RV Educational Institutions ®
RV College of Engineering ®

Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi

Approved by AICTE, New Delhi

Go, change the world

BACHELOR OF ENGINEERING (B.E.)
2022 SCHEME

SCHEME & SYLLABUS
SECOND YEAR B.E. PROGRAMS

INDUSTRIAL ENGINEERING & MANAGEMENT

ACADEMIC YEAR 2023-24

INDUSTRIAL ENGINEERING & MANAGEMENT

DEPARTMENT VISION

Imparting innovation and value-based education in Industrial Engineering and Management for steering organizations to global standards with an emphasis on sustainable and inclusive development.

DEPARTMENT MISSION

1. To impart scientific knowledge, engineering and managerial skills for driving organizations to global excellence.
2. To promote a culture of training, consultancy, research and entrepreneurship interventions among the students.
3. To institute collaborative academic and research exchange programs with national and globally renowned academia, industries and other organizations.
4. To establish and nurture centers of excellence in the niche areas of Industrial and Systems Engineering.

PROGRAM EDUCATIONAL OBJECTIVES

PEO1	Conceive, design, implement and operate integrated systems, focus on appropriate measures of performance at strategic, tactical and operational levels.
PEO2	Develop competency to adapt to changing roles for achieving organizational excellence.
PEO3	Design and develop sustainable technologies and solutions for betterment of society.
PEO4	Pursue entrepreneurial venture with a focus on creativity and innovation for developing newer products, processes and systems.

PROGRAM SPECIFIC OUTCOMES

PSO1	Design, develop, implement and improve integrated systems that include people, Materials, information, equipment and energy.
PSO2	Apply statistical and simulation tools, optimization and meta heuristics techniques for analysis of various systems leading to better decision making.
PSO3	Demonstrate the engineering relationships between the management tasks of planning, Organization, leadership, control, and the human element in various sectors of economy.

LEAD SOCIETY

Institute of Industrial Engineers (IIE)

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	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.	AI & ML	Artificial Intelligence & Machine Learning
21.	PY	Physics
22.	CY	Chemistry
23.	MA	Mathematics
24.	AEC	Ability Enhancement Courses

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Bachelor of Engineering in

INDUSTRIAL ENGINEERING AND MANAGEMENT

III SEMESTER

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total				Theory	Lab		Theory	Lab
1.	MAT231BT	Statistics, Laplace Transform and Numerical Methods	3	1	0	**4**	MAT	Theory	1.5	**100**	--	**3**	**100**	--
2.	XX232AT	Basket Courses - Group A	3	0	0	**3**	CV/ ME/ BT	Theory	1.5	**100**	--	**3**	**100**	--
3.	IM233AI	Work Systems Design	3	0	1	**4**	IM	Theory+Lab	1.5	**100**	**50**	**3**	**100**	**50**
4.	IM234AI	Manufacturing Processes	3	0	1	**4**	IM	Theory+Lab	1.5	**100**	**50**	**3**	**100**	**50**
5.	IM235AI	Digital Metrology	3	0	1	**4**	IM	Theory+Lab	1.5	**100**	**50**	**3**	**100**	**50**
6.	HS237XL	Ability Enhancement course-Group C	0	0	2	**2**	HS	Lab	1	--	**50**	**2**	--	**50**
7.	CS139AT	Bridge Course: C Programming	2(A)	0	0	**AUDIT**	CS	Theory	1	**50**	--	--	--	
						21								

Group A: Basket Courses (Students can select any ONE COURSE out of THREE COURSES in ODD Sem & ONE COURSE out of remaining courses in EVEN Sem)					
Sl. No.	**BoS**	**Course Code**	**Course Title**	**Category**	**Credits**
2	CV	CV232AT	Environment & Sustainability	Theory	3
	ME	ME232AT	Material Science for Engineers	Theory	3
	BT	BT232AT	Bio Safety Standards and Ethics	Theory	3

Group C: Ability Enhancement Course					
Sl. No.	**BoS**	**Course Code**	**Course Title**	**Category**	**Credits**
7	HS	HS237AL	National Service Scheme	LAB	2
	HS	HS237BL	National Cadet Corps	LAB	2
	HS	HS237CL	Physical Education: Sports & Athletics	LAB	2
	HS	HS237DL	Music	LAB	2
	HS	HS237EL	Dance	LAB	2
	HS	HS237FL	Theatre (Light Camera & Action)	LAB	2
	HS	HS237GL	Art Work & Painting	LAB	2
	HS	HS237HL	Photography & Film Making	LAB	2

Bachelor of Engineering in

INDUSTRIAL ENGINEERING AND MANAGEMENT

IV SEMESTER

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total				Theory	Lab		Theory	Lab
1	IM241AT	Statistics For Data Analytics	3	0	0	3	IM	Theory	1.5	100	--	3	100	--
2	XX242AT	Basket Courses - Group A	3	0	0	3	CV/ ME/ BT	Theory	1.5	100	--	3	100	--
3	IM343AI	CAD/CAM & Robotics	3	0	1	4	IM	Theory + Lab	1.5	100	50	3	100	50
4	IM244AI	Operations Research	3	0	1	4	IM	Theory + Lab	1.5	100	50	3	100	50
5	IM345AT	Marketing Management	3	0	0	3	IM	Theory	1.5	100	--	3	100	--
6	XX246XT	Professional Core Course I – Group B	2	0	0	2	IM/EI/ ME	**NPTEL**	1	50	--	2	50	--
7	IM247DL	Design Thinking Lab	0	0	2	2	IM	Lab	1	--	50	2	--	50
8	HS248AT	Universal Human Values	2	0	0	2	HS	Theory	1	50	--	2	50	--
9	MAT149AT	Bridge Course: Mathematics	2 (A)	1	0	AUDIT	MAT	Theory	1	50	--	2	50	--
						23								

Group A: Basket Courses (Students can select any ONE COURSE out of THREE COURSES in ODD Sem & ONE COURSE out of remaining courses in EVEN Sem)					
Sl. No.	**BoS**	**Course Code**	**Course Title**	**Category**	**Credits**
2	CV	CV242AT	Environment & Sustainability	Theory	3
	ME	ME242AT	Material Science for Engineers	Theory	3
	BT	BT242AT	Bio Safety Standards and Ethics	Theory	3

Group B- Professional Elective- (NPTEL elective)			
Sl. No.	**Course Code**	**Course Title**	**Credits**
6	IM246AT	Data Science for Engineers	02
	IM246BT	Foundation course in Managerial Economics	02
	EI246CT	Introduction to Machine Learning	02
	ME246DT	Manufacturing Guidelines for Product Design	02
	IM246ET	Mechanics of Machining	02

Semester: III						
STATISTICS, LAPLACE TRANSFORM AND NUMERICAL METHODS (Theory) (AS, BT, CH, IM, ME)						
Course Code	**:**	**MAT231BT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:1:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L+30T**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**
Statistics: Central moments, mean, variance, coefficients of skewness and kurtosis in terms of moments. Correlation analysis, rank correlation, curve fitting, linear and multivariate regression analysis – problems. Implementation using MATLAB.	
Unit – II	**09 Hrs**
Complex Analysis: Real and complex numbers, basic properties and geometry. Analytic functions, Cauchy-Riemann equations, Harmonic functions, Derivatives of analytic functions, Taylor, Maclaurin, Laurent series. Zeros and poles, Residue theorem. Implementation using MATLAB.	
Unit –III	**09 Hrs**
Laplace Transform: Existence and uniqueness of Laplace transform, transform of elementary functions, region of convergence. Properties - linearity, scaling, s - domain shift, differentiation in the s - domain, division by t, differentiation and integration in the time domain. Laplace transform of time domain periodic functions, Heaviside unit step function, unit impulse function, t - shift property. Implementation using MATLAB.	
Unit –IV	**09 Hrs**
Inverse Laplace Transform: Definition, properties, evaluation using different methods. Convolution theorem, problems. Application to solve ordinary linear differential equations. Implementation using MATLAB.	
Unit –V	**09 Hrs**
Numerical Methods for Partial Differential Equations: Numerical solutions to partial differential equations – Finite difference approximation to derivatives, solution of Laplace equation in two-dimension, heat and wave equations in one dimension (explicit methods). Implementation using MATLAB.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Illustrate the fundamental concepts of statistics, complex analysis, Laplace & inverse Laplace transform and numerical methods.
CO2:	Apply the acquired knowledge of statistics, complex analysis, Laplace transform and numerical methods for partial differential equations to solve the problems of engineering applications.
CO3:	Analyze the solution of the problems obtained from appropriate techniques of statistics, complex analysis, Laplace transform and numerical methods to the real - world problems.
CO4:	Interpret the overall knowledge of statistics, complex analysis, Laplace transform and numerical methods to solve partial differential equations arising in many practical situations.

Reference Books	
1	Advanced Engineering Mathematics, Dennis G. Zill, Warren S. Wright 6th Edition, 2016, Jones and Bartlett publishers, ISBN: 13-978-1284105902.
2	Numerical methods for scientific and engineering computation, M.K. Jain, S.R.K. Iyenger and R.K. Jain, 6th Edition, 2012, New Age International Publishers, ISBN: 9788122433234, 8122433235.
3	Advanced Engineering Mathematics, Erwin Kreyszig, 9th Edition, 2007, John Wiley & Sons, ISBN: 978-81-265-3135-6.
4	Higher Engineering Mathematics, B.S. Grewal, 44th Edition, 2015, Khanna Publishers, ISBN: 81-7409-195-5.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (05), Program specific requirements (05), Video based Seminar / presentation / demonstration (10), MATLAB (20). **ADDING UPTO 40MARKS**.	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: III						
ENVIRONMENT AND SUSTAINABILITY **Category: Professional Core Course** **(Common to all Programs)** **(Theory)**						
Course Code	**:**	**CV232AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**10 Hrs**
ENVIRONMENT AND BIODIVERSITY: Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity. **ENVIRONMENTAL POLLUTION:** Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollution. Solid, Hazardous and E-Waste management. Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.	
Unit – II	**08 Hrs**
RENEWABLE SOURCES OF ENERGY: Energy management and conservation, New Energy Sources: Need of new sources. Different types of new energy sources. Energy Cycles, carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socioeconomical and technological change. Applications of - Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.	
Unit –III	**08 Hrs**
SUSTAINABILITY AND MANAGEMENT: Introduction to Environmental Economics, Environmental Audit, Development, GDP, Sustainability - concept, needs and challenges-economic, social and aspects of sustainability - from unsustainability to sustainability-millennium development goals and protocols. Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.	
Unit –IV	**08 Hrs**
SUSTAINABLE DEVELOPMENT GOALS - targets, indicators and intervention areas Climate change - Global, Regional and local environmental issues and possible solutions. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry. **SUSTAINABILITY PRACTICES:** Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment. Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports.	
Unit –V	**08 Hrs**
CORPORATE SOCIAL RESPONSIBILITY (CSR) - Meaning & Definition of CSR, History & evolution of CSR. Concept of Charity, Corporate philanthropy, Corporate Citizenship, CSR-an overlapping concept. Concept of sustainability & Stakeholder Management. Relation between CSR and Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India. Sustainability Reporting: Flavor of GRI, Dow Jones Sustainability Index, CEPI. Investor interest in Sustainability.	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand the basic elements of Environment and its Biodiversity.
CO2	Explain the various types of pollution and requirement for sustainable strategy for present scenario.
CO3	Evaluate the different concepts of sustainability and its significance for welfare of all life forms.
CO4	Recognize the role of Corporate social responsibility in conserving the Environment.

