RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Scheme and Syllabus of I & II Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

MACHINE DESIGN

DEPARTMENT OF

MECHANICAL ENGINEERING

INNER FRONT COVER PAGE

College Vision & Mission
(To be included from our side)

DEPARTMENT VISION

Quality Education in Design, Materials, Thermal and Manufacturing with emphasis on Research, Sustainable technologies and Entrepreneurship for Societal Symbiosis

DEPARTMENT MISSION

1. Imparting knowledge in basic and applied areas of Mechanical Engineering
2. Providing state-of-art laboratories and infrastructure for academics and research
3. Facilitating faculty development through continuous improvement programs
4. Promoting research, education and training in frontier areas of nanotechnology, advanced composites, surface technologies, MEMS and sustainable technology
5. Strengthening collaboration with industries, research organizations and institutes for internship, joint research and consultancy
6. Imbibing social and ethical values in students, staff and faculty through personality development programs

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1 Practicing Design of Engineering systems through the application of the fundamental knowledge and skills of Mechanical Engineering

PEO2 Enhancing analytical, numerical, experimental, research and project management skills through training, independent inquiry, and professional development.

PEO3 Working independently as well as collaboratively, while demonstrating the professional and ethical responsibilities of the engineering profession.

PROGRAM SPECIFIC OUTCOMES (PSOS)

PSO	Description
PSO1	Demonstrate basic knowledge in Mathematics, basic science, Materials Science and Engineering to formulate and solve mechanical engineering problems
PSO2	Design mechanical and thermal systems by adopting numerical, analytical and experimental techniques and analyse the results.
PSO3	Function in multidisciplinary teams with sound communication skills.
PSO4	Self-learn to acquire and apply allied knowledge and update the same by engaging in life-long learning, practice profession with ethics and promote entrepreneurship .

Lead Society: American Society of Mechanical Engineers – ASME

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	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.	PHY	Physics
21.	CHY	Chemistry
22.	MAT	Mathematics

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R V COLLEGE OF ENGINEERNG, BENGALURU-560 059
(Autonomous Institution Affiliated to VTU, Belagavi)
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech in PRODUCT DESIGN AND MANUFACTURING

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18 MMD 31	Fracture Mechanics	ME	4	1	0	**5**
2	18 XXX3EX	Elective 5	ME	4	0	0	**4**
3	18 MMD 32	Internship	ME	0	0	5	**5**
4	18 MMD 33	Dissertation Phase I	ME	0	0	5	**5**
Total number of Credits				8	1	10	**19**
Total Number of Hours / Week				**16**	**2**	**20**	**48**

LIST OF ELECTIVE COURSES

Group E : Core Electives	
18 MMD 3E1	Mechatronics System Design
18 MPD 3E2	Surface Engineering
18 MMD 3E3	Experimental Mechanics

M.TECH FOURTH SEMSESTER							
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**			**Credits**
				L	**T**	**P**	
1	18MMD41	Dissertation Phase II	ME	0	0	20	20
2	18MMD42	Technical Seminar	ME	0	0	2	2
				0	**0**	**22**	**22**

Semester: III						
FRACTURE MECHANICS (Theory)						
Course Code	**:**	**18MMD31**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**50L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
History and Overview: Historical Perspective, Early Fracture Research, The Liberty Ships, Post-War Fracture Mechanics Research, The Fracture Mechanics Approach to Design, The Energy Criterion, The Stress-Intensity Approach, Time-Dependent Crack Growth and Damage Tolerance, Effect of Material Properties on Fracture, A Brief Review of Dimensional Analysis. **Linear Elastic Fracture Mechanics**, An Atomic View of Fracture, Stress Concentration Effect of Flaws, The Griffith Energy Balance, Comparison with the Critical Stress Criterion, Modified Griffith Equation, The Energy Release Rate, Instability and the R-Curve, Reasons for the R-Curve Shape, Load Control vs. Displacement Control, Structures with Finite Compliance, Stress Analysis of Cracks, The Stress Intensity Factor, Relationship between K and Global Behaviour, Effect of Finite Size , Principle of Superposition, Weight Functions, Relationship between K and G	**10 Hrs**
Unit – II	
Crack-Tip Plasticity: The Irwin Approach, The Strip-Yield Model, Comparison of Plastic Zone Corrections, Plastic Zone Shape, K -Controlled Fracture, Plane Strain Fracture: Fact vs. Fiction, Crack tip Triaxiality, Effect of Thickness on Apparent Fracture Toughness, Plastic Zone Effects, Implications for Cracks in Structures. **Mixed-Mode Fracture:** Propagation of an Angled Crack, Equivalent Mode I Crack, Bi-axial Loading. Interaction of Multiple Cracks, Coplanar Cracks, Parallel Cracks. Mathematical Foundations of Linear Elastic Fracture Mechanics, Plane Elasticity, Cartesian Coordinates, Polar Coordinates, Crack Growth Instability Analysis, Crack-Tip Stress Analysis, Generalized In-Plane Loading, The Westergaard Stress Function.	**10 Hrs**
Unit – III	
Elastic-Plastic Fracture Mechanics: Crack-Tip-Opening Displacement, The Contour Integral, J as a Path-Independent Line Integral , J as a Stress Intensity Parameter , The Large Strain Zone , Laboratory Measurement of J , Relationships Between J and CTOD, Crack-Growth Resistance Curves, Stable and Unstable Crack Growth, Computing J for a Growing Crack, J-Controlled Fracture. **Dynamic and Time Dependent Fracture:** Dynamic Fracture and Crack Arrest, Rapid Loading of a stationary crack, Rapid Crack Propagation and Arrest, Crack Speed, Elastodynamic crack-tip parameters, Dynamic Toughness, Crack Arrest, Dynamic Contour Integrals	**10 Hrs**
Unit – IV	

