RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Scheme and Syllabus of III & IV Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

COMPUTER INTEGRATED MANUFACTURING

DEPARTMENT OF

MECHANICAL ENGINEERING

INNER FRONT COVER PAGE

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

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DEPARTMENT OF MECHANICAL ENGINEERING
M. Tech in COMPUTER INTEGRATED MANUFACTURING

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MCM31	Digital Manufacturing	ME	4	1	0	**4**
2	18XXX1EX	Elective E	ME	4	0	0	**4**
3	18MCM32	Internship	ME	0	0	5	**5**
4	18MCM33	Dissertation Phase I	ME	0	0	5	**5**
				8	**01**	**10**	**18**

III Semester		
GROUP E: CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MCM3E1	Additive Manufacturing
2.	18MPD3E2	Surface Engineering
3.	18MCM3E3	Advanced Manufacturing Practices

FOURTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MCM41	Dissertation Phase II	ME	0	0	20	20
2	18MCM42	Technical Seminar	ME	0	0	2	2
				0	**0**	**22**	**22**

Semester III						
DIGITAL MANUFACTURING						
Course Code	**:**	**18MCM31**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:1:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**48**		**SEE Duration**	**:**	**3 Hrs.**

Unit-I	**09 Hrs**
Introduction: Development of Manufacturing Engineering, Status of Digital Manufacturing, Research Methods, Architecture, Organization Model and Function Model of Digital Manufacturing System, Industrial Internet, Case studies **Design for Additive Manufacturing:** Design for Manufacturing and Assembly, Core DFAM Concepts and Objectives, CAD Tools for AM, Synthesis Methods	
Unit-II	**10 Hrs**
Computing Manufacturing: Virtual Prototyping, Reverse Engineering, Application of Reverse Engineering, Discrete Model of Manufacturing Computing, Information Model of Manufacturing computing, Geometric Modeling in Manufacturing Computing, Computational Geometry **Manufacturing Informatics:** Information Characteristics, Activities and Manufacturing Informatics, Integration, Sharing and Security of Manufacturing Information. Integration Model, Principle and Mechanism of Sharing Manufacturing Resources.	
Unit -III	**09 Hrs**
Intelligent Manufacturing System: The Application of Sensor in the Processing Data Mining, Data Mining Applied to Digital Manufacturing, Knowledge Reasoning in Engineering Design, Intelligent Knowledge-Based Manufacturing System, Self-Learning of Manufacturing System, Adaptation of Manufacturing System, The Concepts and Features of Intelligent Manufacturing, Multi-Agent Manufacturing System. **Future Development of Digital Manufacturing Science:** The Precision of Digital Manufacturing, The Extremalization of Digital Manufacturing, The Environmental Protection of Digital Manufacturing.	
Unit -IV	**10 Hrs**
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture. **Cloud and Fog:** M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	
Unit -V	**10 Hrs**
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance, Assembly, Collaborative Operations , Training. **Smart Factories**: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	

Course outcomes: After completing the course, the students will be able to	
CO1:	Explain the working process and technology development in Digital Manufacturing
CO2:	Apply the principles of DM in the manufacturing industry
CO3:	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4:	Evaluate the effectiveness of Cloud Computing in a networked economy.

Reference Books:	
1	Zude Zhou, Shane (Shengquan) Xie, Dejun Chen "Fundamentals of Digital Manufacturing Science" 2012.Springer ISBN 978-0-85729-564-4,
2	Lihni Wang, Andrew Y.C. Nee "Collabarative design and planning for digital manufacturing" Springer Series,

	2009, ISBN 998-1-84882-286-3
3	Alasdair Gilchrist "Industry 4.0 The Industrial Internet of Things" A press Publisher, ISBN-13 (pbk): 978-1-4842-2046-7.
4	Alp Ustundag • Emre Cevikcan "Industry 4.0: Managing The Digital Transformation", Springer, 2018 ISBN 978-3-319-57869-9

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						
ADDITIVE MANUFACTURING						
Course Code	**:**	**18MCM3E1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48**		**SEE Duration**	**:**	**3 hrs**