Reference Books	
1.	'Environmental Science and Engineering', Benny Joseph, Tata McGraw-Hill, New Delhi, 2016. ISBN-13 - 978-9387432352
2.	'Introduction to Environmental Engineering and Science', Gilbert M.Masters, Wendell P Ela, 3rd edition, Pearson Education, 2006. ISBN-13 - 978-0132339346
3.	Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4.	A Handbook of Corporate Governance and Social Responsibility (Corporate Social Responsibility), David Crowther and Guler Aras, Gower Publishing Ltd, ISBN - 13 - 978-0566088179

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES willbe conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: III

MATERIALS SCIENCE FOR ENGINEERS
Category: Professional Core
(Common to all Programs)
(Theory)

Course Code	**:**	**ME232AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I — **06 Hrs**

The Fundamentals of Materials

The electronic structure of atoms, types of atomic and molecular bonds: ionic bond, covalent bond, metallic bond, secondary bonds, mixed bonding, hybridization. Energy bands in metals, insulators, and semiconductors. Basic crystallography. Defects and dislocations. Types of materials: polymers, metals and alloys, ceramics, semiconductors, composites.

Unit – II — **10 Hrs**

Material behaviour

Thermal properties: thermal conductivity, thermoelectric effects, heat capacity, thermal expansion coefficient, thermal shock, thermocouple. Electrical Properties: dielectric behaviours and temperature dependence of the dielectric constant, insulating materials, ferroelectricity, piezoelectricity, super conductor. Optical properties: luminescence, optical fibers, Mechanical Properties: Stress-strain diagram, elastic deformation, plastic deformation, hardness, viscoelastic deformation, impact energy, fracture toughness, fatigue.

Unit –III — **10 Hrs**

Materials and their Applications

Semiconductors, dielectrics, optoelectronics, structural materials, ferrous alloys, nonferrous alloys, cement, concrete, ceramic, and glasses. Polymers: thermosets and thermoplastics, composites: fibre-reinforced, aggregated composites, electronic packaging materials, biomaterials, processing of structural materials.

Unit –IV — **07 Hrs**

Heat Treatment

Post processing heat treatment of electronic devices: thermal oxidation, diffusion, rapid thermal processing. Heat treatment of ferrous materials: annealing, spheroidizing, normalizing, hardening, tempering. formation of austenite, construction of Time Temperature Transformation (TTT) curves. Special heat treatment processes: carburizing, nitriding, cyaniding, flame, and induction hardening. Defects in heat treatment.

Unit-V — **07 Hrs**

Nanomaterials

Synthesis of nanomaterials: ball milling, sol-gel, vapour deposition growth, pulse laser, magnetron sputtering, lithography. Nano porous materials: zeolites, mesoporous materials, carbon nanotubes, graphene, nano FRPs, nano fabrics, bioresorbable and bio-erodable materials, nano ceramic, nano glasses, nano biomaterials, nano implant associated materials. Characterisation of nano structures, spectroscopic techniques, automatic force microscopy.

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand the classification of materials, their atomic structure, and properties.
CO2	Investigate the properties and applications of different materials.
CO3	Analyse the effect of different heat treatment processes.
CO4	Recognize different types of nanomaterials, synthesis methods and characterisation techniques.

Reference Books	
1.	Material Science and Engineering, William D Callister, 6th Edition, 1997, John Wiley and Sons, ISBN: 9812-53-052-5
2.	Introduction to Physical Metallurgy, Sydney H Avner, 1994, Mc. Graw Hill Book Company, ISBN: 0-07-Y85018-6
3.	Material Science and Engineering, William F Smith, 4th Edition, 2008, Mc. Graw Hill Book Company, ISBN: 0-07-066717-9
4.	A.S. Edelstein and R.C. Cammarata, Nanomaterials: Synthesis, Properties and Applications, CRC Press 1996, ISBN:978-0849322749

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: III						
BIO SAFETY STANDARDS AND ETHICS **Category: Professional Core Course** **(Common to all Programs)** **(Theory)**						
Course Code	**:**	**BT232AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**
Biohazards, Bio safety levels and cabinets: Introduction to Biohazards, Biological Safety levels, Bio safety Cabinets, Study of various types of Bio safety cabinets. Various parameters for design of Biosafety cabinets (Materials used for fabrication, sensors, filters, pumps, compressors)	
Unit – II	**08 Hrs**
Biosafety Guidelines: Biosafety guidelines of Government of India, GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM (Review committee o Genetic manipulation), GEAC (Genetic Engg Approval Committee) for GMO applications in food and agriculture. Overview of National Regulations and relevant International Agreements including Cartagena Protocol.	
Unit –III	**10 Hrs**
Food safety standards: FSSAI (Food Safety and Standards Authority of India), Functions, License, types of FSSAI Licences and compliance rules. **Food Hygiene:** General principles of food microbiology and overview of foodborne pathogens, sources of microorganisms in the food chain (raw materials, water, air, equipment, etc.) Quality of foods, Microbial food spoilage and Foodborne diseases, Overview of beneficial microorganisms and their role in food processing and human nutrition, Food Analysis and Testing, General principles of food safety management systems, Hazard Analysis Critical Control Point (HACCP).	
Unit –IV	**09 Hrs**
Food preservations, Processing, and Packaging: Food Processing Operations, Principles, Good Manufacturing Practices HACCP, Good production, and processing practices (GMP, GAP, GHP, GLP, BAP, etc) Overview of food preservation methods and their underlying principles including novel and emerging methods/principles. Overview of food packaging methods and principles including novel packaging materials.	
Unit –V	**09 Hrs**
Food safety and Ethics: Food Hazards, Food Additives, Food Allergens Drugs, Hormones, and Antibiotics in Animals. Factors That Contribute to Foodborne Illness, Consumer Lifestyles and Demand, Food Production and Economics, History of Food Safety, The Role of Food Preservation in Food Safety. Ethics: Clinical ethics, Health Policy, Research ethics, ethics on Animals. Biosafety and Bioethics.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehensive knowledge of Biohazards and bio safety levels
CO2	Understanding the biosafety guidelines and their importance to the society
CO3	Knowledge with respect to the Food standards, Hygiene, food processing and packing
CO4	Appreciate the food safety, Ethics, biosafety and bio ethics

Reference Books	
1	Deepa Goel, Shomini Parashar IPR, Biosafety and Bioethics 1st Edition, Pearson; 1st edition, 2013, ISBN: 978-8131774700.
2	Cynthia A Roberts, The Food Safety, Oryx Press, first edition, 2001, ISBN: 1–57356–305–6.
3	Hal King, Food Safety Management Systems, Springer Cham, 2020, ISBN: 978-3-030-44734-2.
4	Alastair V. Campbell , Bioethics: The Basics, Routledge; 2nd edition, 2017, ISBN: 978-0415790314.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will beconducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: III						
WORK SYSTEMS DESIGN **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	**IM233AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+ 30P**		**SEE Duration**	**:**	**3.00 +3.00 Hours**

Unit-I	**09 Hrs**
Introduction to Work Systems and Productivity: Pyramidal structure of work, Importance of Time, Physical work systems, work system as a field of professional practice, productivity (includes numericals). **Work and Worker-Machine Systems:** Manual work systems, Worker-machine systems and Automated work systems. Numericals on cycle time analysis of manual work and worker-machine systems.	
Unit – II	**09 Hrs**
Introduction to Methods Engineering and Operations Analysis: Evolution and scope of methods engineering, Application of Methods engineering, Basic Data collection and Analysis techniques (includes case problems), Methods engineering and automation. **Charting and Diagramming techniques for Operations Analysis:** Overview, Network diagrams, Traditional IE charting and Diagramming techniques, Block diagrams and process maps. principles of motion economy and work design.	
Unit –III	**09 Hrs**
Introduction to Work Measurement: Determination of Time Standards, Prerequisites for valid time standards, Allowances in Time standards, Methods of determining time standards ranked by relative accuracy, Methods of determining time standards ranked by relative application speed. **Direct Time Study:** Procedure for standard time determination, Numericals on determining time standards for pure manual tasks and worker machine tasks. **Predetermined Motion Time Systems:** Conceptual overview of PMTS and MTM, Basic MOST, Additional versions of MOST, MOST for windows.	
Unit –IV	**08 Hrs**
Lean Production - Elimination of waste: Production of defective parts, over production and excessive inventories, other forms of waste. **Just in Time Production:** Pull system of production control, set up time reduction, stable and reliable production operations. **Autonomation:** Stopping the process, error prevention and Total productive maintenance**. Worker Involvement:** Continuous improvement, Visual management and 5S, Standardized work procedures (Conceptual Treatment only).	
Unit –V	**08 Hrs**
Introduction to Ergonomics and Human Factors: Overview of Ergonomics, Understanding the interactions in Human –Machine system, Topic Areas in Ergonomics-Physical Ergonomics, Cognitive Ergonomics, Physical Work Environment. **Occupational Safety and Health:** Industrial Accidents and Injuries, Occupational Disorders and diseases.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Recognize the relevance of industrial engineering principles for productivity improvement in the organizations.
CO2	Demonstrate the relevance of methods engineering and operational analysis approach in designing / re-designing of Lean Work Systems.
CO3	Apply engineering work measurement principles in analysing and measurement of work in work systems.
CO4	Summarize the importance of Ergonomics in the design and management of integrated work systems.