Application to Structures: K_I for Part-Through cracks, influence coefficients for polynomial stress distributions, weight functions for arbitrary loading, primary, secondary and residual stresses. CTOD design curve, Failure Assessment Diagrams (FAD), original concept, J-based FAD, application to welded structures, incorporating weld residual stresses, weld misalignment, weld strength mismatch. Primary vs. Secondary stresses in FAD Method, Ductile-tearing Analysis with FAD. **Fatigue Crack Propagation**, Similitude in Fatigue, Empirical Fatigue Crack Growth Equations, Crack Closure , A Closer Look at Crack-Wedging Mechanisms, Effects of Loading Variables on Closure, The Fatigue Threshold, The Closure Model for the Threshold, A Two-Criterion Model, Threshold Behaviour in Inert Environments, Variable Amplitude Loading and Retardation, Linear Damage Model for Variable Amplitude Fatigue, Reverse Plasticity at the Crack Tip, The Effect of Overloads and Under loads , Models for Retardation and Variable Amplitude Fatigue.	**10 Hrs**
Unit –V	
Fracture Testing of Metals & Non-Metals: General Considerations, specimen configurations, Specimen orientation, Fatigue Precracking, Instrumentation, Side grooving, K_{IC} testing, ASTM E399, K-R Curve Testing, Specimen design, experimental measurement of K-R curves, J-testing of metals, CTOD testing, Fracture testing of weldments. Fracture Toughness Measurements in Engineering Plastics, K_{Ic} Testing, J-Testing, Qualitative Fracture Tests on Plastics. **Computational Fracture Mechanics**, Overview of Numerical Methods, The Finite Element Method, The Boundary Integral Equation Method, Traditional Methods in Computational Fracture Mechanics, Stress and Displacement Matching, Elemental Crack Advance, Contour Integration, Virtual Crack Extension: Stiffness Derivative Formulation, Virtual Crack Extension: Continuum Approach.	**10 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Demonstrate the material failure for any combination of applied stresses
CO2	Ability to Assess the failure conditions of a structure
CO3	Determine the stress intensity factor for simple components of simple geometry
CO4	To conduct fracture testing of metals & non-metals and learn computational fracture mechanics using FEM

Reference Books:	
1	T. L. Anderson, Fracture Mechanics: Fundamentals and Applications, Taylor and Francis Fourth Edition, 2005. ISBN: 977-3-735689-37-8
2	David Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, 4th revised edition. ISBN: 978-1-935159-47-9
3	Prashanth Kumar, Elements of Fracture Mechanics, Tata McGraw-Hill Education, 2009 ISBN: 077-1-732682-17-2
4	E.E. Gdoutos, Fracture Mechanics, Kluwer Academic Publishing, Boston, 1993. ISBN: 947-1-272683-32-9