Unit – I	**10 Hrs**
Development of Additive Manufacturing Technology: Computer-Aided Design Technology, Associated Technologies, Classification of AM Processes, Metal Systems, Metal Systems, Hybrid Systems, Steps in Additive Manufacture, Maintenance of Equipment, Materials Handling Issues **Design for AM:** Application Areas, Vat Photopolymerization Processes, Materials, Reaction Rates, Process Modeling, Vector Scan VP Machines, Two-Photon Vat Photopolymerization, Process Benefits and Drawbacks	
Unit – II	**10 Hrs**
Powder Bed Fusion Processes: Introduction, Materials, Powder Fusion Mechanisms, Process Parameters and Modeling, Powder Handling, Laser, UV and IR; Process Benefits and Drawbacks. **Extrusion-Based Systems**: Introduction, Basic Principles, Plotting and Path Control, Fused Deposition Modeling, Stereo lithography: Materials, Processes parameters, advantages and limitations.	
Unit – III	**10 Hrs**
Material and Binder Jetting: Evolution, Materials, Material Processing Fundamentals, Material Jetting Machines, Process Benefits and drawbacks, binding materials and systems. **Sheet Lamination Processes:** Introduction, Materials, Processes, Ultrasonic AM**,** Directed Energy Deposition Processes, Material Delivery, DED Systems, Process Parameters	
Unit – IV	**10 Hrs**
Design for Additive Manufacturing: Design for Manufacturing and Assembly, AM Unique Capabilities, Core DFAM Concepts and Objectives, CAD Tools for AM. **Applications for Additive Manufacture:** Introduction, The Use of AM to Support Medical Applications, Aerospace and Automotive Applications.	
Unit –V	**08 Hrs**
Rapid Tooling: Introduction, Direct and Indirect AM tooling process; Production of Injection Molding Inserts, EDM Electrodes, Investment Casting and Other Systems, RTV Silicone Tooling, Calcium silicate based castable tooling. **Direct Digital Manufacturing:** Align Technology, Siemens and Phonak, Custom Footwear and Other DDM Examples, DDM Drivers, Manufacturing Versus Prototyping, Cost Estimation, Cost Model, Build Time Model, Laser Scanning Vat Photopolymerization, , Life-Cycle Costing, Future of DDM	

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain the working process and technology development of Additive Manufacturing.
CO2	Apply the principles of AM in manufacturing industry
CO3	Analyze the concepts of AM in Production Process
CO4	Evaluating the techniques involved in AM

Reference Books:	
1	Ian Gibson, David Rosen, Brent Stucker, "Additive Manufacturing Technologies"- Springer, 2ndEdition. ISBN 978-1-4939-2112-6
2	Chee Kai Chua, Kah Fai Leong, "3D Printing and Additive Manufacturing, Principles and Applications", 4th Ed, ISBN 978-9-8145-7140-1
3	Amit Bandyopadhyay, Susmita Bose " Additive Manufacturing", CRC Press 2015 ISBN 9781482223590

4	Lihni Wang, Andrew Y.C. Nee "Collabarative design and planning for digital manufacturing" Springer Series, 2009, ISBN 998-1-84882-286-3

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

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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	**09 Hrs**
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, int	
Unit – II	**09 Hrs**
Surface Engineering of ferrous and nonferrous 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	
Unit – III	**10 Hrs**
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.	
Unit – IV	**10 Hrs**
Sputter technique – Methods, applications, plasma treatments, nitriding, carbonizing, boriding, titanising methods, applications **Laser coatings** : Laser alloying, sources, variables, methods, applications, specific industrial applications	
Unit –V	**10 Hrs**
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.	

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	Analyse tests for assessment of wear and corrosion behavior.

Reference Books	
1.	Sudarshan T S, 'Surface modification technologies - An Engineer's guide', Marcel Dekker, Newyork, *ISBN* 10: 0824780094, 1989
2.	Varghese C.D, 'Electroplating and Other Surface Treatments - A Practical Guide', TMH, 0074604643 9780074604649, 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, *ISBN* 13: 9780138780593 (1990).