Reference Books	
1	Work Systems – The Methods, Measurement & Management of Work, Mikell P Groover, 2017, Pearson India Education, ISBN: 978-93-325-8124-1
2	Introduction to work study, George Kanawaty, 4th revised Edition, 1992, ILO, ISBN: 9221071081.
3	Motion and Time study for Lean Manufacturing, Fred E.Meyers and James R.Stewart, 3rd Edition, 2002, Prentice Hall, ISBN:0-13-031670-9.
4	Human Factors in Engineering Design, Sanders.M.S and E J Mc Cormick, 7th Edition,1993, Mc Graw – Hill, ISBN: 10 : 0070449023

e-Book	
1	Handbook of Industrial Engineering Technology and Operations Management, Third Edition, Edited by GAVRIEL SALVENDY, JOHN WILEY & SONS, INC.2001 https://pdfcoffee.com/handbook-of-industrial-engineering-3rd-editionpdf-pdf-free.html

Laboratory Component
• Exercises based on Methods Engineering • Exercises based on Work Measurement • Exercises based on Physical, Cognitive and Environmental Ergonomics

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20Marks) adding up to 50 Marks. **THE FINAL MARKS WILL BE50 MARKS.**	**50**
MAXIMUM MARKS FOR THE CIE THEORY & PRACTICE		**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: III						
MANUFACTURING PROCESSES **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	**IM234AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**3.00 +3.00 Hours**

Unit-I	**08 Hrs**
Introduction to Manufacturing: Manufacturing Processes, Production Systems, Recent Developments in Manufacturing. **Casting Process:** Metal Casting Process: Casting terminology, sand mould making procedure. Pattern: Pattern allowances, core prints, pattern materials, types of patterns, pattern color code. Molding sand composition, testing sand properties, molding sand properties, molding machines, types of cores, chaplets.	
Unit – II	**09 Hrs**
Metal Forming: Overview of Metal Forming, Hot working & cold working, rolling, forging operations, smith forging, drop forging, press forging, Principle of extrusion. Metal spinning and Hydro Forming techniques. **Special Casting Processes:** Shell molding, precision investment casting, die casting, centrifugal casting and continuous casting	
Unit –III	**08 Hrs**
Welding Process: Arc Welding, Resistance Welding, Oxyfuel Gas Welding, Thermit welding, electron beam welding, Fusion-Welding Processes, Solid-State Welding, Weld Quality, Weldability, Brazing, Soldering, Adhesive Bonding, defects in welding.	
Unit –IV	**09 Hrs**
Theory of metal cutting: Single point tool nomenclature, geometry, orthogonal & oblique cutting, mechanism of chip formation, types of chips, Merchants analysis, shear angle relationship. Tool wear, Tool life criteria, Taylor's tool life equation, problems on Merchants analysis & tool life evaluation Cutting tool materials: Desired properties, types of cutting tool materials- HSS carbides, coated carbides, ceramics. Cutting fluids- properties, types & selection. Machinability, factors affecting machinability.	
Unit –V	**08 Hrs**
Drilling machines: Classification, constructional features. Types of drill, drill bit nomenclature, geometry of twist drill. Drilling & related operations. Problems on calculating the machining time. **Milling machines**: Classification, constructional features. Milling cutters & nomenclatures. Milling operations - up milling & down milling concepts. Indexing: Purpose of indexing, indexing methods.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the basic principles and methodology of various manufacturing processes that are used for the production of different products.
CO2	Compare and contrast the advantages and limitations of different manufacturing processes
CO3	Identify the suitable manufacturing process to develop a product considering quality, economic and environmental aspects
CO4	Analyze the various hardware and software components used in smart manufacturing

Reference Books	
1	Fundamentals of Modern Manufacturing: Materials, Processes and Systems, Fifth Edition, Mikell P. Groover, Wiley publications, 978-1-118-231463
2	Manufacturing Technology: Foundry Forming and Welding, P.N. Rao, 2nd Edition, 1998,TMH, ISBN: 0-07-463180-2.
3	Manufacturing Processes, J.P.Kaushish, 2nd Edition, 2010, PHI Learning Pvt. Ltd, ISBN: 978-81-203-4082-4
4	Fundamentals of Metal Machining & Machine Tools, G. Boothroyd, 3rd Edition 2004, Mc Graw Hill, ISBN: 978-1-5-7442659 -3.

Laboratory Component
1. Testing of Moulding sand and Core sand Preparation of specimen and conduction of the following tests: a) Compression/ Shear /Tensile tests b) Permeability test c) Grain fineness test d) Clay content test 2. Preparation of moulds - two box method: using split pattern. Match plate pattern & Cores. 3. Preparation of models involving the following lathe operations: Plain Turning, Taper Turning, Step Turning, Thread Cutting, Facing, Knurling, and forming. 4. Cutting of gear teeth using milling machine 5. Demonstration of welding experiments 6. Demonstration of surface grinding. 7. Experiential learning with the focus on smart manufacturing systems: Understanding hardware and software components.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20Marks) adding up to 50 Marks. **THE FINAL MARKS WILL BE50 MARKS.**	**50**
MAXIMUM MARKS FOR THE CIE THEORY & PRACTICE		**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: III						
DIGITAL METROLOGY **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	**IM235AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+ 30P**		**SEE Duration**	**:**	**3.00 +3.00 Hours**

Unit-I	**09 Hrs**
Concept of Measurements: General concept – Generalised measurement system, Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration. Classification of transducers, Selection of transducers, Resistive, capacitive & inductive transducers, Piezoelectric, Hall effect, optical and digital transducers,	
Unit – II	**09 Hrs**
Classification of sensors: Sensors, Specifications of sensors, classification of sensors - Displacement, position and proximity sensors – Potentiometers, Velocity and motion sensors – Tacho generator, Pyro electric sensors, Force - Strain gauge load cell. Fluid pressure - Piezoelectric sensors and Tactile sensor, Elements of data acquisition system, A/D, D/A converters.	
Unit –III	**09 Hrs**
Limits, Fits & Tolerance: System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances. Introduction to GD&T.	
Unit –IV	**08 Hrs**
Optical Interferometer and Form Measurements: Interferometry - optical flats, Tool Makers microscope. Measurement of screw threads - Thread gauges, floating carriage micrometer – Measurement of gears tooth thickness - Gear tooth vernier method, Measurement of surface finish – analysis of surface traces - Ten-Point Height Average Value, Root Mean Square Value, Tomlinson Surface Meter. Measurement of straightness – Autocollimator, measurement of flatness and roundness.	
Unit –V	**08 Hrs**
Advances in Metrology: Coordinate measuring machine (CMM)- Constructional features – types, applications – digital devices- computer aided inspection. **Laser metrology** - Precision instruments based on laser principles, Uses of Laser, Michelson Interferometer, interferometric measurement of angle, Geometrical Checks on Machine Tools.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Discuss the principles and practices of metrology in manufacturing environment and analyze uncertainty in an appropriate manner
CO2	Describe the operating principles of range of widely used instrumentation techniques and illustrate how to use them in the design of measurement systems.
CO3	Compare the production process, the product function and the product design, and to select appropriate measurement quantities and tools for these purposes.
CO4	Evaluate and respond to the need for rigorous and formal metrology concepts in designing and using measurement systems

Reference Books	
1	Engineering Metrology, Jain R.K., 18th edition, 2006, Khanna Publishers, ISBN: 71-7409-024-x
2	Mechanical Measurements, Beckwith T.G, and N. Lewis Buck, 5th Edition, 1991, Addison Wesley, ISBN: 81-7808-055-9
3	Electrical and Electronic Measurements and Instrumentation, A.K.Sawhney, 18th Edition, 2008, Dhanpat Rai and Sons, ISBN 8177000160
4	MEMS Mechanical Sensors, Stephen Beeby, 2004, Artech House, ISBN 1-58053-536-4

Laboratory Component
• Exercises based on Measurement • Exercises based on Calibration

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20Marks) adding up to 50 Marks. **THE FINAL MARKS WILL BE50 MARKS.**	**50**
MAXIMUM MARKS FOR THE CIE THEORY & PRACTICE		**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: III						
NATIONAL SERVICE SCHEME (NSS) (Practical)						
Course Code	**:**	**HS237AL**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**26P**		**SEE Duration**	**:**	**2.00 Hours**

Prerequisites:

1. Students should have service-oriented mindset and social concern.
2. Students should have dedication to work at any remote place, any time with available resources and propertime management for the other works.
3. Students should be ready to sacrifice some of the timely will and wishes to achieve service-oriented targets on time.

Content	**13 Hrs**

Students must take up any one activity on below mentioned topics and must prepare contents for awareness and technical contents for implementation of the projects and has to present strategies for implementation of the same. Compulsorily must attend one camp.

CIE will be evaluated based on their presentation, approach, and implementation strategies. (Any one of the below mentioned activity)

1. Helping local schools to achieve good result and enhance their enrolment in Higher/technical/ vocational education.
2. Preparing an actionable business proposal for enhancing the village/ farmer income and approach for implementation.
3. Developing Sustainable Water management system for rural/ urban areas and implementation approaches.
4. Setting of the information imparting club for women leading to contribution in social and economic issues.
5. Spreading public awareness/ government schemes under rural outreach program. (Minimum 5 programs)
6. Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc...
7. Social connect and responsibilities
8. Plantation and adoption of plants. Know your plants
9. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing
10. Waste management – Public, Private and Govt organization, 5 R's
11. Water conservation techniques – Role of different stakeholders - Implementation
12. Govt. School Rejuvenation and assistance to achieve good infrastructure.
13. Organize National integration and social harmony events/ workshops / seminars. (Minimum 2 programs) and ONE NSS-CAMP.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the importance of his/her responsibilities towards society.
CO2	Analyze the environmental and societal problems/ issues and will be able to design solutions for thesame.
CO3	Evaluate the existing system and to propose practical solutions for the same for sustainabledevelopment.

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the project with report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
NATIONAL CADET CORPS (NCC) (Practical)						
Course Code	**:**	**HS237BL**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**26P**		**SEE Duration**	**:**	**2.00 Hours**

Unit-I	**07 Hrs**
Drill: Foot Drill- Drill ki Aam Hidayaten, Word ki Command, Savdhan, Vishram, Aram Se, Murdna, Kadvar Sizing, Teen Line Banana, Khuli Line, Nikat Line, Khade Khade Salute Karna	
Unit – II	**03 Hrs**
Weapon Training (WT): Introduction & Characteristics of 7.62 Self Loading rifle, Identification of rifle parts	
Unit –III	**03 Hrs**
Adventure activities: Trekking and obstacle course	
Unit –IV	**02 Hrs**
Social Service and Community Development (SSCD): Students will participate in various activities throughout the semester e.g., Blood donation Camp, Swachhata Abhiyan, Constitution Day, All National Festival	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand that drill as the foundation for discipline and to command a group for common goal.
CO2	Understand the importance of a weapon its detailed safety precautions necessary for prevention of accidents and identifying the parts of weapon.
CO3	Understand that trekking will connect human with nature and cross the obstacles to experience army way of life.
CO4	Understand the various social issues and their impact on social life, Develop the sense of self-less social service for better social & community life.

Reference Books	
1.	NCC Cadet Hand Book by R K Gupta, Ramesh Publishing House, New Delhi, Book code:R- 1991,ISBN: 978-93-87918-57-3, HSN Code: 49011010
2.	nccindia.ac.in

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the project with report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
PHYSICAL EDUCATION (SPORTS & ATHLETICS) (Practical)						
Course Code	**:**	**HS237CL**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**26P**		**SEE Duration**	**:**	**2.5 Hrs**
Content						**30 Hrs**

Topics for Viva:

1. On rules and regulations pertaining to the games / sports
2. On dimensions of the court, size / weight of the ball and standards pertaining to that sports / game
3. Popular players and legends at state level / National level/ International level
4. Recent events happened and winner / runners in that sport / game
5. General awareness about sport / game, sports happenings in the college campus

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the basic principles and practices of Physical Education and Sports.
CO2	Instruct the Physical Activities and Sports practices for Healthy Living.
CO3	To develop professionalism among students to conduct, organize & Officiate Physical Education andSports events at schools and community level.