Continuous Internal Evaluation (CIE): Total marks: 100

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: III						
MECHATRONICS SYSTEM DESIGN (Group E: Core Elective)						
Course Code	**:**	**18MMD3E1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**0:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**50L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction: Definition, Multidisciplinary Scenario, Evolution of Mechatronics, Design of Mechatronics system, Objectives, advantages and disadvantages of Mechatronics. **Transducers and sensors:** Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, proximity switches and Hall effect sensors.	**10 Hrs**
Unit – II	
Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. **Microprocessor Architecture**: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data, Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor**.**	**10 Hrs**
Unit – III	
Programmable logic controller: Introduction to PLC's, basic structure, Principle of operation, Programming and concept of ladder diagram, concept of latching & selection of a PLC **Integration:** Introduction & background, Advanced actuators, Pneumatic actuators, Industrial Robot, different parts of a Robot-Controller, Drive, Arm, End Effectors, Sensor & Functional requirements of robot.	**10 Hrs**
Unit – IV	
Mechanical actuation systems: Mechanical systems, types of motion, Cams, Gear trains, Ratchet & Pawl, belt and chain drives, mechanical aspects of motor selection. **Electrical actuation systems:** Electrical systems, Mechanical switches, Solenoids, Relays, DC/AC Motors, Principle of Stepper Motors & servo motors**.**	**10 Hrs**
Unit –V	
Pneumatic and hydraulic actuation systems: Actuating systems, Pneumatic and hydraulic systems, Classifications of Valves, Pressure relief valves, Pressure regulating/reducing valves, Pressure sequence valve, Cylinders and rotary actuators. **DCV & FCV-** Principle & construction details, types of sliding spool valve, solenoid operated, Symbols of hydraulic elements, components of the hydraulic system, functions of various units of hydraulic system. Design of simple hydraulic circuits for various	**10 Hrs**

applications.	

Course Outcomes: After going through this course the student will be able to:	
CO1	Define and illustrate the various components of Mechatronics system.
CO2	Identify, Categorize and apply transducers and sensors used in automation, control system and instruments.
CO3	Assess various control systems used in automation.
CO4	Develop mechanical, hydraulic, pneumatic and electrical based circuit systems.

Reference Books:	
1	Nitaigour Premchand Mahalik, Mechatronics-Principles, Concepts and Applications, Tata McGraw Hill, 1st Edition, 2003, ISBN No. 0071239243.
2	Mechatronics by HMT Ltd., Tata McGraw Hill, 1st Edition, 2000, ISBN No. 9780074636435.
3	W.Bolton , Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education, 1st Edition, 2005, ISBN No.81-7758-284-4.
4	Anthony Esposito, Fluid Power, Pearson Education-Sixth Edition-2011, ISBN N0:9789332518544

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester III						
SURFACE ENGINEERING						
Course Code	**:**	**18 MPD 3E2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Surface cleaning – classification, and selection of cleaning processes-alkaline cleaning, solvent cold cleaning and vapour degreasing, eemulsion cleaning, pickling and descaling **Tribology -** surface degradation, wear and corrosion, types of wear, roles of friction and lubrication- overview of different forms of corrosion.	**09 Hrs**
Unit – II	
Surface Engineering of ferrous and non ferrous materials : cast iron, carbon and alloy steels,aluminium and alloys, copper and alloys, magnesium and alloys. Nickel and alooys, **Conversion coatings** : Chemical and electrochemical polishing, significance, specific examples, phosphate, chromating, chemical coloring, anodizing of aluminum alloys, thermo chemical processes -industrial practices	**09 Hrs**
Unit – III	
Surface pre-treatment, deposition of copper, zinc, nickel and chromium - principles and practices, alloy plating, electro composite plating, electroless plating of copper, nickel phosphorous, nickel-boron; **Environmental protection issues**;Environmental regulation of surface engineering , cadmium elimination vapour degreasing alternatives, compient organic coating.	**10 Hrs**
Unit – IV	
Sputter technique – Methods, applications, plasma treatments, nitriding, carbonizing, boriding, titanising methods, applications **Laser coatings** : Laser alloying, sources, variables, methods, applications, specific industrial applications	**10 Hrs**
Unit –V	
Thermal spraying- techniques, advanced spraying techniques - plasma surfacing, D-Gun and high velocity oxy-fuel processes, **Laser surface alloying and Cladding -** specific industrial applications, tests for assessment of wear and corrosion behaviour.	**10 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain various forms of corrosion and basic concepts of surface engineering
CO2	Evaluate the different surface engineering processes with respect to industrial practices
CO3	Apply the knowledge of different spraying techniques in surface engineering
CO4	Analyze tests for assessment of wear and corrosion behaviour.