4.	Mathews, A., Advanced Surface Coatings: A Hand book of Surface Engineering, Spinger, *ISBN* 095328–7203 (1991).

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

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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						
ADVANCED MANUFACTURING PRACTICES (Offered by BoS: PG CIM)						
Course Code	**:**	**18 MCM 3E3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit –I	**10 Hrs**
Just in Time Production – Primary purpose, profit through cost reduction, elimination of over production, quality control, quality assurance, respect for humanity, flexible work force, JIT production adapting to changing production quantities, process layout for shortened lead Times, standardization of operation, automation. **Sequence and Scheduling Used by Suppliers:** Monthly and daily Information. sequenced withdrawal system by sequenced schedule table, problems and counter measures in applying the Kanban system to sub-contractors.	
Unit -II	**10 Hrs**
Toyota Production System-The philosophy of TPS, basic frame work of TPS, Kanbans. Determining the number of Kanbans in Toyota Production System, Kanban number under constant quantity withdrawal system, constant cycle, non-constant quantity withdrawal system. **Kanban Systems-** Supplier Kanban and the sequence schedule for use by suppliers - Later replenishment system by Kanban, Sequenced Withdrawal System and Circulation of the Supplier Kanban within Toyota. production smoothing in TPS, production planning, production smoothing, adaptability to demand fluctuations, sequencing method for the mixed model assembly line to realize smoothed production of goal.	
Unit -III	**08 Hrs**
Just-in-Time Production with Total Quality Control just in time concept, cutting lot sizes, cutting set-up times, cutting purchase order costs, the JIT cause-Effect chain, **Quality Improvements:** scrap/quality improvements, motivational effects, responsibility effects, small group improvement activities, withdrawal of buffer inventory, the total quality control concept.	
Unit -IV	**10 Hrs**
Total Quality Control-Introduction-Total Quality Control concepts, responsibility, learning from the west, TQC concepts categorized, goals, habit of improvement, perfection, basics, process control, easy to see quality control as facilitator, small lot sizes, housekeeping, **Scheduling**: Capacity scheduling, daily machine checking, techniques and Aids, exposure of problems, fool proof devices, tools of analysis, QC circles, TQC in Japanese-owned US electronics plant, TQC in Japanese-owned automotive plants.	
Unit -V	**10 Hrs**
Plant Configurations: Introduction-ultimate plant configuration, job shop fabrication, frame welding, forming frame parts from tubing, dedicated production lines, overlapped production, the daily schedule, forward linkage, physical merger of processes, adjacency, **Material Handling Systems**: mixed models, automated production lines, pseudo robots, robots, CAD and manufacturing, conveyors and stacker cranes, automatic quality monitoring	

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain the role of JIT, TPS and TQC strategies in production system
CO2	Analyze the various concepts of modern manufacturing practices
CO3	Apply the concepts of JIT and TPS in real time applications
CO4	Evaluate the various process requirement to decide the plant configuration

Reference Books:	
1	Richard Schonberger, Japanese Manufacturing Techniques, Pearson Higher Education - ISBN:0029291003, 1982
2	Yasuhiro Monden, An Integrated Approach To Just In Time, Toyota Production system, CRC Press, 4th Edition, ISBN: 9781439820971, 2011
3	James Womack, Simon & Schuster, Adult Lean Thinking, ISBN: 0743249275, 2003.
4	James P. Womack, Daniel T Jones, and Daniel Roos, The machine that changed the World - The story of Lean production, Harper Perennial edition published, ISBN-13: 978-0-7432-9979-4, 1991.