Reference Books	
1.	Health, Exercise and Fitness, Muller, J. P. (2000), Delhi: Sports.
2.	Play Field Manual, Anaika ,2005, Friends Publication New Delhi.
3.	IAAF Manual.
4.	Track and Field Marking and Athletics Officiating Manual, M.J Vishwanath,2002, Silver StarPublication, Shimoga.
5.	Steve Oldenburg (2015) Complete Conditioning for Volleyball, Human Kinetics'.
Note: Skills of Sports and Games (Game Specific books) may be referred	

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour withsurveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementationmethodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the project with report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
MUSIC (Practical)						
Course Code	:	**HS237DL**		**CIE**	:	**50 Marks**
Credits: L: T: P	:	**0:0:2**		**SEE**	:	**50 Marks**
Total Hours	:	**26P**		**SEE Duration**	:	**2.00 Hours**
Content						**13 Hrs**

1. Introduction to different genres of music
2. Evolution of genres in India: Inspiration from the world
3. Ragas, time and their moods in Indian Classical Music
4. Identification of ragas and application into contemporary songs
5. Adding your touch to a composition
6. Maths and Music: A demonstration
7. Harmonies in music
8. Chords: Basics and application into any song
9. Music Production-I
10. Music Production-II

Students have to form groups of 2-4 and present a musical performance/ a musical task which shall be given by the experts. The experts shall judge the groups and award marks for the same.
CIE will be evaluated based on their presentation, approach, and implementation strategies. Students need to submit their certificates of any event they participated or bagged prizes in. This shall also be considered for CIE evaluation.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand basics of Music and improve their skills.
CO2	Appreciate the impacts on health and well-being.
CO3	Perform and present music in a presentable manner.
CO4	Develop skills like team building and collaboration.

Reference Books	
1.	Music Cognition: The Basics by Henkjan Honing.
2.	Basic Rudiments Answer Book - Ultimate Music Theory: Basic Music Theory Answer Book by GlorySt Germain.
3.	Elements Of Hindustani Classical Music by Shruti Jauhari.
4.	Music in North India: Experiencing Music, Expressing Culture (Global Music Series) by George E. Ruckert.

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1): Justification for Importance, need of the hour withsurveyed data	**10**	*****
EXPERIENTIAL LEARNING: Presentation 2 (phase 2): Content development, strategies for implementationmethodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the projectwith report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
DANCE (Practical)						
Course Code	:	**HS237EL**		**CIE**	:	**50 Marks**
Credits: L: T: P	:	**0:0:2**		**SEE**	:	**50 Marks**
Total Hours	:	**26P**		**SEE Duration**	:	**2.00 Hours**

Contents **13 Hrs**

1. Introduction to Dance
2. Preparing the body for dancing by learning different ways to warm up.
3. Basics of different dance forms i.e., classical, eastern, and western.
4. Assessing the interest of students and dividing them into different styles based on interaction.
5. Advancing more into the styles of interest.
6. Understanding of music i.e., beats, rhythm, and other components.
7. Expert sessions in the respective dance forms.
8. Activities such as cypher, showcase to gauge learning.
9. Components of performance through demonstration.
10. Introduction to choreographies and routines.
11. Learning to choreograph.
12. Choreograph and perform either solo or in groups.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the fundamentals of dancing.
CO2	Adapt to impromptu dancing.
CO3	Ability to pick choreography and understand musicality.
CO4	To be able to do choreographies and perform in front of a live audience.

Reference Books	
1.	Dance Composition: A practical guide to creative success in dance making, Jacqueline M. Smith

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour withsurveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementationmethodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the projectwith report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
Theater (Light Camera & Action) (Practical)						
Course Code	:	**HS237FL**		**CIE**	:	**50 Marks**
Credits: L:T:P	:	**0:0:2**		**SEE**	:	**50 Marks**
Total Hours	:	**26P**		**SEE Duration**	:	**2.00 Hours**

Contents — **13 Hrs**

1. Break the ICE
2. Introduction to freedom Talk to each and every single person for a period of 5 complete minutes. Thisis aimed at to make everyone in the room comfortable with each other. This helps everyone get over socialanxiety, Shyness and Nervousness.
3. Ura
4. Rhythm Voice Projection, Voice Modulation, Weeping & Coughing Voice projection is the strength of speaking or singing whereby the voice is used powerfully and clearly. It is a technique employed to command respect and attention, as when a teacher talks to a class, or simply to be heard clearly, as used by an actor in a theatre.
5. It's Leviosa, Not Leviosaaa!
6. Speech work: Diction, Intonation, Emphasis, Pauses, Pitch and Volume Tempo Dialogues delivery. The art of dialogue delivery plays a vital role in in ensuring the efficacy of communication especially from the dramatic aspect of it, this unit discusses some tips to help the young actors improve their dialogue deliveryskills:
7. Elementary, My dear Watson.
8. Responsibilities of an actor tools of an actor character analysis Observations aspects, Stage presence, concentration, conviction, confidence, energy and directionality.
9. Show time
10. Pick a genre: COMEDY, THRILLER, HORROR, and TRAGEDY: Showcase a performance. Stylized acting with reference to historical and mythological plays. Mime: conventional, occupational and pantomime Mono acting: different types of characters

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Develop a range of Theatrical Skills and apply them to create a performance.
CO2	Work collaboratively to generate, develop, and communicate ideas.
CO3	Develop as creative, effective, independent, and reflective students who are able to make informed choices in process and performance.
CO4	Develop an awareness and understanding of the roles and processes undertaken in contemporaryprofessional theatre practice.

Reference Books	
1.	The Empty Space by Peter Brook.
2.	The Viewpoints Book: A Practical Guide to Viewpoints and Composition by Anne Bogart and TinaLandau.

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50% CIE**	**50% SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour withsurveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementationmethodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the projectwith report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
ART WORK & PAINTING (Practical)						
Course Code	:	**HS237GL**		**CIE**	:	**50 Marks**
Credits: L: T: P	:	**0:0:2**		**SEE**	:	**50 Marks**
Total Hours	:	**26P**		**SEE Duration**	:	**2.00 Hours**

Contents — **13 Hrs**

1. Use points, line and curves to create various shapes and forms
2. Use of shapes and forms to create various objects and structures
3. Recognizing distinctions in objects when viewed from various perspectives and grasping basic notions of perspective
4. Students will be introduced to the significance of color in art, as well as the principles of color theory and application.
5. Applied the concepts of unity, harmony, balance, rhythm, emphasis and proportion, abstraction and stylization to create a composition.
6. Learn how to use which materials and for what types of art and textures.
7. Use of the above concepts to create art through the medium of collage, mosaic, painting, mural, batik, tie anddye.
8. Real world application of the above concepts in the form of book cover design and illustration, cartoon, poster, advertisements, magazine, computer graphics and animation
9. Familiarization with the many art forms and techniques of expression found throughout India.

AND

ONE EDUCATIONAL VISIT TO AN ART MUSEUM / INSTITUTE / GALLERY

Students must turn in assignments for each of the above said topics on a weekly basis and have to compulsorily take part in the museum visit. CIE will be evaluated based on a still life piece, a composition using any one of the media of composition and a presentation on Indian art styles and creation of a piece pertaining to the presentedart style.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Use lines, shapes, and colors to depict the various sentiments and moods of life and nature.
CO2	Use one's creativity to develop forms and color schemes, as well as the ability to portray them effectivelyin drawing and painting on paper.
CO3	Develop the ability to properly use drawing and painting materials (surfaces, tools and equipment, and soon).
CO4	Improve their observation abilities by studying everyday items as well as numerous geometrical and non-geometrical (i.e., organic) shapes found in life and nature and to hone their drawing and painting talents in response to these insights.

Reference Books	
1.	Catching the Big Fish: Meditation, Consciousness, and Creativity, David Lynch
2.	Art & Fear: Observations on the Perils (and Rewards) of Artmaking, David Bayles & Ted Orland

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50% CIE**	**50% SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementationmethodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the projectwith report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
PHOTOGRAPHY & FILM MAKING (Practical)						
Course Code	**:**	**HS237HL**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**26P**		**SEE Duration**	**:**	**2.00 Hours**

Contents **13 Hrs**

1. Introduction to photography.
2. Understanding the terminologies of DSLR.
3. Elements of photography.
4. Introduction to script writing, storyboarding.
5. Understanding the visualization and designing a set.
6. Basics of film acting
7. Video editing using software
8. Introduction to cinematography.
9. Understanding about lighting and camera angles.
10. Shooting a short film.

Students must form groups of 2-4 and present a short film which shall be given by the experts. The experts shall judge the groups and award marks for the same.

CIE will be evaluated based on their presentation, approach and implementation strategies. Students need to submit their certificates of any event they participated or bagged prizes in. This shall also be considered for CIE evaluation.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand basics of photography and videography and improve their skills.
CO2	Appreciate the skills acquired from photography.
CO3	Perform and present photos and films in a presentable manner.
CO4	Develop skills like team building and collaboration.

Reference Books	
1.	Read This If You Want to Take Great Photographs – Henry Carroll
2.	The Digital Photography Book: Part 1 – Scott Kelby

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50% CIE**	**50% SEE**
Presentation 1- Selection of topic- (phase 1): Justification for Importance, need of the hour withsurveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2): Content development, strategies for implementationmethodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the projectwith report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
BRIDGE COURSE: C PROGRAMMING (Mandatory Audit Course) (Common to all Programs)						
Course Code	:	**CS139AT**		**CIE**	:	**50 Marks**
Credits: L:T:P	:	**2:0:0(Audit)**		**SEE**	:	--
Total Hours	:	**30L**		**SEE Duration**	:	--

Unit-I	**6 Hrs**
Introduction to Programming: Definition of a computer. Components of computer system, Programming Languages. Design and implementation of efficient programs. Program Design Tools: Algorithms, Flowcharts and Pseudo codes. Types of Errors.	
Unit – II	**6 Hrs**
Introduction to C: Introduction, structure of a C program, Writing the first program, Files used in a C program. Compiling and executing C Programs using comments, C Tokens, Character set in C, Keywords, Identifiers, Basic Data Types in C, Variables, Constants, I/O statements in C. Operators in C, Type conversion and type casting, scope of variables.	
Unit –III	**6 Hrs**
Decision Control and Looping Statements: Introduction to decision control, conditional branching statements, iterative statements, Nested loops, Break and continue statements, go to statements. **Arrays:** Introduction, Declaration of Arrays, accessing elements of an array, Storing values in arrays, Operations on Arrays- Traversing, Inserting and Deletion of element in an array. Two dimensional arrays- Operations on two dimensional arrays.	
Unit –IV	**6 Hrs**
Strings: Introduction, Operations on strings- finding length of a string, converting characters of a string into uppercase and lowercase, concatenating two strings, appending a string to another string, comparing two string, reversing a string. String and character Built in functions. **Functions:** Introduction, using functions, Function declaration/function prototype, Function definition, Function call, Return statement.	
Unit-V	**6 Hrs**
Functions: Passing parameters to a function, Built-in functions. Passing arrays to functions. Recursion. **Structures and Pointers:** Introduction: Structure Declaration, Typedef declaration, initialization of structures, accessing members of a structures, Introduction to pointers, declaring pointer variables.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Analyse problems and design solution using program design tools.
CO2	Evaluate the appropriate method/data structure required in C programming to develop solutions by investigating the problem.
CO3	Design a sustainable solution using C programming with societal and environmental concern by engaging in lifelong learning for emerging technology
CO4	Demonstrate programming skills to solve inter-disciplinary problems using modern tools effectively by exhibiting team work through oral presentation and written reports.