Reference Books	
1.	Sudarshan T S, 'Surface modification technologies - An Engineer's guide', Marcel Dekker, Newyork, 1989
2.	Varghese C.D, 'Electroplating and Other Surface Treatments - A Practical Guide', TMH, 1993
3.	Strafford, K.N., Datta, P.K., and Gray, J.S., Surface Engineering Practice, Processes, Fundamentals and Applications in Corrosion and Wear, Ellis Harwood (1990).
4.	Mathews, A., Advanced Surface Coatings: A Hand book of Surface Engineering, Spinger (1991).

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: III						
EXPERIMENTAL MECHANICS (Group E: Core Elective)						
Course Code	**:**	**18MMD3E3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**50L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction: Definition of terms, calibration, standards, dimensions and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning. **Analysis of Experimental Data:** Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, Gaussian, normal distribution. Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis.	**10 Hrs**
Unit – II	
Data Acquisition and Processing: General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion, Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic. **Force, Torque and Strain Measurement:** Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage.	**10 Hrs**
Unit – III	
Photoelastic Stress Analysis: Two Dimensional Photo elasticity **-** Nature of light, - wave theory of light - optical interference - Polariscopes Stress-optic law- effect of stressed model in plane and circular Polariscopes. **Isoclinic Iso chromatics fringe order determination** – Fringe multiplication techniques - Calibration of Photoelastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling**.**	**10 Hrs**
Unit – IV	

Three Dimensional Photo elasticity: Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principals stresses, Scattered light photo elasticity, Principles, Polari scope and stress data analyses. **Coating Methods:** Photoelastic Coating Method-Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photoelastic strain gauges. Brittle Coatings Method: Brittle coating technique Principles data analysis - coating materials, Coating techniques.	**10 Hrs**
Unit –V	
Moiré Technique - Geometrical approach, Displacement approach- sensitivity of moiré data reduction, In plane and out plane moiré methods, Moiré photography, moiré grid production. **Holography:** Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffeld curves, Reconstruction process, Holographic interferometry, Real-time and double exposure methods, Displacement measurement, Isopachics.	**10 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Understand experimental investigations to verify predictions by other methods.
CO2	Ability to acquire skills for experimental investigations
CO3	To provide a detailed knowledge of modern full field techniques such as Photoelastic Stress Analysis (PSA), Three Dimensional Photo elasticity (TDP)
CO4	Explain different types of coatings, test strain data using brittle coating and birefringent coating & holographic techniques

Reference Books:	
1	Holman, Experimental Methods for Engineers, 7th Edition, Tata McGraw-Hill Companies, Inc, New York, 2007
2	R. S. Sirohi, H. C. Radha Krishna, Mechanical measurements, New Age International Pvt. Ltd., New Delhi, 2004
3	Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra, Pant, Experimental Stress Analysis, Tata McGraw Hill, 1984.
4	Nakra & Chaudhry, B C Nakra K K Chaudhry, Instrumentation, Measurement And Analysis, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