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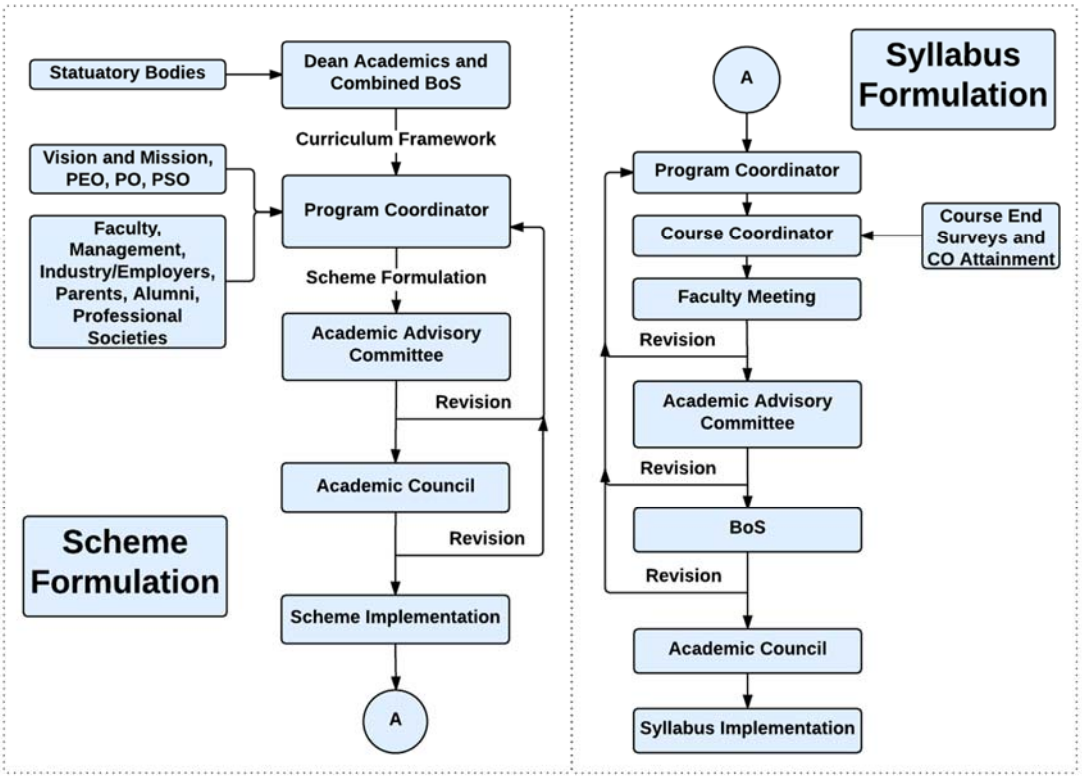