Reference Books	
1.	Programming in C, Reema Thareja, 2018, Oxford University Press. ISBN: 9780199492282.
2.	The C Programming Language, Kernighan B.W and Dennis M. Ritchie, 2015, 2nd Edition, Prentice Hall, ISBN (13): 9780131103627.
3.	Turbo C: The Complete Reference, H. Schildt, 2000, 4th Edition, McGraw Hill Education, ISBN-13: 9780070411838.
4.	Algorithmic Problem Solving, Roland Backhouse, 2011, Wiley, ISBN: 978-0-470-68453-5

PRACTICE PROGRAMS

Implement the following programs using cc/gcc compiler

1. Familiarization with programming environment: Concept of creating, naming and saving the program file in gedit/vi editor, Concept of compilation and execution, Concept of debugging in GDB environment.
2. Implementation and execution of simple programs to understand working of
- Formatted input and output functions- printf() and scanf().
- Escape sequences in C.
- Using formula in a C program for specific computation: For example: computing area of circle, converting Celsius to Fahrenheit, area of a triangle, converting distance in centimeters to inches, etc.
- Preprocessor directives (#include, #define).
3. Execution of erroneous C programs to understand debugging and correcting the errors like:
- Syntax / compiler errors.
- Run-time errors.
- Linker errors.
- Logical errors.
- Semantical errors.
4. Implementation and execution of simple programs to understand working of operators like:
- Unary.
- Arithmetic.
- Logical.
- Relational.
- Conditional.
- Bitwise.
5. Develop a C program to compute the roots of the equation ax2 + bx + c = 0.
6. Develop a C program that reads N integer numbers and arrange them in ascending or descending order using selection sort and bubble sort technique.
7. Develop a C program for Matrix multiplication.
8. Develop a C program to search an element using Binary search and linear search techniques.
9. Using functions develop a C program to perform the following tasks by parameter passing to read a string from the user and print appropriate message for palindrome or not palindrome.
10. Develop a C program to compute average marks of 'n' students (Name, Roll_No, Test Marks) and search a particular record based on 'Roll_No'.
11. Develop a C program using pointers to function to find given two strings are equal or not.
12. Develop a C program using recursion, to determine GCD , LCM of two numbers and to perform binary to decimal conversion.

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 05 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**10**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 25 Marks, adding up to 50 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 20 MARKS.**	**20**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (10) & Phase II (10) ADDING UPTO 20 MARKS**.	**20**
MAXIMUM MARKS FOR THE CIE THEORY		**50**

Semester: IV

STATISTICS FOR DATA ANALYTICS
Category: Professional Core Course
(Theory)

Course Code	**:**	**IM241AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**

Data Summary and Presentation: Data types, tabular and graphical displays: Stem and Leaf diagrams, Histograms, Box plots, Radar diagrams.
Concepts of Probability: Sample spaces and Events, Interpretations of probability, Addition rules, Conditional probability, Multiplication and Total probability rules, Independence, Bayes Theorem. Numerical Problems

Unit-II	**09 Hrs**

Concepts of Random Variables: Random Variables, Discrete and continuous random variables. Probability distributions and mass functions, Numerical Problems
Discrete Probability Distributions: Discrete uniform, Binominal, Poisson, Geometric, Negative binomial, Applications, Numerical Problems.

Unit-III	**09 Hrs**

Continuous Probability Distributions: Continuous uniform, Normal, Normal approximations, Exponential, Applications, Numerical Problems.
Sampling Distribution: Sampling distribution, Central Limit Theorem, Sampling distribution of means and derived quantities, Numerical Problems.

Unit-IV	**09 Hrs**

Simple Linear Regression and Correlation: Empirical models, Simple Linear Regression, Properties of Least square Estimators and Estimation of variances, Common abuses of regression, Prediction of new observations, Correlation, Numerical Problems. Interpretation of graphical output from software packages such as Minitab

Unit-V	**09 Hrs**

Statistical Inference for a single sample: Hypothesis testing, Inference on the mean of a normal population (variance known and unknown), Inference on the variance of a Normal population, Testing for Goodness of Fit, Tests of association, Numerical Problems
Interval Estimation: Confidence Intervals on mean (variance known and unknown), and variance of a normal population

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe and report data set using data analysis, presentation and interpretation techniques to understand various phenomena in the fields of science and engineering.
CO2	Apply various statistical processing techniques to handle a set of data to estimate probabilities.
CO3	Apply an appropriate statistical tool and analyze a specific set of data to estimate and draw conclusions about population parameters
CO4	Draw inferences about population parameters and relations between variables based on analysis of sample data

References Books	
1.	Engineering Statistics, Douglas C. Montgomery, George C. Runger, Norma FarisHubele, 5th Edition, 2011, John Wiley & Sons, Inc., ISBN-13: 978- 0-470-63147-8
2.	Applied statistics and Probability for Engineers, Douglas C Montgomery, George C Runger, Wiley, 4th Edition, 2007, Asia Student Edition, ISBN: 978-81-265-2315-3.
3.	Statistics for Management, Richard I Levin, David S Rubin, 7th Edition, 1997, Prentice Hall India, ISBN: 9780134762920.
4.	Probability and Statistics for Engineers and Scientists, Walpole, Myers, Myers, Ye, 8th Edition, 2007, Pearson Education Inc., ISBN: 978-81-317-1552-9.
5.	Softwares : Microsoft Excel / Minitab / Matlab / R

6.	Online resources: a) http://172.16.44.44/nnptel.html - choose NOC:Introduction to Data Analytics(Course sponsored by Aricent) b) https://onlinecourses.nptel.ac.in/noc22_mg31/preview -Introduction to probability and Statistics c) https://newonlinecourses.science.psu.edu/statprogram/undergraduate-studies d) https://www.khanacademy.org/math/statistics-probability

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40**	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: IV						
ENVIRONMENT AND SUSTAINABILITY **Category: Professional Core Course** **(Common to all Programs)** **(Theory)**						
Course Code	**:**	**CV242AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**10 Hrs**
ENVIRONMENT AND BIODIVERSITY: Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity. **ENVIRONMENTAL POLLUTION:** Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollution. Solid, Hazardous and E-Waste management. Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.	
Unit – II	**08 Hrs**
RENEWABLE SOURCES OF ENERGY: Energy management and conservation, New Energy Sources: Need of new sources. Different types of new energy sources. Energy Cycles, carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socioeconomical and technological change. Applications of - Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.	
Unit –III	**08 Hrs**
SUSTAINABILITY AND MANAGEMENT: Introduction to Environmental Economics, Environmental Audit, Development, GDP, Sustainability - concept, needs and challenges-economic, social and aspects of sustainability - from unsustainability to sustainability-millennium development goals and protocols. Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.	
Unit –IV	**08 Hrs**
SUSTAINABLE DEVELOPMENT GOALS - targets, indicators and intervention areas Climate change - Global, Regional and local environmental issues and possible solutions. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry. **SUSTAINABILITY PRACTICES:** Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment. Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports.	
Unit –V	**08 Hrs**
CORPORATE SOCIAL RESPONSIBILITY (CSR) - Meaning & Definition of CSR, History & evolution of CSR. Concept of Charity, Corporate philanthropy, Corporate Citizenship, CSR-an overlapping concept. Concept of sustainability & Stakeholder Management. Relation between CSR and Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India. Sustainability Reporting: Flavor of GRI, Dow Jones Sustainability Index, CEPI. Investor interest in Sustainability.	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand the basic elements of Environment and its Biodiversity.
CO2	Explain the various types of pollution and requirement for sustainable strategy for present scenario.
CO3	Evaluate the different concepts of sustainability and its significance for welfare of all life forms.
CO4	Recognize the role of Corporate social responsibility in conserving the Environment.

Reference Books	
1.	'Environmental Science and Engineering', Benny Joseph, Tata McGraw-Hill, New Delhi, 2016. ISBN-13 - 978-9387432352
2.	'Introduction to Environmental Engineering and Science', Gilbert M.Masters, Wendell P Ela, 3rd edition, Pearson Education, 2006. ISBN-13 - 978-0132339346
3.	Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4.	A Handbook of Corporate Governance and Social Responsibility (Corporate Social Responsibility), David Crowther and Guler Aras, Gower Publishing Ltd, ISBN - 13 - 978-0566088179

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will beconducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40**	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: IV						
MATERIALS SCIENCE FOR ENGINEERS **Category: Professional Core Course** **(Common to all programs)** **(Theory)**						
Course Code	**:**	**ME242AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**06 Hrs**
The Fundamentals of Materials The electronic structure of atoms, types of atomic and molecular bonds: ionic bond, covalent bond, metallic bond, secondary bonds, mixed bonding, hybridization. Energy bands in metals, insulators, and semiconductors. Basic crystallography. Defects and dislocations. Types of materials: polymers, metals and alloys, ceramics, semiconductors, composites.	
Unit – II	**10 Hrs**
Material behaviour Thermal properties: thermal conductivity, thermoelectric effects, heat capacity, thermal expansion coefficient, thermal shock, thermocouple. Electrical Properties: dielectric behaviours and temperature dependence of the dielectric constant, insulating materials, ferroelectricity, piezoelectricity, super conductor. Optical properties: luminescence, optical fibers, Mechanical Properties: Stress-strain diagram, elastic deformation, plastic deformation, hardness, viscoelastic deformation, impact energy, fracture toughness, fatigue.	
Unit –III	**10 Hrs**
Materials and their Applications Semiconductors, dielectrics, optoelectronics, structural materials, ferrous alloys, nonferrous alloys, cement, concrete, ceramic, and glasses. Polymers: thermosets and thermoplastics, composites: fibre-reinforced, aggregated composites, electronic packaging materials, biomaterials, processing of structural materials.	
Unit –IV	**07 Hrs**
Heat Treatment Post processing heat treatment of electronic devices: thermal oxidation, diffusion, rapid thermal processing. Heat treatment of ferrous materials: annealing, spheroidizing, normalizing, hardening, tempering. formation of austenite, construction of Time Temperature Transformation (TTT) curves. Special heat treatment processes: carburizing, nitriding, cyaniding, flame, and induction hardening. Defects in heat treatment.	
Unit-V	**07 Hrs**
Nanomaterials Synthesis of nanomaterials: ball milling, sol-gel, vapour deposition growth, pulse laser, magnetron sputtering, lithography. Nano porous materials: zeolites, mesoporous materials, carbon nanotubes, graphene, nano FRPs, nano fabrics, bioresorbable and bio-erodable materials, nano ceramic, nano glasses, nano biomaterials, nano implant associated materials. Characterisation of nano structures, spectroscopic techniques, automatic force microscopy.	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand the classification of materials, their atomic structure, and properties.
CO2	Investigate the properties and applications of different materials.
CO3	Analyse the effect of different heat treatment processes.
CO4	Recognize different types of nanomaterials, synthesis methods and characterisation techniques.