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Scheme of Semester End Examination (SEE) for 100 marks:
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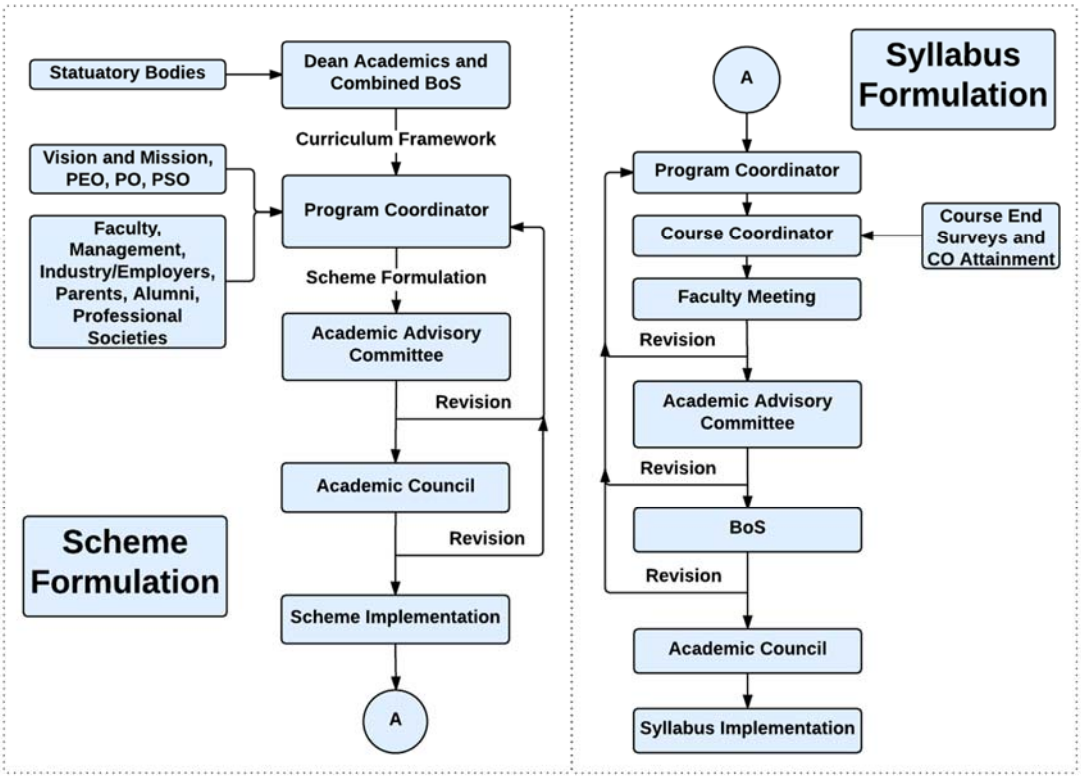
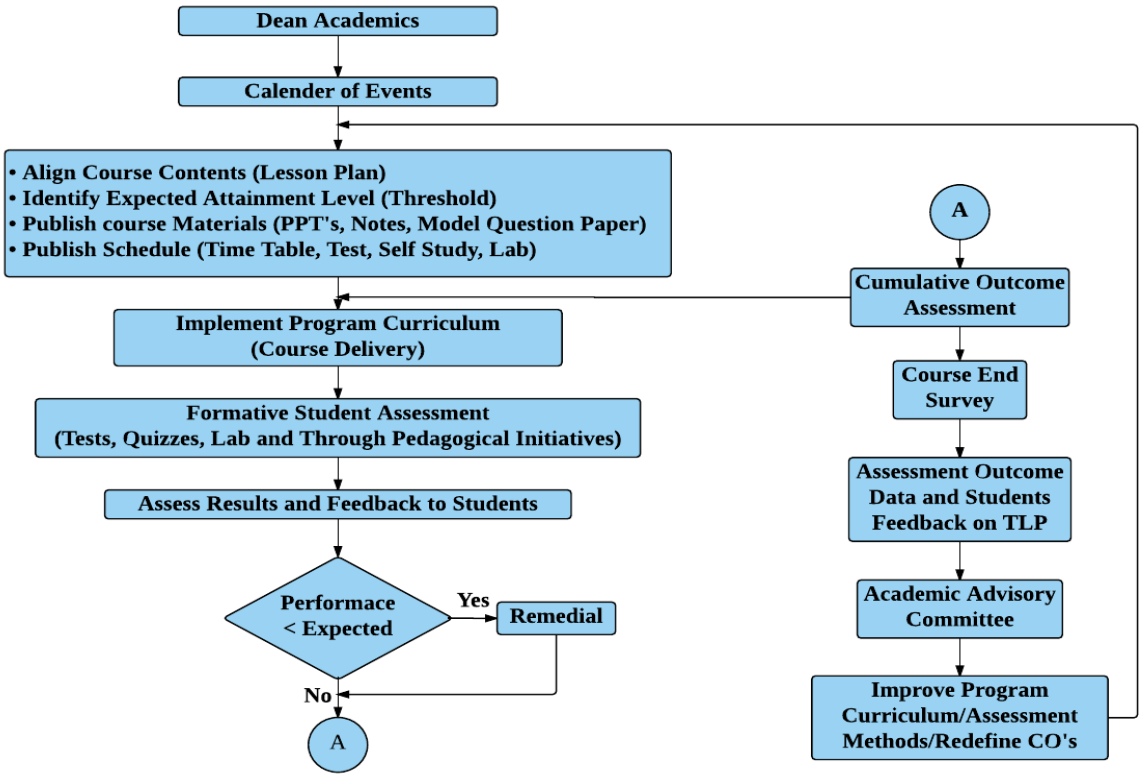
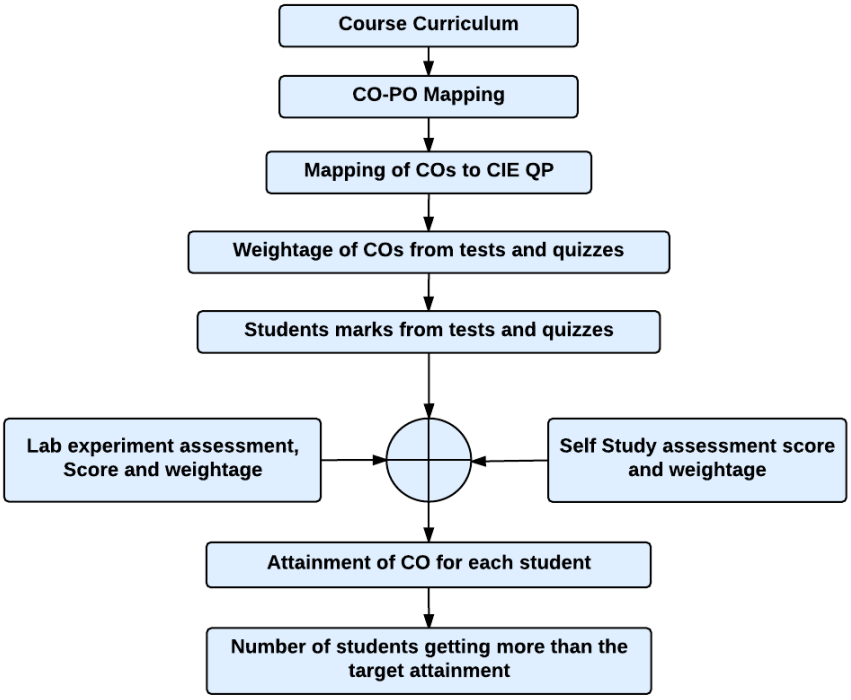
Curriculum Design Process