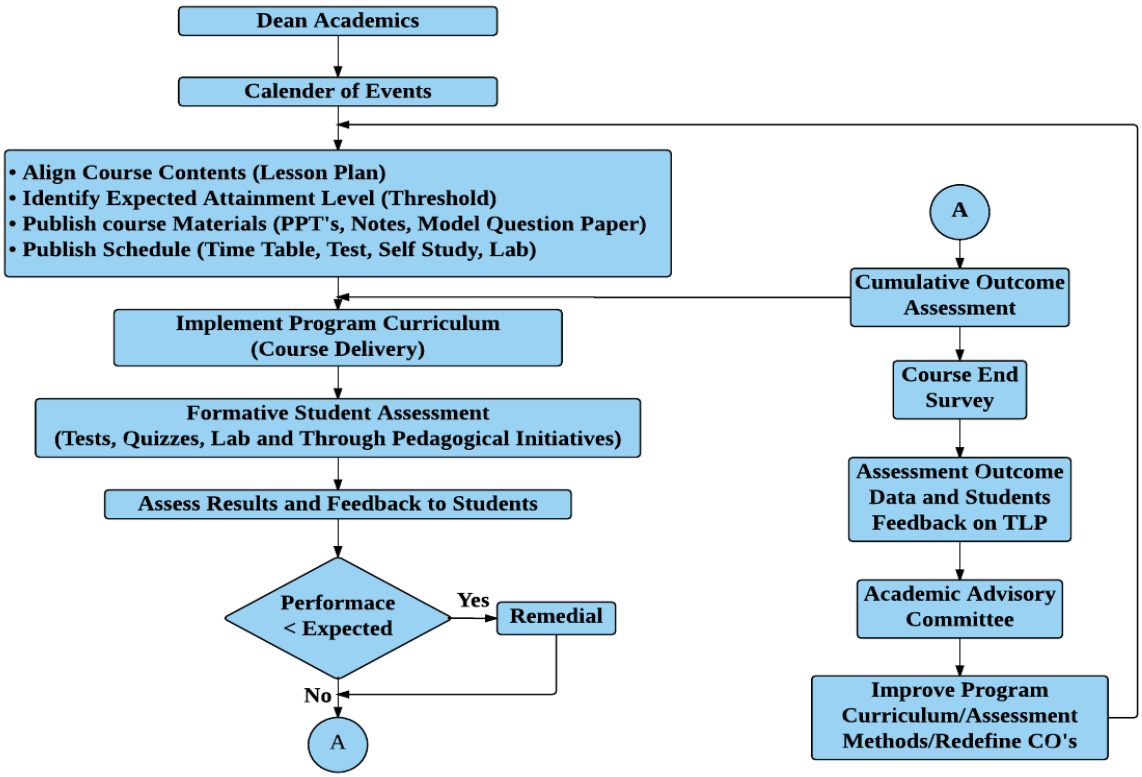
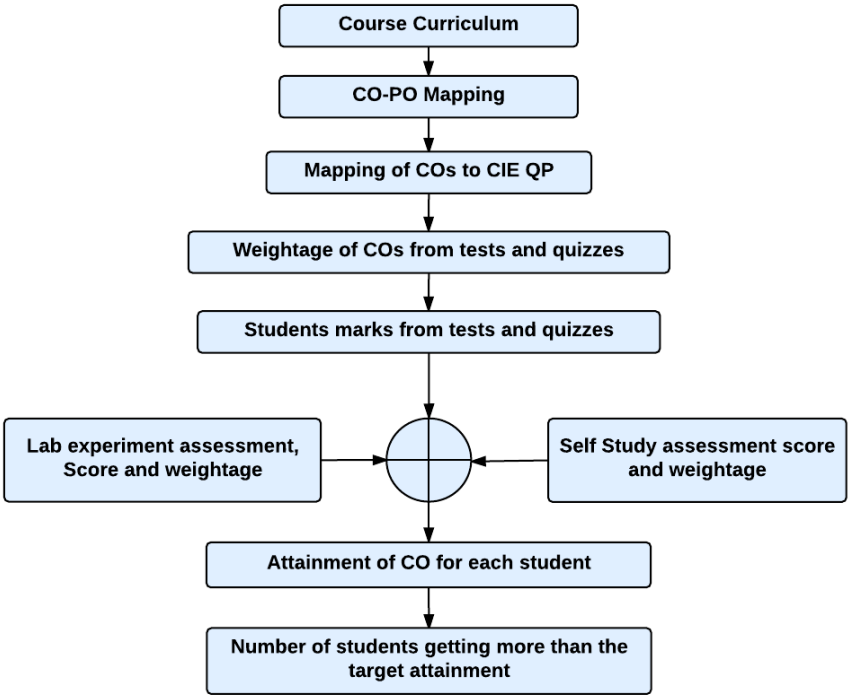
Curriculum Design Process