Reference Books	
1.	Material Science and Engineering, William D Callister, 6th Edition, 1997, John Wiley and Sons, ISBN: 9812-53-052-5
2.	Introduction to Physical Metallurgy, Sydney H Avner, 1994, Mc. Graw Hill Book Company, ISBN: 0-07-Y85018-6
3.	Material Science and Engineering, William F Smith, 4th Edition, 2008, Mc. Graw Hill Book Company, ISBN: 0-07-066717-9
4.	A.S. Edelstein and R.C. Cammarata, Nanomaterials: Synthesis, Properties and Applications, CRC Press 1996, ISBN:978-0849322749

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: IV

BIO SAFETY STANDARDS AND ETHICS
Category: PROFESSIONAL CORE COURSE
(Common to all programs)
(Theory)

Course Code	**:**	**BT242AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**

Biohazards, Bio safety levels and cabinets: Introduction to Biohazards, Biological Safety levels, Bio safety Cabinets, Study of various types of Bio safety cabinets. Various parameters for design of Biosafety cabinets (Materials used for fabrication, sensors, filters, pumps, compressors)

Unit – II	**08 Hrs**

Biosafety Guidelines: Biosafety guidelines of Government of India, GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM (Review committee o Genetic manipulation), GEAC (Genetic Engg Approval Committee) for GMO applications in food and agriculture. Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Unit –III	**10 Hrs**

Food safety standards: FSSAI (Food Safety and Standards Authority of India), Functions, License, types of FSSAI Licences and compliance rules.
Food Hygiene: General principles of food microbiology and overview of foodborne pathogens, sources of microorganisms in the food chain (raw materials, water, air, equipment, etc.)
Quality of foods, Microbial food spoilage and Foodborne diseases, Overview of beneficial microorganisms and their role in food processing and human nutrition, Food Analysis and Testing, General principles of food safety management systems, Hazard Analysis Critical Control Point (HACCP).

Unit –IV	**09 Hrs**

Food preservations, Processing, and Packaging: Food Processing Operations, Principles, Good Manufacturing Practices HACCP, Good production, and processing practices (GMP, GAP, GHP, GLP, BAP, etc)
Overview of food preservation methods and their underlying principles including novel and emerging methods/principles. Overview of food packaging methods and principles including novel packaging materials.

Unit –V	**09 Hrs**

Food safety and Ethics: Food Hazards, Food Additives, Food Allergens Drugs, Hormones, and Antibiotics in Animals. Factors That Contribute to Foodborne Illness, Consumer Lifestyles and Demand, Food Production and Economics, History of Food Safety, The Role of Food Preservation in Food Safety.
Ethics: Clinical ethics, Health Policy, Research ethics, ethics on Animals. Biosafety and Bioethics.

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehensive knowledge of Biohazards and bio safety levels
CO2	Understanding the biosafety guidelines and their importance to the society
CO3	Knowledge with respect to the Food standards, Hygiene, food processing and packing
CO4	Appreciate the food safety, Ethics, biosafety and bio ethics

Reference Books	
1	Deepa Goel, Shomini Parashar IPR, Biosafety and Bioethics 1st Edition, Pearson; 1st edition, 2013, ISBN: 978-8131774700.
2	Cynthia A Roberts, The Food Safety, Oryx Press, first edition, 2001, ISBN: 1–57356–305–6.
3	Hal King, Food Safety Management Systems, Springer Cham, 2020, ISBN: 978-3-030-44734-2.
4	Alastair V. Campbell , Bioethics: The Basics, Routledge; 2nd edition, 2017, ISBN: 978-0415790314.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40**	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: IV						
CAD/CAM & ROBOTICS **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	**IM343AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**3.00 +3.00 Hours**

Unit-I	**08 Hrs**
Fundamentals of CAD: Introduction, The CAD system definition, Reasons for implementing CAD. Design process (Shigley Model), Application of computers in design, benefits of CAD. **Principle of Interactive computer Graphics**: Graphic primitives, Line drawing algorithms, Bresenham's circle algorithm, Scan conversion, Rendering, Z buffer algorithm, Reflection, Shading	
Unit-II	**09Hrs**
Numerical & Computer control in Production system: NC procedure, NC coordinate systems, Elements & Classification of NC system, Functions & Features of CNC, DNC Concepts, and Components & Types of DNC. **NC part programming & computer aided part programming:** Manual part programming, Computer Assisted part programming, Computer assisted NC part programming, APT Language.	
Unit-III	**08 Hrs**
Automation: Introduction, Definition of Automation, Mechanization vs. Automation, Advantages of Automation, Goals of Automation, Social Issues of Automation, Low Cost Automation, Types of Automation Current Emphasis in Automation, Reasons for Automation, Reasons for not Automation, Issues for Automation in Factory Operations, Strategies for Automation.	
Unit-IV	**09 Hrs**
Robotics: Introduction, History of Robots, Definition of a Robot, Industrial Robot, Laws of Robotics Motivating Factors, Advantages and Disadvantages of Robots, Characteristics of an Industrial Robot, Components of an Industrial Robot, Comparison of the Human and Robot Manipulator, Robot Wrist and End of Arm Tools, Robot Terminology, Robotic Joints, Classification of Robots.	
Unit-V	**08Hrs**
Robotic Sensors & Robot End Effectors: Introduction, Types of Sensors in Robots, Exteroceptors or External Sensors, Introduction to End Effector, Classification of End Effectors, Grippers, Selection of Gripper, Gripping Mechanisms. **Robot Programming**: Introduction, Robot Programming, Robot Programming Techniques, On-line Programming, Lead-Through Programming, Walk-Through Programming or Teaching Off-line Programming, Overview of Robot Programming Languages, Robot Languages, Types of Robot Languages	

Laboratory Component
Part – I
• Two experiments on Simulation of Turning and milling operation on CNC Train software. • Four experiments on CNC turning & milling machines.
Part – II
• Experiments on robot programming to perform simple task

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the Elements of CNC technology and their role in CAD/CAM environment
CO2	Apply the principles of automation in manufacturing technology to improve overall organizational productivity
CO3	Summarize the different types of transfer and feeder devices used in automation.
CO4	Understanding the functionality and limitations of robotic actuators and sensors

Reference Books	
1.	CAD / CAM, Ibrahim Zeid, 1st Edition, 2000, McGraw Hill, ISBN – 0070728577.
2.	Industrial Automation and Robotics, A. K. Gupta, S. K. Arora 3rd Edition, 2013, University Science press.
3.	Automation, Production System and Computer Integrated Manufacturing, Mikell.P.Groover, 3rd Edition, 2007, PHI New Delhi, ISBN – 0132393212
4.	Computer Aided Design and Manufacturing,K. Lalit Narayan, K Mallikarjuna Rao & M.M.M Sarcar, 1st edition, 2008, PHI New Delhi, ISBN-978-81-203-3342-0

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20Marks) adding up to 50 Marks. **THE FINAL MARKS WILL BE50 MARKS.**	**50**
MAXIMUM MARKS FOR THE CIE THEORY & PRACTICE		**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: IV						
OPERATIONS RESEARCH **Category: Professional Core Course** **(Theory And Practice)**						
Course Code	**:**	**IM244AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**3.00 +3.00 Hours**

Unit-I	**06 Hrs**
Introduction to Model Building: An Introduction to Modeling, Prescriptive or Optimization Models – Objective function, Decision Variable & Constraints, The Seven-Step Model-Building Process. **Introduction to Operations Research:** Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR. **Linear Programming:** Definition, Mathematical Formulation, Standard Form, Proportionality and Additivity Assumptions, Divisibility Assumption, Certainty Assumption, Feasible Region and Optimal Solution, Degenerate, A Diet Problem, A Work-Scheduling Problem, A Capital Budgeting Problem, Blending Problems, Production Process Models, The Graphical Solution of Two-Variable Linear Programming Problems.	
Unit – II	**08 Hrs**
Simplex Algorithm: How to Convert an LP to Standard Form, Preview of the Simplex Algorithm, Direction of Unboundedness, Why Does an LP Have an Optimal basic feasible solution, The Simplex Algorithm, Using the Simplex Algorithm to Solve Minimization Problems, Alternative Optimal Solutions, Degeneracy and the Convergence of the Simplex Algorithm, The Big M Method, The Two-Phase Simplex Method. **Sensitivity Analysis and Duality:** A Graphical Introduction to Sensitivity Analysis, Some Important Formulas, Sensitivity Analysis, Finding the Dual of an Linear Programming, Economic Interpretation of the Dual Problem, The Dual Simplex Method	
Unit –III	**08 Hrs**
Transportation Problem: Formulating a transportation problem, General Description of a Transportation Problem, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Variants in Transportation Problems, Applications of Transportation problems. **Assignment Problem:** Formulation of the Assignment problem, Solution method of assignment problem – Hungarian Method, Solution method of assignment problem – Hungarian Method, Variants in assignment problem, Traveling Salesman Problem. Usage of software tools to demonstrate Transportation and Assignment problems	
Unit –IV	**08 Hrs**
Project Management Using Network Analysis: Network construction, CPM & PERT, Determination of critical path and duration, floats. Crashing of Network. Usage of software tools to demonstrate N/W flow problems	
Unit –V	**06 Hrs**
Game Theory: Introduction, Two person Zero Sum game, Pure strategies – Games with saddle point, Graphical Method, The rules of dominance, solution method of games without saddle point, Arithmetic method.	

Laboratory Work
• Introduction to Operations Research Packages - using MAT Lab, GAMS Excel, TORA and LINGO • Exercise on application of Operations Research Models to various sector of economy including Manufacturing, Health Care, Infrastructure, Insurance, Banking, Retail, Agriculture and Governance

Course Outcomes: After completing the course, the students will be able to know	
CO1:	Understand the characteristics of different types of decision – making environments and the appropriate decision making approaches and tools to be used in each type.
CO2:	Build and solve Transportation Models and Assignment Models.
CO3:	Design new simple models, like: CPM, PERT to improve decision –making and develop critical thinking and objective analysis of decision problems.
CO4:	Implement practical cases, by using TORA, WinQSB, Excel, GAMS.