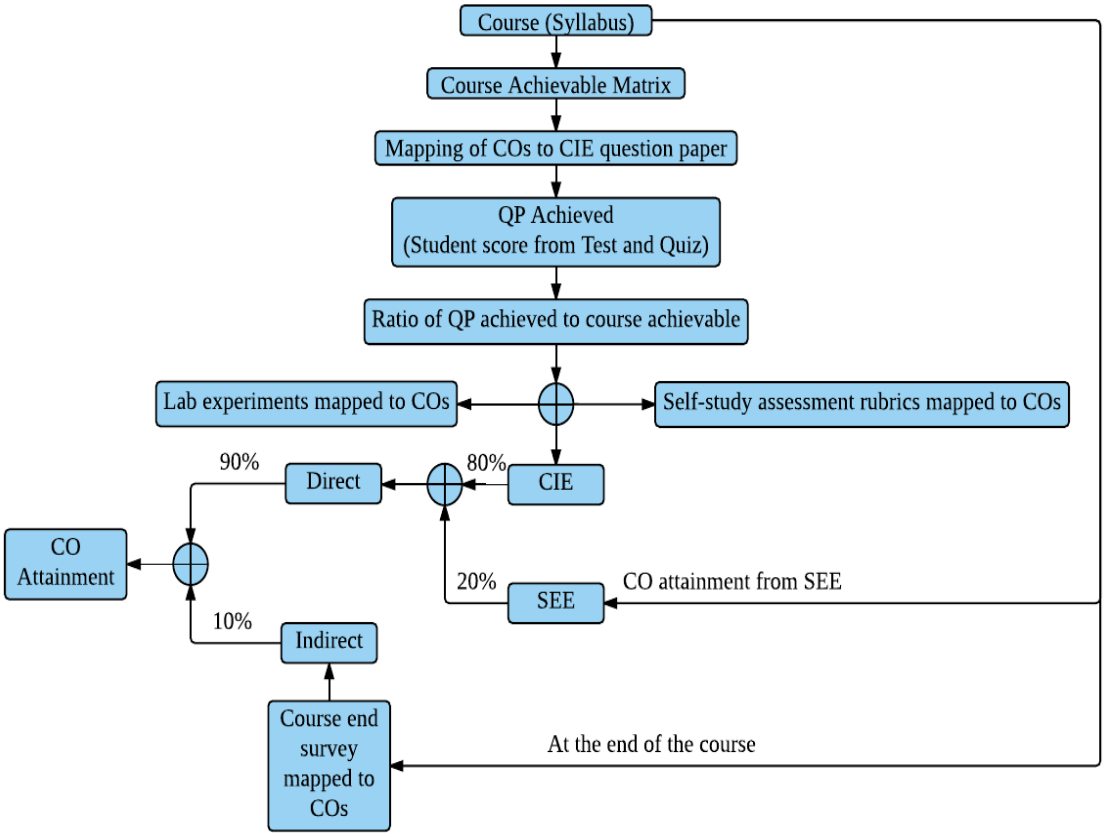
Academic Planning And Implementation



Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process