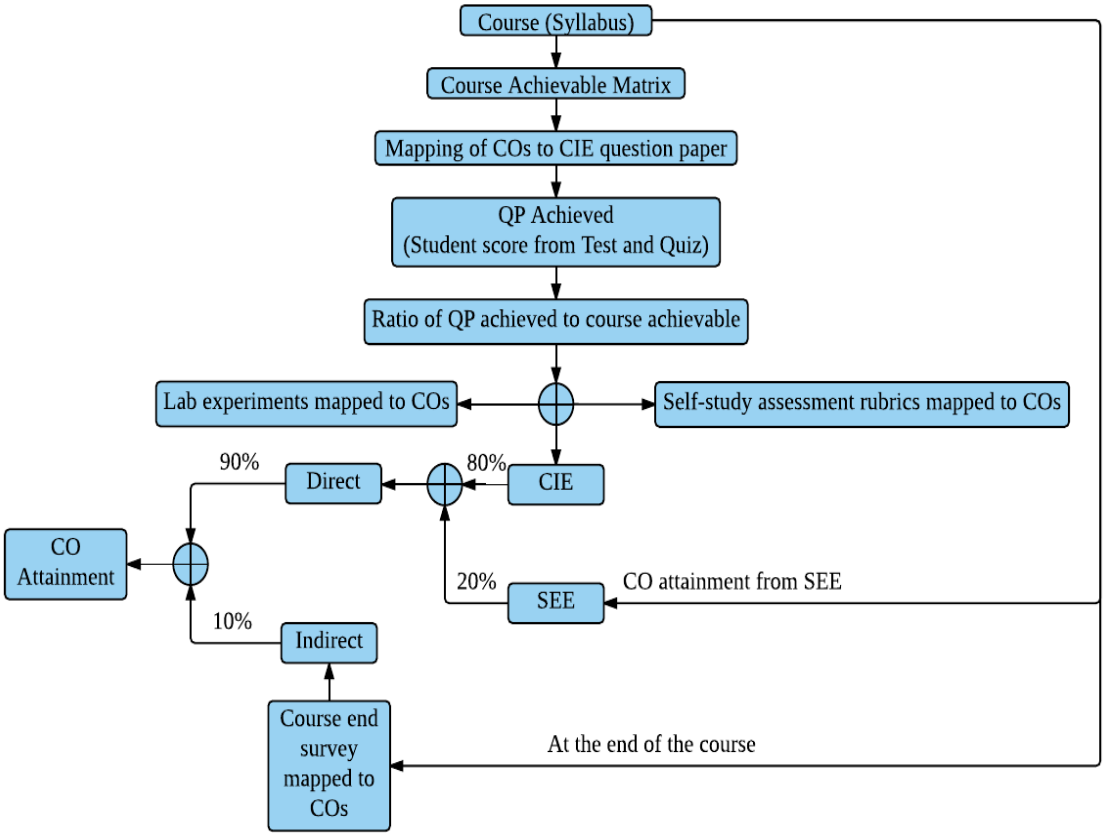
Academic Planning And Implementation



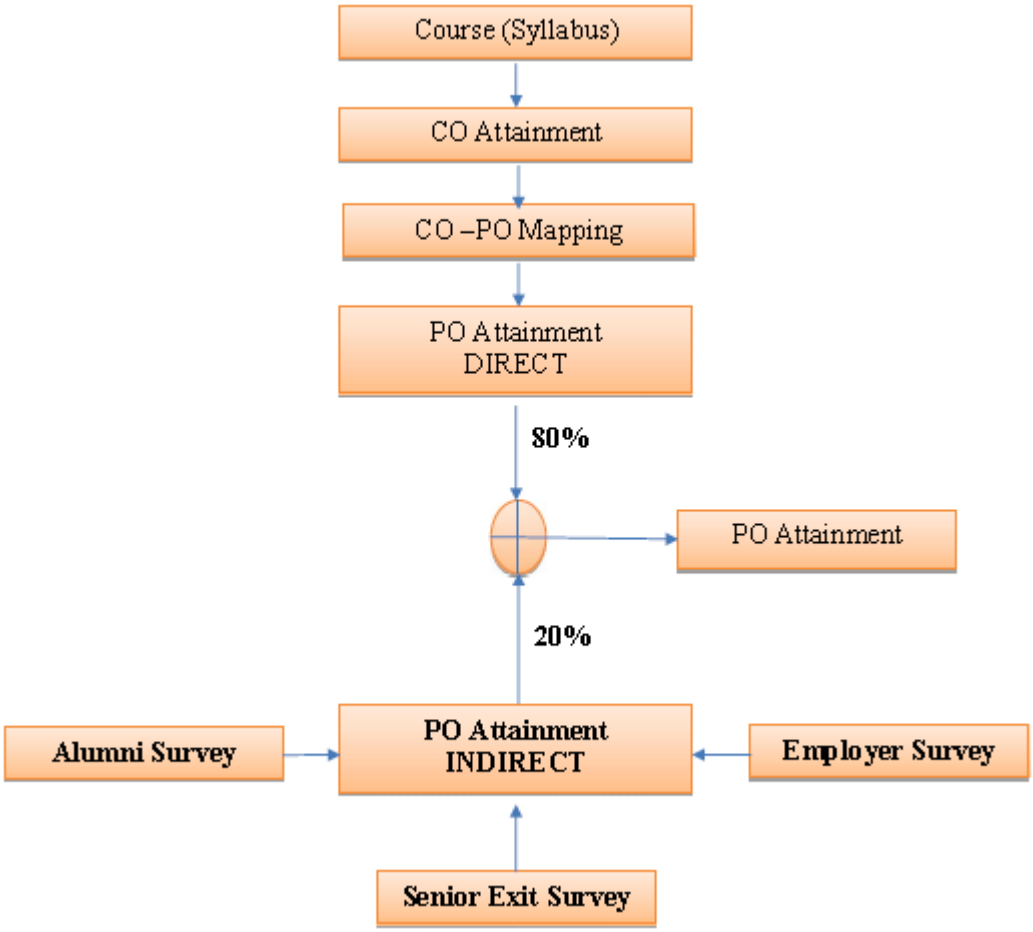
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



PROGRAM OUTCOMES (PO)

M. Tech. in Computer Integrated Manufacturing graduates will be able to:

PO1: An ability to independently carry out a research / investigation and development work to solve practical problems related to Computer Integrated Manufacturing

PO2: An ability to write and present a substantial technical report / document

PO3: An ability to demonstrate a degree of mastery over the areas of Computer Integrated Manufacturing. The mastery should be at a level higher than the requirements in the BE Mechanical Engineering and allied programs

PO4: An ability to use latest technology for the design and analysis of CNC based manufacturing and automation systems

PO5: An ability to adapt technical, safety, ethical and environmental factors in the design of Intelligence systems

PO6: An ability to perform interdisciplinary teams with social and management skills with a commitment to lifelong learning