Reference Books	
1.	Operations Research: Applications & Algorithms, Wayne L. Winston, 4th Edition, 2004, Thomson Books, ISBN 0-534-52020-0.
2.	Operation Research An Introduction, Taha H A, 8th Edition, 2004, PHI, ISBN: 0130488089.
3.	Operations Research: Principles and Practice, Ravindran, Phillips, Solberg, 2nd Edition, 2007, John Wiley & Sons, ISBN8126512563
4.	Operations Research Theory and Application, J K Sharma, 2nd Edition, 2003, Pearson Education Pvt Ltd, ISBN: 0333-92394-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20Marks) adding up to 50 Marks. **THE FINAL MARKS WILL BE50 MARKS.**	**50**
MAXIMUM MARKS FOR THE CIE THEORY & PRACTICE		**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: IV						
MARKETING MANAGEMENT **Category: Professional Core Course** **(Theory)**						
Course Code	**:**	**IM345AT**		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

UNIT-I	**07Hrs**
Introduction to Digital Marketing: Principles of Digital Marketing; Digital Marketing Channels; Tools to Create Buyer Persona; Competitor Research Tools, Website Analysis Tools, etc. **Content Marketing:** Content Marketing Concepts & Strategies; Planning, Creating, Distributing & Promoting Content; Optimize Website UX & Landing Pages; Measure Impact; Metrics & Performance; Using Content Research for Opportunities, etc.	
UNIT-II	**08Hrs**
Social Media Marketing: Introduction; Major Social Media Platforms for Marketing; Developing Data-driven Audience & Campaign Insights; Social Media for Business; Creation & Optimization of Social Media Campaigns, etc. **Search Engine Optimization:** Search Engine Optimization Fundamentals; Keywords and SEO Content Plan; SEO & Business Objectives; Writing SEO Content; On-site & off-site SEO; Optimize Organic Search Ranking, etc.	
UNIT-III	**07Hrs**
Web Analytics & Google Analytics: Google Analytics Tools; Web Analytics Tools, etc. **E-mail Marketing:** Effective E-mail Campaigns; E-mail Plan; E-mail Marketing Campaign Analysis; Measuring Conversions & keeping up, etc.	
UNIT-IV	**07Hrs**
Web Design: Web design, optimization of websites; Publishing a basic website; User-centered Design and Website Optimization; Design Principles and Website Copy; Website Metrics & Developing Insight, etc. **Mobile Marketing:** Difference between mobile advertising and marketing, utilizing mobile marketing for sales promotions, online applications, etc.	
UNIT-V	**07Hrs**
Conversion Optimization: What is AIDAS and its role; website optimization; what visitors want to see on the website; how to optimize key element and increase the effect of landing on a particular page **Digital Analytics:** Evolution of Digital Analytics, information about end-to-end customer experience, analyst's influence on business, role as a change agent, etc.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Differentiate the benefits drawn by updated marketing mix from traditional marketing mix for effective marketing management there by to stay competitive in today's global market-place.
CO2	Develop an effective holistic marketing atmosphere to efficiently face the challenges in dynamically changing market.
CO3	Formulate a potential marketing plan to effectively reach the targeted market segments, by delivering the value to targeted customers through practicing sound marketing research.
CO4	Create new channels to improvise marketing to achieve and maintain competitive position in globalized market-place.

Reference Books	
1.	Marketing Management, Philip Kotler, Kevin Lane Keller, 15th Edition, 2016, Pearson, ISBN:978-93-325-5718-5
2.	Digital Marketing - Strategy, Implementation & Practice, Dave Chaffey, Fiona Ellis – Chadwick, 7th Edition, 2019, Pearson, ISBN - 9781292241623, 1292241624
3.	Marketing Research, Donald S Tull, Del I Hawkins, 6th Edition, Prentice Hall India, ISBN: 8120309618
4.	Marketing Management - A South Asian Perspective, Philip Kotler, Kevin Lane Keller, Abrahan Koshy, MithileshwarJha, 14th Edition, 2013, Pearson, ISBN –978-81-317-6716-0
5.	Marketing Research, David A. Aaker, V. Kumar, George S. Day, 9th Edition, 2008, John Wiley & Sons, ISBN: 978-265-1791-6

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40**	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester IV						
DESIGN THINKING LAB **Category: Professional Core Course** **(Practice)**						
Course Code	**:**	**IM247DL**		**CIE Marks**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50 Marks**
Total Hours	**:**	**30P**		**SEE Duration**	**:**	**3.00 Hours**

Unit - I	**10 Hrs**
Understanding Design thinking: Design Thinking Methodology: The 5 Stages of the Design Thinking Process- Empathise, Define (the problem), Ideate, Prototype, and Test. Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – Multivarible product or Prototyping, Real-Time design interaction capture and analysis – Enabling efficient collaboration in digital space – Empathy for design – Collaboration in distributed Design	
Unit - II	**15 Hrs**
DT For strategic innovations Growth: Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design - Standardization – Humanization - Creative Culture – Rapid prototyping, Strategy and Organization – Business Model design.	
Unit - III	**14 Hrs**
Design Thinking Workshop: The Design Challenge: Define the Design Challenge, Prototyping & Iteration- Feasibility Study, Testing- Documentation and the Pitching: 10 hours design thinking workshop from the expect and then presentation by the students on the learning from the workshop,	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understanding various design process procedure
CO2:	Explore reverse engineering to understand products
CO3:	Develop technical drawing/prototype for design ideas
CO4:	Create design ideas through different techniques

References Books:	
1	Kilion Langenfeld, Design Thinking for Beginners, Personal Growth Hackers, ISBN: 13-9783967160628
2	Andrew Pressman, Design Thinking: A Guide to Creative Problem Solving for Everyone, Routeldge Taylor & Francis Grovel, 1st Edition, 2018, ISBN: 13-978-1-315-56193-6
3	Walter Brenner, Falk Uebernickel, Design Thinking for Innovation Research and Practice, Springer, 1st Edition, 2016, ISBN: 13-9783319260983
4	Emrah Yayici, Design Thinking Methodology Book, ArtBiz Tech Publishers, 1st Edition, 2016, ISBN:10-6058603757, 13-9786058603752

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (LAB)		
#	**COMPONENTS**	**MARKS**
1.	Conduction of laboratory exercises, lab report, observation, and analysis	20
2.	Experiential Learning	20
3.	Lab test	10
	MAXIMUM MARKS FOR THE CIE THEORY	**50**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**

Semester: IV						
UNIVERSAL HUMAN VALUES (Common to all Programs) (Theory)						
Course Code	**:**	**HS248AT**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**28L**		**SEE Duration**	**:**	**2.00 Hours**

Unit-I	**10 Hrs**

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education: Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration 'Natural Acceptance' and Experiential Validation Continuous Happiness and Prosperity- Human Aspirations, Right understanding, Relationship and Physical Facility, Understanding Happiness and Prosperity correctly.

Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility.

Understanding Harmony in the Human Being - Harmony in Myself!: Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' Understanding the Body as an instrument of Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health;

Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life.

Unit – II	**10 Hrs**

Understanding Harmony in the Family and Society- Harmony in Human Human Relationship: Understanding values in human-human relationship; meaning of Justice and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust.

Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

Unit –III	**08 Hrs**

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence: Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all pervasive space, Holistic perception of harmony at all levels of existence.

Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Course Outcomes: After completion of the course the students will be able to	
CO1	Become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions,
CO2	Understand human relationships and human nature in mind so that they will have better critical ability.
CO3	Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
CO4	Apply what they have learnt to their own self in different day-to-day settings in real life.

Reference Books	
1	Human Values and Professional Ethics, R. R. Gaur, R Sangal, G P Bagaria, 1st Edition, 2010, Excel Books, New Delhi, ISBN: 9788174467812.
2	Human Values, A.N. Tripathi, 3rd Edition, 2019, New Age Intl. Publishers, New Delhi, ISBN: 9788122425895.
3	India Wins Freedom, Maulana Abdul Kalam Azad, 1st Edition, 1988, Orient Blackswan, ISBN: 97881250051481.
4	The Story of My Experiments with Truth, Mohandas Karamchand Gandhi, 1st Edition, 2011, Create Space Publishing platform, ISBN: 9781463694876.
5	Small is Beautiful, E. F Schumacher, 1st Edition, 2011, (PBD)VINTAGE, ISBN: 9780099225614.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 05 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	10
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO** tests will be conducted. Each test will be evaluated for 25 Marks, adding upto 50 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 20 MARKS.**	20
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (05), Program specific requirements (05), Video based seminar/presentation/demonstration (10**). Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome).THE SUM OF ALL WILL BE THE FINAL MARKS OF 20.**	20
	MAXIMUM MARKS FOR THE CIE THEORY	**50**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	10
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	14
3 & 4	Unit 2 : Question 3 or 4	13
5 & 6	Unit 3 : Question 5 or 6	13
	TOTAL	**50**

Semester: IV						
Bridge Course: MATHEMATICS (Mandatory Audit Course) (AS, BT, CH, CV, EC, EE, EI, ET, IM, ME)						
Course Code	**:**	**MAT149AT**		**CIE**	**:**	**50 Marks**
Credits: L: T:P	**:**	**2:0:0**		**SEE**	**:**	**NO SEE (Audit Course)**
Total Hours	**:**	**30L**				

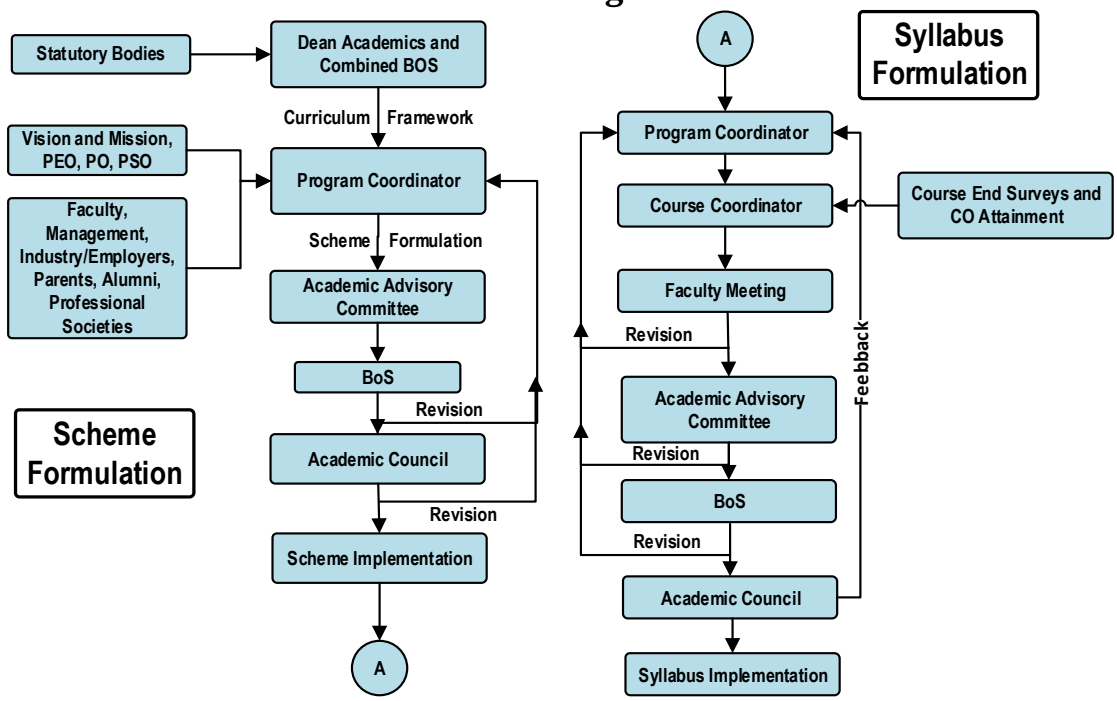
Unit-I	**10 Hrs**
Multivariable Calculus: **Partial Differentiation:** Introduction, simple problems. Total derivative, composite functions. Jacobians – simple problems. **Vector Differentiation:** Introduction, velocity and acceleration, gradient, divergence – solenoidal vector function, curl – irrotational vector function and Laplacian, simple problems.	
Unit – II	**10 Hrs**
Differential Equations: Higher order linear differential equations with constant coefficients, solution of homogeneous equations - Complementary functions. Non-homogeneous equations – Inverse differential operator method of finding particular integral based on input function (force function).	
Unit –III	**10 Hrs**
Numerical Methods: Solution of algebraic and transcendental equations – Intermediate value property, Newton-Raphson method. Solution of first order ordinary differential equations – Taylor series and 4^{th} order Runge-Kutta methods. Numerical integration – Simpson's $1/3^{rd}$, $3/8^{th}$ and Weddle's rules. (All methods without proof)**.**	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Illustrate the fundamental concepts of partial differentiation, vector differentiation, higher order linear differential equations and numerical methods.
CO2:	Derive the solution by applying the acquired knowledge of differential calculus, differential equations, velocity, and acceleration vectors to the problems of engineering applications.
CO3:	Evaluate the solution of the problems using appropriate techniques of differential calculus, vector differentiation, differential equations, and numerical methods.
CO4:	Compile the overall knowledge of differential calculus, vector differentiation, differential equations and numerical methods gained to engage in life – long learning.

