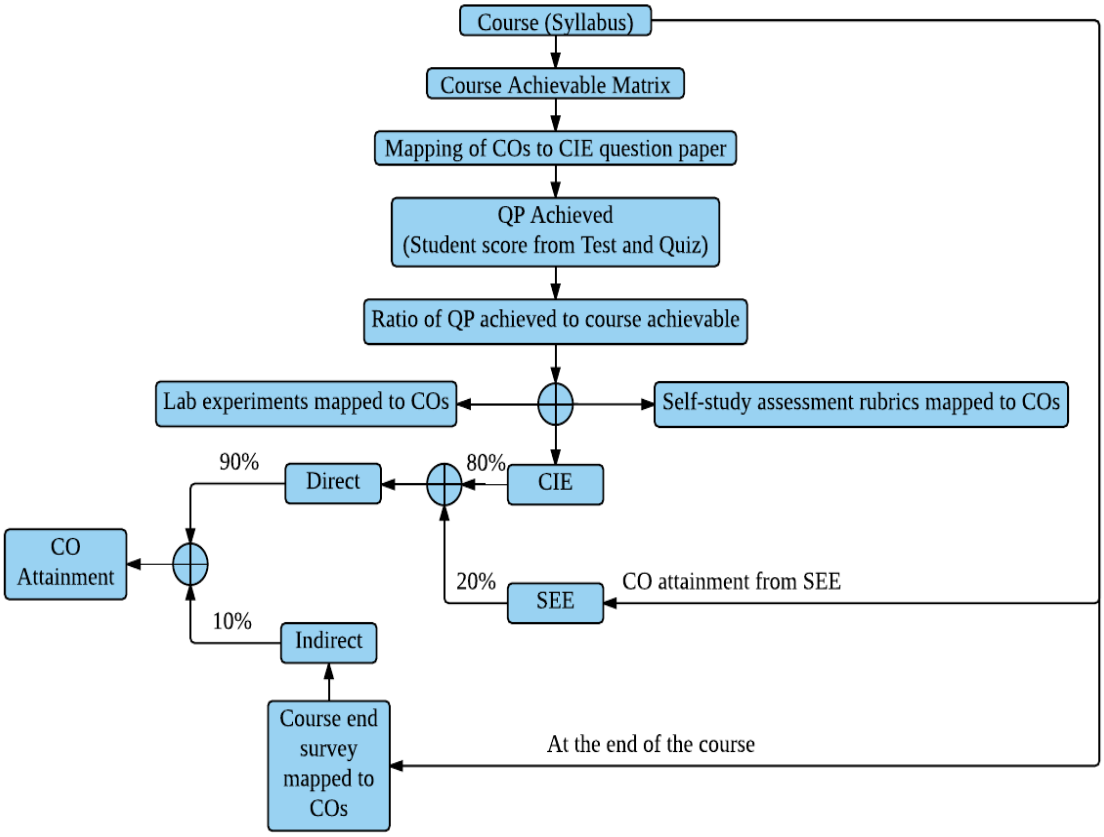
Academic Planning And Implementation



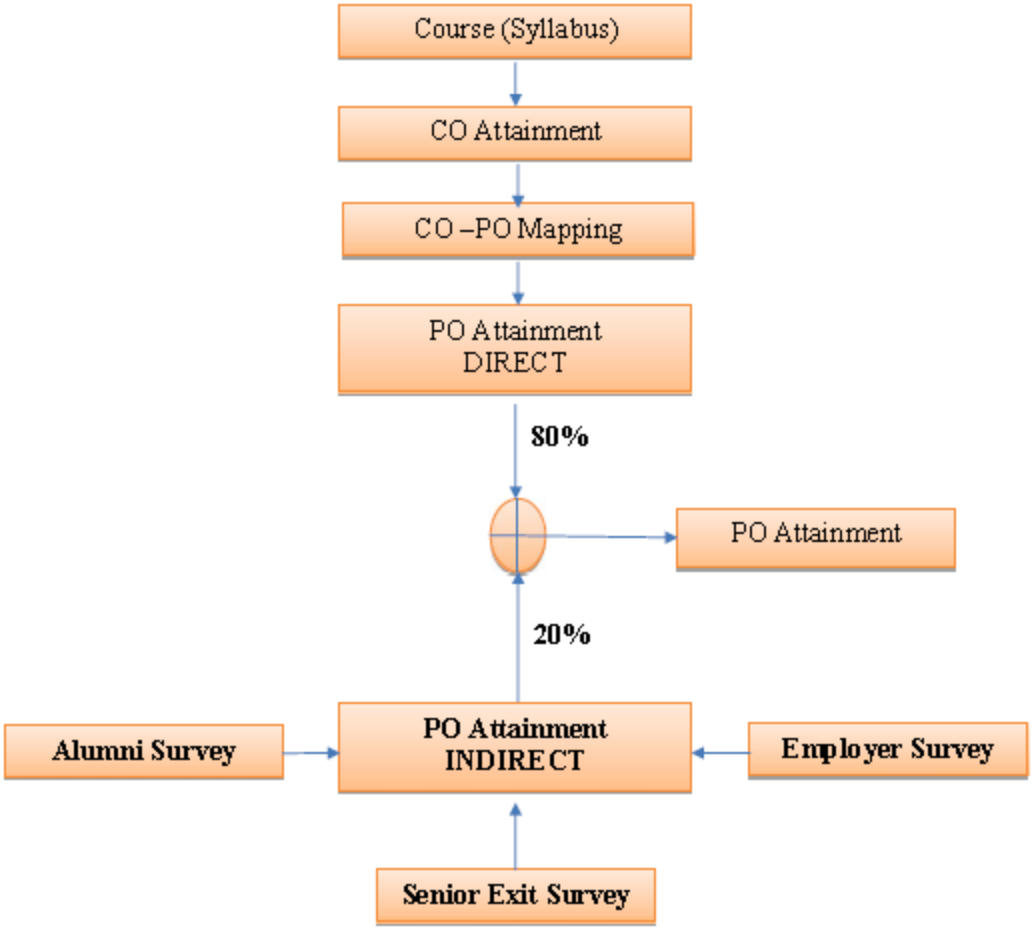
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



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PROGRAM OUTCOMES (POs)

1**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet t h e specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with t h e society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.