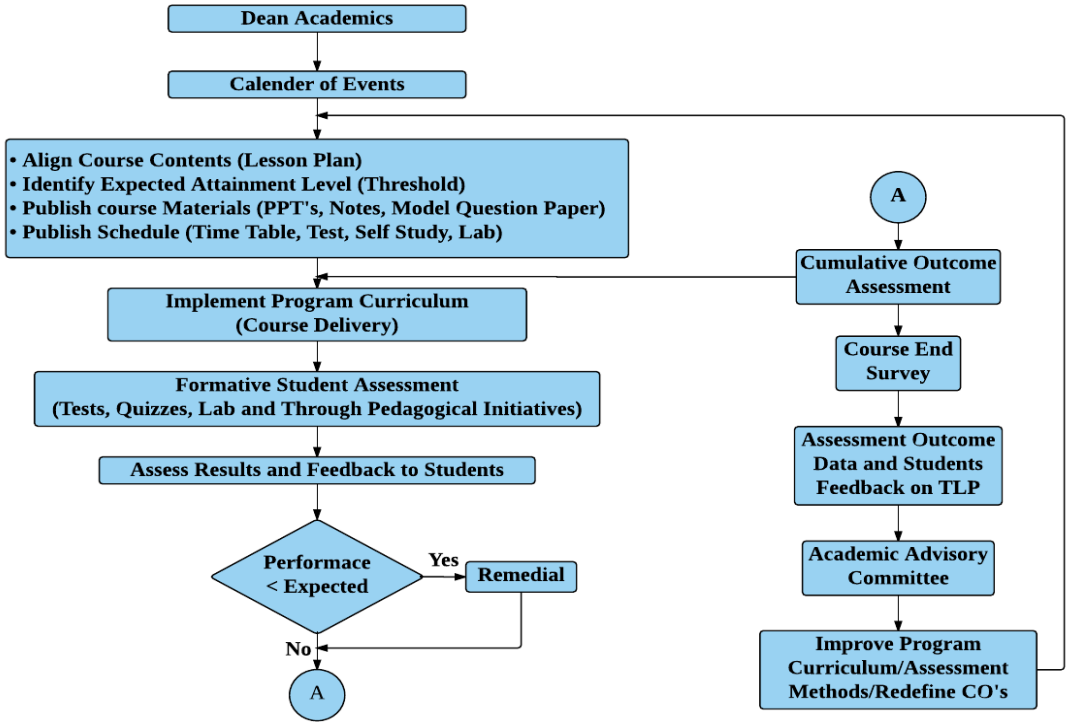
Reference Books	
1	Higher Engineering Mathematics, B.S. Grewal, 44^{th} Edition, 2015, Khanna Publishers, ISBN: 978-81-933284-9-1.
2	Higher Engineering Mathematics, B.V.Ramana, 11^{th} Edition, 2010, Tata McGraw-Hill, ISBN:978-0-07-063419-0.
3	A Textbook of Engineering Mathematics, N.P. Bali & Manish Goyal, 7^{th} Edition, 2010, Lakshmi Publications, ISBN: 978-81-31808320.
4	Advanced Engineering Mathematics, E. Kreyszig, 10^{th} Edition (Reprint), 2016. John Wiley & Sons, ISBN: 978-0470458365.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO TESTS will be conducted. Each test will be evaluated for 30 Marks, adding upto 60 Marks. **FINAL TEST MARKS WILL BE AVERAGE OF TWO TESTS.**	**30**
	MAXIMUM MARKS FOR THE CIE THEORY	**50**

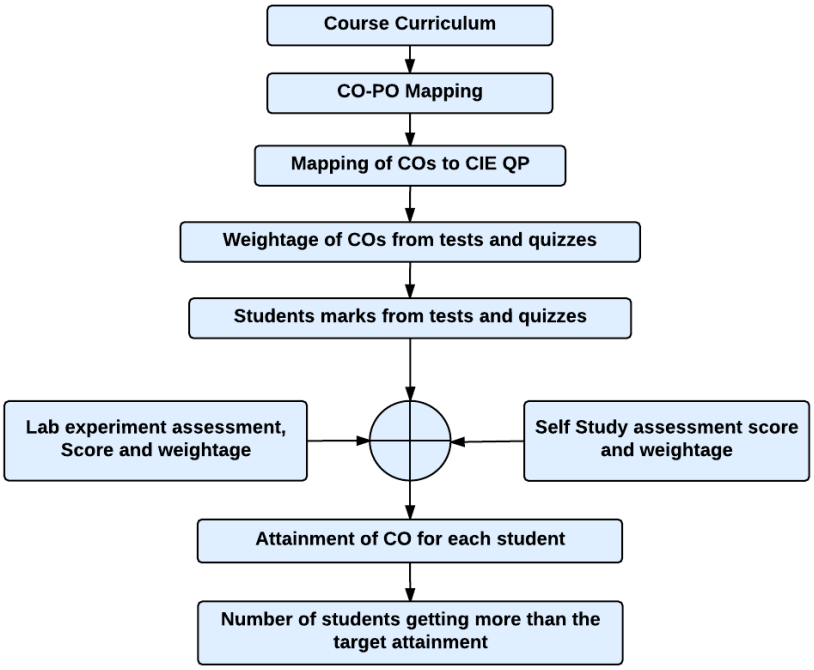
Curriculum Design Process



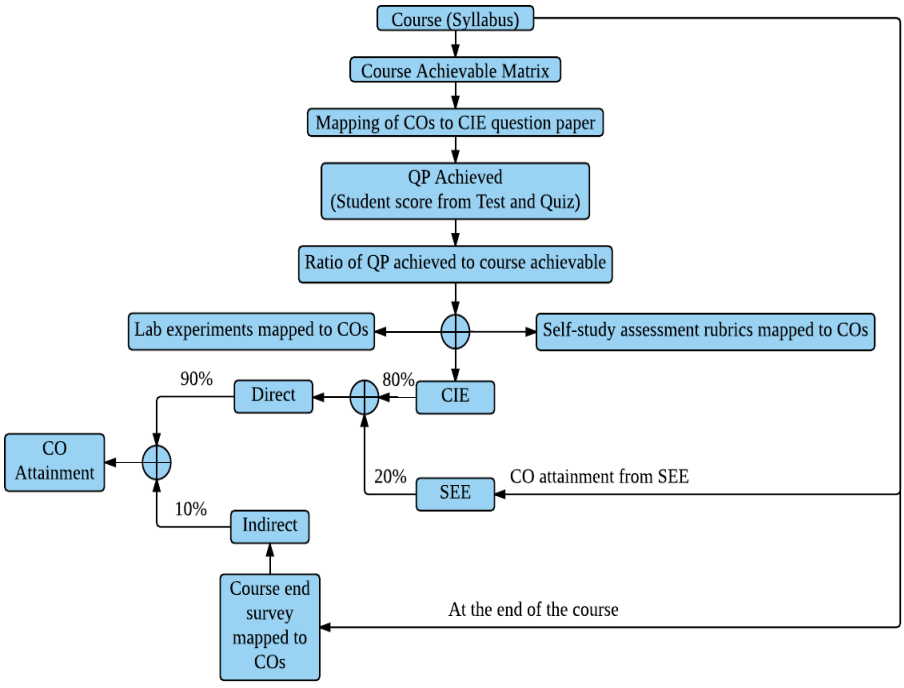
Academic Planning and Implementation



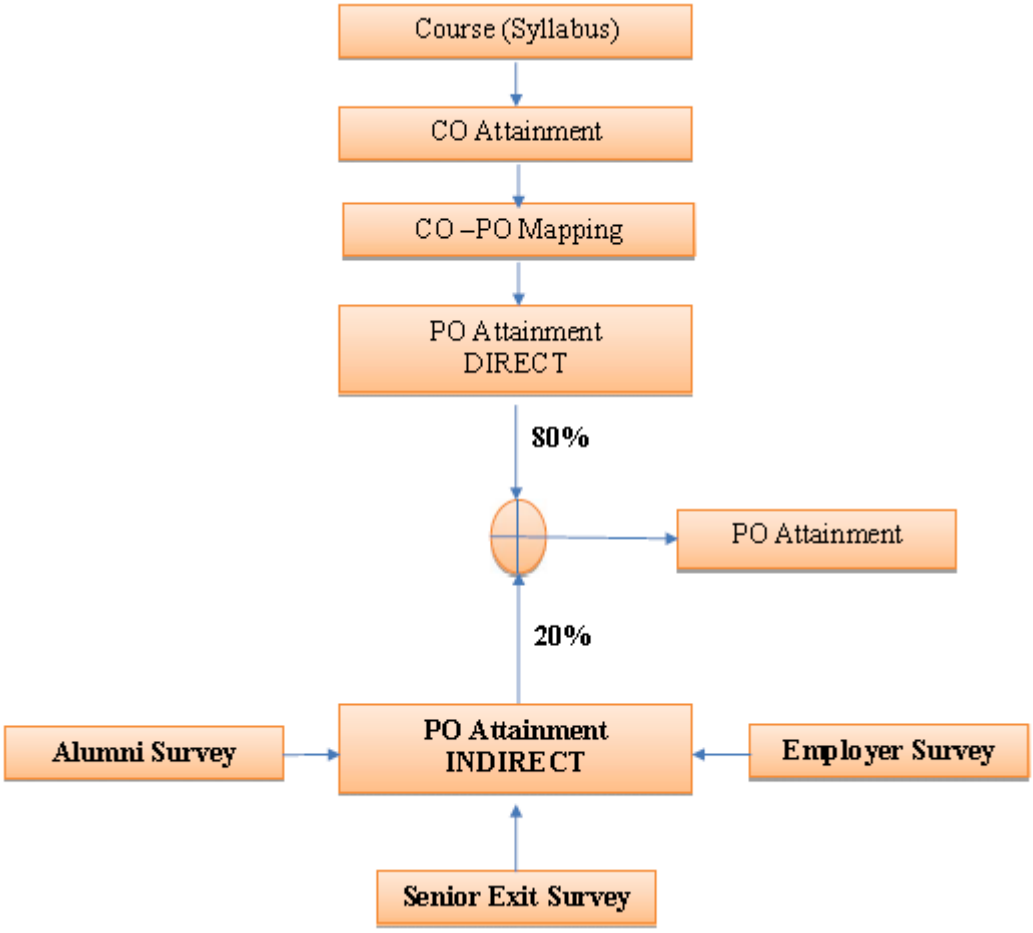
Process For Course Outcome Attainment



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 the 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 the 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.